

NFPA 30

Flammable and Combustible Liquids Code

2003 Edition



NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

NFPA License Agreement

This document is copyrighted by the National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101 USA.
All rights reserved.

NFPA grants you a license as follows: The right to download an electronic file of this NFPA document for temporary storage on one computer for purposes of viewing and/or printing one copy of the NFPA document for individual use. Neither the electronic file nor the hard copy print may be reproduced in any way. In addition, the electronic file may not be distributed elsewhere over computer networks or otherwise. The hard copy print may only be used personally or distributed to other employees for their internal use within your organization.

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA DOCUMENTS

NOTICE AND DISCLAIMER OF LIABILITY CONCERNING THE USE OF NFPA DOCUMENTS

NFPA codes, standards, recommended practices, and guides, of which the document contained herein is one, 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 this document. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this document 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 this document 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 this document. Nor does the NFPA list, certify, test or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document 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

This document is copyrighted by the NFPA. It is 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 this document available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to this document.

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, P.O. Box 9101, Quincy, MA 02269-9101.

For more information about NFPA, visit the NFPA website at www.nfpa.org.

Copyright © 2003, National Fire Protection Association, All Rights Reserved

NFPA 30

Flammable and Combustible Liquids Code

2003 Edition

This edition of NFPA 30, *Flammable and Combustible Liquids Code*, was prepared by the Technical Committees involved with the Flammable and Combustible Liquids project, released by the Technical Correlating Committee on Flammable and Combustible Liquids, and acted on by NFPA at its May Association Technical Meeting held May 18–21, 2003, in Dallas, TX. It was issued by the Standards Council on July 18, 2003, with an effective date of August 7, 2003, and supersedes all previous editions.

This edition of NFPA 30 was approved as an American National Standard on July 18, 2003.

Origin and Development of NFPA 30

From 1913 to 1957, this document was written as a model municipal ordinance known as the *Suggested Ordinance for the Storage, Handling, and Use of Flammable Liquids*. In 1957, the format was changed to a code, although the technical requirements and provisions remained the same. During the 90-year period of existence of NFPA 30, numerous revised editions have been published as dictated by experience and advances in technology.

A brief review of the major changes adopted over the previous six editions follows. In 1984, the chapter covering automotive and marine service stations was removed from NFPA 30 and was used as the basis for a separate document, NFPA 30A, *Automotive and Marine Service Station Code*, now titled *Code for Motor Fuel Dispensing Facilities and Repair Garages*. In 1987, Chapter 5 (Industrial Plants), Chapter 6 (Bulk Plants and Terminals), Chapter 7 (Process Plants), and Chapter 8 (Refineries, Chemical Plants, and Distilleries) were combined into a single chapter on operations. In 1990, a new section was added to Chapter 4 to address hazardous materials storage lockers, and more detailed guidance was added to Section 5-3 to address ventilation of enclosed process areas and for estimation of fugitive emissions. In 1993, Chapter 4, Container and Portable Tank Storage, was completely rewritten so that its requirements were presented more clearly, especially for mercantile occupancies. In addition, changes were made to the tank diking provisions to allow combined remote impounding and diking systems and to provide relief from the spill control requirements for certain secondary containment-type tanks.

In 1996, the following major changes were incorporated: requirements for temporary and permanent closure of underground storage tanks; requirements for tightness testing of tanks of specific design; recognition of intermediate bulk containers; mandatory fire protection design criteria for inside storage of liquids.

In 2000, the following major changes were incorporated: complete editorial rewrites of Chapter 2, Tank Storage, and Chapter 3, Piping Systems; requirements for vaults for above-ground tanks and for protected aboveground tanks; recognition of specific nonmetallic intermediate bulk containers for Class II and Class III liquids, along with fire protection system design criteria; simplified spill containment and drainage requirements; new fire protection design criteria for a number of flammable and combustible liquid commodities; expansion of the requirements in Subsection 5.3.3.1 for construction and separation of process buildings; new Section 5.4 was added to address recirculating heat transfer fluid heating systems; new Section 5.11 was added to address solvent recovery distillation units; consolidation into a new Chapter 6 of all requirements for hazardous location electrical area classification.

This 2003 edition of NFPA 30 incorporates the following changes:

- (1) All mandatory referenced publications have been consolidated into a new Chapter 2 and all definitions into a new Chapter 3. All subsequent chapters have been renumbered accordingly.
- (2) Numerous occupancy definitions have either been added or corrected to correlate with NFPA 1, *Uniform Fire Code*TM; NFPA 101[®], *Life Safety Code*[®]; and NFPA 5000TM, *Building Construction and Safety Code*TM.
- (3) Separation distance requirements have been reduced in Table 4.3.2.1.1 (a) for protected aboveground tanks, and separation distance requirements for tanks in vaults constructed in accordance with 4.2.7 have been eliminated.
- (4) Special operating requirements have been added in 4.6.1.5 for shop-fabricated aboveground tanks with abnormally long vertical piping for fill and/or vent lines.
- (5) New criteria have been added for maximum allowable container sizes in Table 6.2.3 and in appropriate paragraphs of Chapter 6.
- (6) A new Table 6.8.2(k) contains fire protection design criteria for unsaturated polyester resins, including appropriate amendments to Figure 6.8.2(a) and Figure 6.8.5.
- (7) A new Annex D.5 contains suggested fire protection design criteria using high-expansion foam systems for protection of liquids in 1-gallon plastic containers.
- (8) Revisions have been made to the Section 7.3 spacing requirements and construction requirements for process buildings.
- (9) Special requirements have been added in Section 7.4 for insulated piping for recirculating heat transfer systems.
- (10) A new 7.13.3.2 provides guidance prohibiting permanent interconnections between fire water systems and process water systems.

Technical Correlating Committee on Flammable and Combustible Liquids

Edward Hildebrandt, *Chair*
Village of Morton Grove, IL [E]

John A. Davenport, West Point, VA [I]
James D. Kieffer, Kieffer & Associates, Inc., Canada [SE]
Richard S. Kraus, Petroleum Safety Consultants, VA [M]
Rep. American Petroleum Institute
William E. Rehr, BOCA International, Inc., IL [E]

Douglas A. Rivers, 3M Company, MN [U]
Orville M. Slye, Jr., Loss Control Associates Inc., PA [SE]
Hugh Patrick Toner, Society of the Plastics Industry, Inc., DC [M]

Alternate

Clark D. Shepard, ExxonMobil Corporation, VA [M]
(Alt. to R. S. Kraus)

Nonvoting

David L. Blomquist, Blomquist Fire Protection Engineering, CA
(Member Emeritus)
Gary R. Glowinski, Glowinski & Associates, Inc., WI [SE]
Donald M. Johnson, Walnut Creek, CA
(Member Emeritus)

Anthony M. Ordile, Loss Control Associates, Inc., PA
Brooke B. Smith, Jr., Aspen Engineering Inc., CO
Jack Woycheese, Hughes Associates, Inc., CA

Robert P. Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding against the fire and explosion hazards associated with the storage, handling, and use of flammable and combustible liquids; and classifying flammable and combustible liquids.

Technical Committee on Fundamentals (FLC-FUN)

Gary R. Glowinski, *Chair*
Glowinski & Associates, Inc., WI [SE]

Robert P. Benedetti, *Nonvoting Secretary*
NFPA, MA

Gerald A. Gordon, Greif Brothers Corporation, IL [M]
Dwight H. Havens, City of Phoenix Fire Department, AZ [E]
Jay J. Jablonski, HSB Professional Loss Control, TX [I]
James D. Kieffer, Kieffer & Associates, Inc., Canada [SE]

Richard S. Kraus, Petroleum Safety Consultants, VA [M]
Jack Woycheese, Hughes Associates, Inc., CA [SE]
Cherilyn A. Zeisset, Pennzoil-Quaker State Company, TX [M]

Alternates

Peter R. Apostoluk, Greif Brothers Corporation, IL [M]
(Alt. to G. Gordon)
Joseph L. Scheffey, Hughes Associates, Inc. MD [SE]
(Alt. to J. Woycheese)

Kenneth H. Turnbull, Texaco, TX [M]
(Alt. to R. S. Kraus)

Robert P. Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents on the basic requirements for safeguarding against the fire and explosion hazards associated with the storage and handling of flammable and combustible liquids. This Committee shall also have responsibility for definitions related to flammable and combustible liquids and for criteria for the classification of flammable and combustible liquids.

Technical Committee on Operations (FLC-OPS)

Jack Woycheese, Chair
Hughes Associates, Inc., CA [SE]

Brian J. Clark, Liberty Mutual Group, CT [I]
Rep. Alliance of American Insurers
Gary R. Glowinski, Glowinski & Associates, Inc., WI [SE]
John P. Hartmann, John Hartmann & Associates, IL [SE]
Dwight H. Havens, City of Phoenix Fire Department, AZ [E]
Richard J. Hild, DuPont Performance Coatings, DE [M]
Edward Hildebrandt, Village of Morton Grove, IL [E]
Richard B. Hopkinson, Kemper Insurance Companies, MA [I]
Jay J. Jablonski, HSB Professional Loss Control, TX [I]
Joshy Paul Kallungal, Office of the Fire Marshal, Canada [E]
James D. Kieffer, Kieffer & Associates, Inc., Canada [SE]
Gregory D. Kirby, CYTEC Industries, Incorporated, WV [U]
Rep. American Chemistry Council
David C. Kirby, Baker Engineering & Risk Consulting, WV [SR]
Donald J. Kohn, Kohn Engineering, PA [SE]

Richard S. Kraus, Petroleum Safety Consultants, VA [M]
Rep. American Petroleum Institute
Larry M. Kreh, PPG Industries, Inc., PA [M]
John A. LeBlanc, FM Global, MA [I]
Robert E. McClay, East Carolina University, NC [SE]
Rep. American Society of Safety Engineers
Thaddeus A. Nosal, American Insurance Services Group, NY [I]
Anthony M. Ordile, Loss Control Associates, Inc., PA [SE]
Arlyn H. Poppen, 3M Company-Industrial Markets, MN [U]
Susan M. Preske, St. Paul Insurance Companies, NY [I]
Robert N. Renkes, Petroleum Equipment Institute, OK [M]
George A. Seuss, Jr., Verlan Fire Insurance Company, MD [I]
Clark D. Shepard, ExxonMobil Corporation, VA [M]
Brooke B. Smith, Jr., Aspen Engineering Inc., CO [SE]
Scott M. Tyler, Duke Engineering and Services, IL [U]
Rep. Edison Electric Institute

Alternates

John A. Davenport, West Point, VA [I]
(Voting Alt. to GEGAPS Rep.)
Claire V. De Taeye, LMG Property Engineering, NY [I]
(Alt. to B. J. Clark)
David W. Owen, ExxonMobil Corporation, VA [M]
(Alt. to C. D. Shepard)
Douglas A. Rivers, 3M Company, MN [U]
(Alt. to A. H. Poppen)

Joseph L. Scheffey, Hughes Associates, Inc., MD [SE]
(Alt. to J. Woycheese)
Orville M. Slye, Jr., Loss Control Associates Inc., PA [SE]
(Alt. to A. M. Ordile)
Kevin F. Sykora, The Sherwin-Williams Company, OH [SE]
(Alt. to R. E. McClay)

Nonvoting

Michael B. Moore, U.S. Occupational Safety & Health Administration, DC

Terence P. Smith, U.S. Department of Labor, DC
(Nonvoting Alt. to M. B. Moore)

Robert P. Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents on safeguarding against the fire and explosion hazards associated with operations that involve the handling, transfer, and use of flammable and combustible liquids, either as a principal activity or as an incidental activity.

Technical Committee on Storage and Warehousing of Containers and Portable Tanks (FLC-SWC)

Anthony M. Ordile, *Chair*
Loss Control Associates, Inc., PA [SE]

John A. Davenport, West Point, VA [I]
Rep. GE Global Asset Protection Services
John J. Foley, The RJA Group, Inc., GA [SE]
Gary R. Glowinski, Glowinski & Associates, Inc., WI [SE]
Gerald A. Gordon, Greif Brothers Corporation, IL [M]
Dwight H. Havens, City of Phoenix Fire Department, AZ [E]
Richard J. Hild, DuPont Performance Coatings, DE [M]
Rep. National Paint & Coatings Association
Edward Hildebrandt, Village of Morton Grove, IL [E]
Joshy Paul Kallungal, Office of the Fire Marshal, Canada [E]
James D. Kieffer, Kieffer & Associates, Inc., Canada [SE]
Gregory D. Kirby, CYTEC Industries, Incorporated, WV [U]
Rep. American Chemistry Council
David C. Kirby, Baker Engineering & Risk Consultants, WV [SE]
Richard S. Kraus, Petroleum Safety Consultants, VA [M]
Rep. American Petroleum Institute
John A. LeBlanc, FM Global, MA [I]

Jerry Massa, CP Louisiana, Incorporated, LA [M]
Rep. Steel Shipping Container Institute
Roger McKim, LMG Property Engineering, OR [I]
Rep. Alliance of American Insurers
Navin D. Mehta, U.S. Department of Defense-Defense Logistic Agency, VA [U]
Martin J. Pabich, Underwriters Laboratories Inc., IL [RT]
Lee Rindfuss, Marsh Risk Consulting, MA [I]
Douglas A. Rivers, 3M Company, MN [U]
Joseph L. Scheffey, Hughes Associates, Inc., MD [SE]
Michael Spence, Brown Sprinkler Corporation, KY [IM]
Rep. National Fire Sprinkler Association
Arthur M. Stevens, Stevens Associates, FL [M]
Rep. Safe-T-Way Manufacturing, Inc.
David C. Tabar, The Sherwin-Williams Company, OH [M]
William J. Tomes, TVA Fire and Life Safety, GA [U]
Rep. The Home Depot
Hugh Patrick Toner, Society of the Plastics Industry, Inc., DC [M]
Martin H. Workman, The Viking Corporation, MI [M]
Rep. American Fire Sprinkler Association, Inc.

Alternates

Peter R. Apostoluk, Greif Brothers Corporation, IL [M]
(Alt. to G. A. Gordon)
Tracey D. Bellamy, TVA Fire and Life Safety, GA [U]
(Alt. to W. J. Tomes)
Robert H. Christopher, R-C Associates, DE [M]
(Alt. to R. J. Hild)
Brian J. Clark, Liberty Mutual Group, CT [I]
(Alt. to R. McKim)
Dennis R. Freezer, Steel Shipping Container Institute, DC [M]
(Alt. to J. Massa)
Pravinray D. Gandhi, Underwriters Laboratories Inc., IL [RT]
(Alt. to M. J. Pabich)
Douglas L. Jeffries, Chevron Research & Technology Company, CA [M]
(Alt. to R. S. Kraus)

Craig A. Martens, Lake Havasu City Fire Department, AZ [E]
(Alt. to D. H. Havens)
Arlyn H. Poppen, 3M Company-Industrial Markets, MN [U]
(Alt. to D. A. Rivers)
Orville M. Slye, Jr., Loss Control Associates Inc., PA [SE]
(Alt. to A. M. Ordile)
Ronald J. Stephens, Allan Automatic Sprinkler Corporation of Southern California, CA [IM]
(Alt. to M. Spence)
David C. Swenson, The Sherwin-Williams Company, OH [M]
(Alt. to D. C. Tabar)
Daniel J. Venier, Marsh USA Inc., MI [I]
(Alt. to L. Rindfuss)
Jack Woycheese, Hughes Associates, Inc., CA [SE]
(Alt. to J. L. Scheffey)

Robert P. Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents on safeguarding against the fire and explosion hazards associated with the storage, warehousing, and display merchandising of flammable and combustible liquids in containers and in portable tanks whose capacity does not exceed 2500 liters (660 gallons).

Technical Committee on Tank Storage and Piping Systems (FLC-TAN)

Brooke B. Smith, Jr., *Chair*
Aspen Engineering Inc., CO [SE]

Gary T. Austerman, Burns & McDonnell Engineering Co., MO [SE]
Jon V. Brannan, Underwriters Laboratories Inc., IL [RT]
Sullivan D. Curran, Fiberglass Tank & Pipe Institute, TX [M]
Charles A. Davis, URS Corporation, FL [SE]
Wayne Geyer, Steel Tank Institute, IL [M]
Robert D. Grausam, PARTNER RE US, CT [I]
John P. Hartmann, John Hartmann & Associates, IL [SE]
Dwight H. Havens, City of Phoenix Fire Department, AZ [E]
Douglas L. Jeffries, Chevron Research & Technology Company, CA [U]
Rep. American Petroleum Institute
Joshy Paul Kallungal, Office of the Fire Marshal, Canada [E]
James D. Kieffer, Kieffer & Associates, Inc., Canada [SE]
Gregory D. Kirby, CYTEC Industries, Incorporated, WV [U]
Rep. American Chemistry Council

David C. Kirby, Baker Engineering & Risk Consultants, WV [SE]
Michael D. Lattner, Morrison Brothers Company, IA [M]
Armin E. Mittermaier, Data Action, IN [U]
Rep. Petroleum Marketers Association of America
Susan M. Preske, St. Paul Insurance Companies, NY [I]
Robert N. Renkes, Petroleum Equipment Institute, OK [M]
David P. Saporito, Kemper Insurance Companies, AZ [I]
Clark D. Shepard, ExxonMobil Corporation, VA [U]
Orville M. Slye, Jr., Loss Control Associates Inc., PA [SE]
Brian P. Stuber, Oldcastle Precast/Utility Vault, AZ [M]
Jack Woycheese, Hughes Associates, Inc., CA [SE]
Andrea R. Zajac, Michigan Department of Environmental Quality, MI [E]
Cherilyn A. Zeisset, Pennzoil-Quaker State Company, TX [U]

Alternates

John A. Davenport, West Point, VA [I]
(Voting Alt. to GEGAPS Rep.)
Rodney Hoke, URS Corporation, FL [SE]
(Alt. to C. A. Davis)
Shari L. Hunter, Underwriters Laboratories Inc., CA [RT]
(Alt. to J. V. Brannan)
Makhoul (Mike) T. Kadri, Michigan Department of Environmental Quality, MI [E]
(Alt. to A. R. Zajac)
Richard S. Kraus, Petroleum Safety Consultants, VA [U]
(Alt. to D. L. Jeffries)

Patrick A. McLaughlin, McLaughlin & Associates, RI [M]
(Alt. to S. D. Curran)
Anthony M. Ordile, Loss Control Associates, Inc., PA [SE]
(Alt. to O. M. Slye, Jr.)
David W. Owen, ExxonMobil Corporation, VA [U]
(Alt. to C. D. Shepard)
Jeffrey M. Shapiro, International Code Consultants, TX [M]
(Alt. to B. P. Stuber)

Nonvoting

David L. Blomquist, Blomquist Fire Protection Engineering, CA
(Member Emeritus)

Donald M. Johnson, Walnut Creek, CA
(Member Emeritus)

Robert P. Benedetti, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents on safeguarding against the fire and explosion hazards associated with the storage of flammable and combustible liquids in fixed aboveground and underground tanks of any size, including tanks in buildings, except as specifically covered by other NFPA documents, and with the installation of piping systems for flammable and combustible liquids. This Committee shall also have primary responsibility for documents or portions of documents on safeguarding against the fire and explosion hazards associated with the storage of flammable and combustible liquids in portable tanks whose capacity exceeds 2500 liters (660 gallons).

Contents

Chapter 1 Administration	30- 8	6.8 Automatic Fire Protection for Inside Storage	30- 44
1.1 Scope	30- 8	6.9 Manual Fire Protection	30- 60
1.2 Purpose	30- 8	6.10 Control of Ignition Sources	30- 61
1.3 Application	30- 8	Chapter 7 Operations	30- 62
1.4 Retroactivity	30- 8	7.1 Scope	30- 62
1.5 Equivalency	30- 8	7.2 General	30- 62
1.6 Enforcement	30- 9	7.3 Facility Design	30- 62
1.7 Definition and Classification of Liquids ...	30- 9	7.4 Recirculating Heat Transfer Systems	30- 65
1.8 Use of Other Units	30- 9	7.5 Incidental Operations	30- 65
1.9 General Requirements	30- 9	7.6 Loading and Unloading Operations and Facilities	30- 66
Chapter 2 Referenced Publications	30- 9	7.7 Wharves	30- 67
2.1 General	30- 9	7.8 Reserved	30- 68
2.2 NFPA Publications	30- 10	7.9 Control of Ignition Sources	30- 69
2.3 Other Publications	30- 10	7.10 Vapor Recovery and Vapor Processing Systems	30- 70
Chapter 3 Definitions	30- 11	7.11 Solvent Distillation Units	30- 70
3.1 General	30- 11	7.12 Management of Fire Hazards	30- 71
3.2 NFPA Official Definitions	30- 11	7.13 Fire Protection and Fire Suppression	30- 71
3.3 General Definitions	30- 11	Chapter 8 Electrical Equipment and Installations	30- 72
Chapter 4 Tank Storage	30- 14	8.1 Scope	30- 72
4.1 General	30- 14	8.2 General	30- 72
4.2 Design and Construction of Tanks	30- 14	Annex A Explanatory Material	30- 75
4.3 Installation of Tanks and Tank Appurtenances	30- 19	Annex B Emergency Relief Venting for Fire Exposure for Aboveground Tanks	30- 90
4.4 Testing Requirements for Tanks	30- 29	Annex C Temporarily Out of Service, Closure in Place, or Closure by Removal of Underground Tanks	30- 93
4.5 Fire Prevention and Control	30- 29	Annex D Development of Fire Protection Criteria Shown in Section 6.8 and Suggested Fire Protection for Some Containers of Flammable and Combustible Liquids Not Covered in Section 6.8	30- 95
4.6 Operations and Maintenance of Tanks	30- 30	Annex E Suggested Test Protocol for Developing Fire Protection for Containers of Flammable and Combustible Liquids	30-101
Chapter 5 Piping Systems	30- 32	Annex F Fugitive Emissions Calculations	30-106
5.1 Scope	30- 32	Annex G Sample Ordinance Adopting NFPA 30	30-107
5.2 General Requirements	30- 32	Annex H Informational References	30-108
5.3 Materials for Piping Systems	30- 32	Index	30-112
5.4 Pipe Joints	30- 33		
5.5 Installation of Piping Systems	30- 33		
5.6 Testing	30- 34		
5.7 Vent Piping	30- 34		
5.8 Static Electricity	30- 35		
5.9 Identification	30- 35		
Chapter 6 Container and Portable Tank Storage	30- 35		
6.1 Scope	30- 35		
6.2 Design, Construction, and Capacity of Containers	30- 35		
6.3 Design, Construction, and Capacity of Storage Cabinets	30- 36		
6.4 Design, Construction, and Operation of Inside Liquid Storage Areas	30- 36		
6.5 Requirements for Liquid Storage Areas in Other Occupancies	30- 40		
6.6 Hazardous Materials Storage Lockers	30- 42		
6.7 Outdoor Storage	30- 43		

NFPA 30

Flammable and Combustible Liquids Code

2003 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notices and Disclaimers Concerning NFPA Documents." They can also be obtained on request from NFPA or viewed at www.nfpa.org/disclaimers.

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex H lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex H.

Chapter 1 Administration

1.1 Scope.

1.1.1* This code shall apply to the storage, handling, and use of flammable and combustible liquids, including waste liquids, as herein defined and classified.

1.1.2 This code shall not apply to the following:

- (1)*Any liquid that has a melting point equal to or greater than 37.8°C (100°F) or that does not meet the criteria for fluidity given in the definition for *liquid* in Section 1.7
- (2) Any liquefied gas or cryogenic liquid as defined in Chapter 3
- (3)*Any liquid that does not have a flash point, but which is capable of burning under certain conditions; such liquids include certain halogenated hydrocarbons and certain mixtures of flammable or combustible liquids and halogenated hydrocarbons
- (4)*Any aerosol product
- (5) Any mist, spray, or foam

1.1.3 This code shall also not apply to the following:

- (1)*Transportation of flammable and combustible liquids as governed by the U.S. Department of Transportation
- (2)*Storage, handling, and use of fuel oil tanks and containers connected with oil-burning equipment

1.2* Purpose. The purpose of this code shall be to provide reasonable requirements for the safe storage and handling of flammable and combustible liquids.

1.3 Application. Chapter 4 and Chapter 5 shall apply to bulk storage of liquids in tanks and similar vessels. Chapter 6 shall apply to storage of liquids in containers and portable tanks in storage areas and in warehouses. Chapter 7 shall apply to handling of liquids in manufacturing and related operations and processes. Chapter 8 shall apply to electrical systems.

1.4* Retroactivity. The provisions of this code shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion. They shall reflect situations and the state of the art prevalent at the time the code was issued. Unless otherwise noted, it shall not be intended that the provisions of this code be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this code, except in those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or adjacent property.

1.5 Equivalency.

1.5.1 Nothing in this code shall be intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, or safety over those prescribed by this code, provided that technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

1.5.2 The provisions of this code shall be permitted to be altered at the discretion of the authority having jurisdiction after consideration of special situations, such as topographical conditions of the site, presence or absence of protective features (e.g., barricades, walls, etc.), adequacy of building exits, the nature of the occupancy, proximity to buildings or adjoining property and the construction of such buildings, capacity and construction of proposed storage tanks and the nature of the liquids to be stored, the nature of the process, the degree to which private fire protection is provided, and the capabilities of the local fire department. Such alternate arrangements shall provide protection at least equivalent to that required by this code.

1.5.3 The provisions of this code shall also be permitted to be altered at the discretion of the authority having jurisdiction in cases where other regulations, such as those for environmental protection, impose requirements that are not anticipated by this code. Such alternate arrangements shall provide protection at least equivalent to that required by this code.

1.5.4 Installations made in accordance with the applicable requirements of the following standards shall be deemed to be in compliance with this code:

- (1) NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
- (2) NFPA 32, *Standard for Drycleaning Plants*
- (3) NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- (4) NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*
- (5) NFPA 35, *Standard for the Manufacture of Organic Coatings*
- (6) NFPA 36, *Standard for Solvent Extraction Plants*

- (7) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
- (8) NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*
- (9) Chapter 10 of NFPA 99, *Standard for Health Care Facilities*

1.6 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. (See Annex G for sample wording for enabling legislation.)

1.7 Definition and Classification of Liquids.

1.7.1 Scope. Section 1.7 shall establish a uniform system of defining and classifying flammable and combustible liquids for the purpose of proper application of this code. This section shall apply to any liquid within the scope of, and subject to, the requirements of this code.

1.7.1.1 Section 1.7 shall not apply to mists, sprays, or foams.

1.7.1.2 Section 1.7 shall not apply to liquids that do not have flash points, but are capable of burning under certain conditions; such liquids include certain halogenated hydrocarbons and certain mixtures of flammable or combustible liquids and halogenated hydrocarbons. [See A.1.1.2(3).]

1.7.2 Definitions. For the purpose of this section, the terms in 1.7.2.1 through 1.7.2.4 shall have the definitions given.

1.7.2.1* Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. For purposes of defining the boiling point, atmospheric pressure shall be considered to be 14.7 psia (760 mm Hg). For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D 86, *Standard Method of Test for Distillation of Petroleum Products*, shall be considered to be the boiling point.

1.7.2.2* Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in 1.7.4.

1.7.2.3 Liquid. Any material that has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Method of Test for Penetration of Bituminous Materials*.

1.7.2.4* Vapor Pressure. The pressure, measured in pounds per square inch, absolute (psia), exerted by a liquid, as determined by ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*.

1.7.3* Classification of Liquids. Any liquid within the scope of this code and subject to the requirements of this code shall be known generally as either a flammable liquid or a combustible liquid and shall be defined and classified in accordance with this subsection.

1.7.3.1 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in 1.7.4. Combustible liquids are classified as Class II or Class III as follows: (1) *Class II Liquid* — any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C); (2) *Class IIIA* — any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C); (3) *Class IIIB* — any liquid that has a flash point at or above 200°F (93°C).

1.7.3.2* Flammable Liquid. Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in 1.7.4. Flammable liquids are classified as Class I as follows: *Class I Liquid* — any liquid that has a closed-cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding 40 psia (2068.6 mm Hg) at 100°F (37.8°C), as determined by ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*. Class I liquids are further classified as follows: (1) *Class IA liquids* — those liquids that have flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C); (2) *Class IB liquids* — those liquids that have flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C); (3) *Class IC liquids* — those liquids that have flash points at or above 73°F (22.8°C), but below 100°F (37.8°C).

1.7.4 Determination of Flash Point. The flash point of a liquid shall be determined according to the methods specified in this subsection.

1.7.4.1 The flash point of a liquid having a viscosity below 5.5 centiStokes at 40°C (104°F) or below 9.5 centiStokes at 25°C (77°F) shall be determined in accordance with ASTM D 56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester*.

Exception: Cut-back asphalts, liquids that tend to form a surface film, and liquids that contain suspended solids shall not be tested in accordance with ASTM D 56, even if they otherwise meet the viscosity criteria.

1.7.4.2 The flash point of a liquid having a viscosity of 5.5 centiStokes or more at 40°C (104°F) or 9.5 centiStokes or more at 25°C (77°F) or a flash point of 93.4°C (200°F) or higher shall be determined in accordance with ASTM D 93, *Standard Test Methods for Flash Point by the Pensky-Martens Closed Tester*.

1.7.4.3 As an alternative, ASTM D 3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components that have flash points between 0°C (32°F) and 110°C (230°F) and viscosities below 150 Stokes at 25°C (77°F).

1.7.4.4 As an alternative, ASTM D 3828, *Standard Test Methods for Flash Point by Small Scale Closed Tester*, shall be permitted to be used for materials other than those for which ASTM D 3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, is specifically required.

1.8 Use of Other Units. If a value for measurement given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. The given equivalent value shall be considered to be approximate.

1.9 General Requirements.

1.9.1 Storage. Liquids shall be stored in tanks in accordance with Chapter 4 or in containers, portable tanks, and intermediate bulk containers in accordance with Chapter 6.

1.9.2 Exits. Egress from buildings and areas covered by this code shall meet the requirements of NFPA 101, *Life Safety Code*.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2002 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1999 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2000 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 1997 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2003 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2001 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2003 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2002 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2002 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2003 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2001 edition.

NFPA 32, *Standard for Drycleaning Plants*, 2000 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2003 edition.

NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*, 2003 edition.

NFPA 35, *Standard for the Manufacture of Organic Coatings*, 1999 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2001 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2002 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2000 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2001 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2001 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 70, *National Electrical Code*[®], 2002 edition.

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2001 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2002 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 1999 edition.

NFPA 99, *Standard for Health Care Facilities*, 2002 edition.

NFPA 101[®], *Life Safety Code*[®], 2003 edition.

NFPA 220, *Standard on Types of Building Construction*, 1999 edition.

NFPA 221, *Standard for Fire Walls and Fire Barrier Walls*, 2000 edition.

NFPA 230, *Standard for the Fire Protection of Storage*, 2003 edition.

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*, 1999 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, 2000 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 2000 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation*, 2002 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2001 edition.

2.3 Other Publications.

2.3.1 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

API Specification 12B, *Bolted Tanks for Storage of Production Liquids*, 14th edition, 1995.

API Specification 12D, *Field Welded Tanks for Storage of Production Liquids*, 10th edition, 1994.

API Specification 12F, *Shop Welded Tanks for Storage of Production Liquids*, 11th edition, 1994.

API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 9th edition, 1999.

API Standard 650, *Welded Steel Tanks for Oil Storage*, 10th edition, 1998.

API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*, 5th edition, 1998.

2.3.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME Boiler and Pressure Vessel Code.

ASME B31, *Code for Pressure Piping*, 1998.

ASME Code for Unfired Pressure Vessels, 1998.

2.3.3 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 395, *Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, 1999.

ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials*, 1997.

ASTM D 56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester*, 1998.

ASTM D 86, *Standard Method of Test for Distillation of Petroleum Products*, 2000.

ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, 1998.

ASTM D 93, *Standard Test Methods for Flash Point by the Pensky-Martens Closed Tester*, 1999.

ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*, 1999.

ASTM D 3278, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, 1996.

ASTM D 3828, *Standard Test Methods for Flash Point by Small Scale Closed Tester*, 1998.

ASTM F 852, *Standard for Portable Gasoline Containers for Consumer Use*, 1999.

ASTM F 976, *Standard for Portable Kerosene Containers for Consumer Use*, 1999.

2.3.4 ATA Publication. American Trucking Association Traffic Department, 2200 Mill Road, Alexandria, VA 22314.

National Motor Freight Classification.

2.3.5 FMRC Publications. Factory Mutual Research Corporation, 1151 Boston-Providence Turnpike, Norwood, MA 02062.

FMRC Class 6083, *Examination Program for Fusible Closures for Steel Drums.*

2.3.6 NRFC Publication. National Railroad Freight Committee, 222 South Riverside Plaza, Chicago, IL 60606-5945.

Uniform Freight Classification.

2.3.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 58, *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*, 1996.

UL 80, *Standard for Steel Inside Tanks for Oil Burner Fuel*, 1996.

UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, 1993.

UL 971, *Standard for Nonmetallic Underground Piping for Flammable Liquids*, 1995.

ANSI/UL 1313, *Nonmetallic Safety Cans for Petroleum Products*, 1993.

UL 1316, *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures*, 1994.

UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks*, Part I, 1993.

UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*, 2000.

UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, 1997.

UL 2208, *Standard for Solvent Distillation Units*, 1996.

UL 2245, *Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks*, 1999.

UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, 2001.

2.3.8 UN Publication. United Nations, Headquarters, New York, NY 10017.

Recommendations on the Transport of Dangerous Goods, 9th revised edition, 1995.

2.3.9 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 33, *Code of Federal Regulations*, Parts 154, 155 and 156.

Title 46, *Code of Federal Regulations*, Parts 30, 32, 35, and 39.

Title 49, *Code of Federal Regulations*, "Transportation."

Title 49, *Code of Federal Regulations*, Part 173, Appendix H.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction. 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.

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.

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.

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.

3.3 General Definitions.

3.3.1 Area.

3.3.1.1 Fire Area. An area of a building separated from the remainder of the building by construction having a fire resistance of at least 1 hour and having all communicating openings properly protected by an assembly having a fire resistance rating of at least 1 hour.

3.3.1.2 Inside Liquid Storage Area. A room or building used for the storage of liquids in containers or portable tanks, separated from other types of occupancies.

3.3.2 Barrel. A unit of volume used in the petroleum industry that is equal to 0.159 m³ (159 L or 42 gal).

3.3.3 Basement. For the purposes of this code, a story of a building or structure having one-half or more of its height below ground level and to which access for fire-fighting purposes is restricted.

3.3.4 Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. (See 1.7.2.1.)

3.3.5* Boil-Over. An event in the burning of certain oils in an open-top tank when, after a long period of quiescent burning, there is a sudden increase in fire intensity associated with expulsion of burning oil from the tank.

3.3.6 Building. A structure used or intended for supporting or sheltering any use or occupancy.

3.3.6.1 Attached Building. A building having only one common wall with another building having other types of occupancies.

3.3.6.2* Important Building. A building that is considered not expendable in an exposure fire.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not included, common usage of the terms shall apply.

3.3.6.3 Storage Tank Building. A three-dimensional space that is enclosed by a roof and a wall that covers more than one-half of the possible area of the sides of the space, is of sufficient size to allow entry by personnel, will likely limit the dissipation of heat or dispersion of vapors, and restricts access for fire fighting. (See 4.3.4.)

3.3.7* Container. Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids.

3.3.7.1 Closed Container. A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures.

3.3.8 Crude Petroleum. Hydrocarbon mixtures that have a flash point below 65.6°C (150°F) and that have not been processed in a refinery.

3.3.9 Cryogenic Liquid. A liquid having a boiling point lower than -101°C (-150°F) at an absolute pressure of 101 kPa (14.7 psi). [55:3.3]

3.3.10 Damage-Limiting Construction. Any set of construction elements which will act to limit damage from an explosion, including open structures, pressure relieving construction, or pressure resistant construction. These features can be used individually or in combination.

3.3.11 Distillery. A plant or that portion of a plant where liquids produced by fermentation are concentrated and where the concentrated products are also mixed, stored, or packaged.

3.3.12 Dwelling.

3.3.12.1 Multifamily Dwelling. A building that contains three or more dwelling units.

3.3.12.2 One-Family Dwelling. A building that consists solely of one dwelling unit.

3.3.12.3 Two-Family Dwelling. A building that consists solely of two dwelling units.

3.3.13 Dwelling Unit. A single unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

3.3.14 Emergency Relief Vent. An opening, construction method, or device that will automatically relieve excessive internal pressure due to an exposure fire.

3.3.15 Fire Point. The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*.

3.3.16 Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in 1.7.4.

3.3.17* Fugitive Emissions. Releases of flammable vapor that continuously or intermittently occur from process equipment during normal operations.

3.3.18* Hazardous Material or Hazardous Chemical. Material presenting dangers beyond the fire problems relating to flash point and boiling point.

3.3.19 Hazardous Materials Storage Locker. A movable prefabricated structure, manufactured primarily at a site other than the final location of the structure and transported completely assembled or in a ready-to-assemble package to the final location. It is intended to meet local, state, and federal requirements for outside storage of hazardous materials.

3.3.20* Hazardous Reaction or Hazardous Chemical Reaction. Reactions that result in dangers beyond the fire problems relating to flash point and boiling point of either the reactants or of the products.

3.3.21 Heat Transfer Fluid (HTF). A liquid that is used as a medium to transfer heat energy from a heater or vaporizer to a remote heat consumer (e.g., injection molding machine, oven, or dryer, or jacketed chemical reactor).

3.3.22 Hotel. A building or groups of buildings under the same management in which there are sleeping accommodations for more than 16 persons and primarily used by transients for lodging with or without meals. [101: 3.3]

3.3.23 Incidental Liquid Use or Storage. Use or storage as a subordinate activity to that which establishes the occupancy or area classification.

3.3.24 Liquefied Gas. A gas, other than in solution, that in a packaging under the charged pressure exists both as a liquid and a gas at a temperature of 20°C (68°F).

3.3.25 Liquid. Any material that has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Method of Test for Penetration of Bituminous Materials*.

3.3.25.1 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in 1.7.4. Combustible liquids are classified as Class II or Class III as follows: (1) *Class II Liquid* — any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C); (2) *Class IIIA* — any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C); (3) *Class IIIB* — any liquid that has a flash point at or above 200°F (93°C).

3.3.25.2 Flammable Liquid. Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in 1.7.4. Flammable liquids are classified as Class I as follows: *Class I Liquid* — any liquid that has a closed-cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding 40 psia (2068.6 mm Hg) at 100°F (37.8°C), as determined by ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*. Class I liquids are further classified as follows: (1) *Class IA liquids* — those liquids that have flash points below 73°F (22.8°C) and boiling points below 100°F (37.8°C); (2) *Class IB liquids* — those liquids that have flash points below 73°F (22.8°C) and boiling points at or above 100°F (37.8°C); (3) *Class IC liquids* — those liquids that have flash points at or above 73°F (22.8°C), but below 100°F (37.8°C).

3.3.25.3 Stable Liquid. Any liquid not defined as unstable.

3.3.25.4 Unstable Liquid. A liquid that, in the pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure, or temperature.

3.3.25.5* Water-Miscible Liquid. A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents.

3.3.26 Liquid Warehouse. See 3.3.49.2.

3.3.27 Occupancy.

3.3.27.1 Assembly Occupancy. An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. [1:3.3]

3.3.27.2 Educational Occupancy. An occupancy used for educational purposes through the twelfth grade by six or more persons for four or more hours per day or more than 12 hours per week. [45:1.4]

3.3.27.3 Institutional Occupancy. A building or structure or any portion thereof used by persons who are harbored or detained to receive medical, charitable, or other care or treatment or by persons involuntarily detained.

3.3.27.4 Mercantile Occupancy. An occupancy used for the display and sale of merchandise. [101:3.3]

3.3.27.5 Office Occupancy. A building or structure or any portion thereof used for the transaction of business or the rendering or receiving of professional services.

3.3.28* Occupancy Classification. The system of defining the predominant operating characteristic of a portion of a building or plant for purposes of applying relevant sections of this code.

3.3.28.1 Outdoor Occupancy Classification. Similar to occupancy classification, except that it applies to outdoor operations not enclosed in a building or shelter.

3.3.29 Operating Unit (Vessel) or Process Unit (Vessel). The equipment in which a unit operation or unit process is conducted. (See also definition 3.3.42, *Unit Operation or Unit Process*.)

3.3.30 Operations. A general term that includes, but is not limited to, the use, transfer, storage, and processing of liquids.

3.3.31* Pier. A structure, usually of greater length than width and projecting from the shore into a body of water with direct access from land, that can be either open deck or provided with a superstructure. [307:2.1]

3.3.32 Plant.

3.3.32.1 Bulk Plant or Terminal. That portion of a property where liquids are received by tank vessel, pipelines, tank car, or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank, or container.

3.3.32.2 Chemical Plant. A large integrated plant or that portion of such a plant, other than a refinery or distillery, where liquids are produced by chemical reactions or used in chemical reactions.

3.3.33 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code*. [52:3.3]

3.3.34* Process or Processing. An integrated sequence of operations.

3.3.35 Protection for Exposures. Fire protection for structures on property adjacent to liquid storage that is provided by (1) a public fire department or (2) a private fire brigade

maintained on the property adjacent to the liquid storage, either of which is capable of providing cooling water streams to protect the property adjacent to the liquid storage.

3.3.36 Refinery. A plant in which flammable or combustible liquids are produced on a commercial scale from crude petroleum, natural gasoline, or other hydrocarbon sources.

3.3.37 Room.

3.3.37.1 Cutoff Room. A room within a building and having at least one exterior wall.

3.3.37.2 Inside Room. A room totally enclosed within a building and having no exterior walls.

3.3.38 Safety Can. A listed container, of not more than 20 L (5.3 gal) capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

3.3.39 Solvent Distillation Unit. An appliance that distills a flammable or combustible liquid to remove contaminants and recover the liquid.

3.3.40 Staging. Temporary storage in a process area of liquids in containers, intermediate bulk containers, and portable tanks.

3.3.41 Tank.

3.3.41.1 Aboveground Tank. A tank that is installed above grade, at grade, or below grade without backfill.

3.3.41.1.1 Protected Aboveground Tank. An aboveground storage tank that is listed in accordance with UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, or an equivalent test procedure that consists of a primary tank provided with protection from physical damage and fire-resistive protection from exposure to a high-intensity liquid pool fire.

3.3.41.2* Atmospheric Tank. A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 6.9 kPa (1.0 psig) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank.

3.3.41.3 Low-Pressure Tank. A storage tank designed to withstand an internal pressure above a gauge pressure of 6.9 kPa (1.0 psig) but not more than 103.4 kPa (15 psig or 1 bar gauge) measured at the top of the tank.

3.3.41.4 Portable Tank. Any closed vessel having a liquid capacity over 230 L (60 gal) and not intended for fixed installation. This includes intermediate bulk containers (IBCs) as defined and regulated by the U.S. Department of Transportation.

3.3.41.5 Secondary Containment Tank. A tank that has an inner and outer wall with an interstitial space (annulus) between the walls and that has a means for monitoring the interstitial space for a leak.

3.3.41.6 Storage Tank. Any vessel having a liquid capacity that exceeds 230 L (60 gal), is intended for fixed installation, and is not used for processing.

3.3.42 Unit Operation or Unit Process. A segment of a physical or chemical process that might or might not be integrated with other segments to constitute the manufacturing sequence.

3.3.43 Vapor Pressure. The pressure, measured in pounds per square inch, absolute (psia), exerted by a liquid, as determined by ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*.

3.3.44 Vapor Processing Equipment. Those components of a vapor processing system designed to process vapors or liquids captured during transfer or filling operations.

3.3.45* Vapor Processing System. A system designed to capture and process vapors displaced during transfer or filling operations by use of mechanical or chemical means.

3.3.46* Vapor Recovery System. A system designed to capture and retain, without processing, vapors displaced during transfer or filling operations.

3.3.47 Vault. An enclosure consisting of four walls, a floor, and a top for the purpose of containing a liquid storage tank and not intended to be occupied by personnel other than for inspection, repair, or maintenance of the vault, the storage tank, or related equipment.

3.3.48* Ventilation. As specified in this code, movement of air that is provided for the prevention of fire and explosion.

3.3.49* Warehouse.

3.3.49.1 General-Purpose Warehouse. A separate, detached building or portion of a building used only for warehousing-type operations.

3.3.49.2 Liquid Warehouse. A separate, detached building or attached building used for warehousing-type operations for liquids.

3.3.50* Wharf. A structure at the shoreline, having a platform built along and parallel to a body of water with either open deck or provided with a superstructure.

Chapter 4 Tank Storage

4.1 General.

4.1.1 Scope. This chapter shall apply to the following:

- (1) The storage of flammable and combustible liquids, as defined in 1.7.3, in fixed aboveground and underground tanks
- (2) The storage of flammable and combustible liquids in portable tanks and bulk containers whose capacity exceeds 3000 L (793 gal)
- (3) The design, installation, testing, operation, and maintenance of such tanks, portable tanks, and bulk containers

4.1.2 Applicability. (Reserved)

4.1.3 Special Terms.

4.1.3.1 Floating Roof Tank. For the purposes of this chapter, a floating roof tank shall mean a tank that incorporates one of the following designs:

- (1) A closed-top pontoon or double-deck metal floating roof in an open-top tank constructed in accordance with API Standard 650, *Welded Steel Tanks for Oil Storage*
- (2) A fixed metal roof with ventilation at the top and roof eaves constructed in accordance with API 650 and containing a closed-top pontoon or double-deck metal floating roof meeting the requirements of API 650
- (3) A fixed metal roof with ventilation at the top and roof eaves constructed in accordance with API 650 and containing a metal floating cover supported by liquidtight metal floating devices that provide sufficient buoyancy to prevent the liquid surface from being exposed when half of the flotation is lost

4.1.3.1.1 An internal metal floating pan, roof, or cover that does not meet this definition or one that uses plastic foam (except for seals) for flotation, even if encapsulated in metal or fiberglass, shall be considered a fixed roof tank.

4.2 Design and Construction of Tanks.

4.2.1 General Requirements. Tanks shall be permitted to be of any shape, size, or type consistent with recognized engineering standards. Metal tanks shall be welded, riveted and caulked, or bolted, or constructed using a combination of these methods.

4.2.1.1 Tanks designed and intended for aboveground use shall not be used as underground tanks.

4.2.1.2 Tanks designed and intended for underground use shall not be used as aboveground tanks.

4.2.2 Materials of Construction. Tanks shall be designed and built in accordance with recognized engineering standards for the material of construction being used. Tanks shall be of steel or other approved noncombustible material, with the following limitations and exceptions:

- (1) The materials of construction for tanks and their appurtenances shall be compatible with the liquid to be stored. In case of doubt about the properties of the liquid to be stored, the supplier, producer of the liquid, or other competent authority shall be consulted.
- (2) Tanks shall be permitted to be constructed of combustible materials when approved by the authority having jurisdiction. Tanks constructed of combustible materials shall be limited to any of the following:
 - (a) Underground installation
 - (b) Use where required by the properties of the liquid stored
 - (c) Aboveground storage of Class IIIB liquids in areas not exposed to a spill or leak of Class I or Class II liquid
 - (d) Storage of Class IIIB liquids inside a building protected by an approved automatic fire-extinguishing system
- (3) Unlined concrete tanks shall be permitted to be used for storing liquids that have a gravity of 40° API or heavier. Concrete tanks with special linings shall be permitted to be used for other liquids provided they are designed and constructed in accordance with recognized engineering standards.
- (4) Tanks shall be permitted to have combustible or noncombustible linings. The choice of the lining material and its required thickness shall depend on the properties of the liquid to be stored.
- (5) Special engineering consideration shall be required if the specific gravity of the liquid to be stored exceeds that of water or if the tank is designed to contain liquids at a liquid temperature below -17.8°C (0°F).

4.2.3 Design Standards.

4.2.3.1 Design Standards for Atmospheric Tanks.

4.2.3.1.1 Atmospheric tanks, including those incorporating secondary containment, shall be designed and constructed in accordance with recognized engineering standards or approved equivalents. Atmospheric tanks that meet any of the following standards shall be deemed as meeting the requirements of 4.2.3.1:

- (1) UL 58, *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*; UL 80, *Standard for Steel Inside Tanks for Oil Burner Fuel*; UL 142, *Standard for Steel Above-ground Tanks for Flammable and Combustible Liquids*; UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*; or UL 2085, *Standard for Protected Above-ground Tanks for Flammable and Combustible Liquids*
- (2) API Specification 12B, *Bolted Tanks for Storage of Production Liquids*; API Specification 12D, *Field Welded Tanks for Storage of Production Liquids*; API Specification 12F, *Shop Welded Tanks for Storage of Production Liquids*; or API Standard 650, *Welded Steel Tanks for Oil Storage*
- (3) UL 1316, *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures*
- (4) UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks*

4.2.3.1.2 Atmospheric tanks designed and constructed in accordance with Appendix F of API Standard 650, *Welded Steel Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 6.9 kPa (1.0 psig). All other tanks shall be limited to operation from atmospheric to a gauge pressure of 3.5 kPa (0.5 psig).

Exception No. 1: Atmospheric tanks that are not designed and constructed in accordance with Appendix F of API Standard 650, Welded Steel Tanks for Oil Storage, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 6.9 kPa (1.0 psig) only if an engineering analysis is performed to determine that the tank can withstand the elevated pressure.

Exception No. 2: Horizontal cylindrical and rectangular tanks built according to any of the standards specified in 4.2.3.1.1 shall be permitted to operate at pressures from atmospheric to a gauge pressure of 6.9 kPa (1.0 psig) and shall be limited to a gauge pressure of 17 kPa (2.5 psig) under emergency venting conditions.

4.2.3.1.3 Low-pressure tanks and pressure vessels shall be permitted to be used as atmospheric tanks.

4.2.3.1.4 Atmospheric tanks shall not be used to store a liquid at a temperature at or above its boiling point.

4.2.3.2 Design Standards for Low-Pressure Tanks.

4.2.3.2.1 Low-pressure tanks shall be designed and constructed in accordance with recognized engineering standards or approved equivalents. Low-pressure tanks that meet either of the following standards shall be deemed as meeting the requirements of 4.2.3.2:

- (1) API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*
- (2) ASME *Code for Unfired Pressure Vessels*, Section VIII, Division 1

4.2.3.2.2 Low-pressure tanks shall not be operated above their design pressures.

4.2.3.2.3 Pressure vessels shall be permitted to be used as low-pressure tanks.

4.2.3.3 Design Standards for Pressure Vessels.

4.2.3.3.1 Tanks with storage pressures above 1 bar gauge (15 psig) shall be designed and constructed in accordance with recognized engineering standards or approved equivalents. Pressure vessels that meet any of the following standards shall be deemed as meeting the requirements of 4.2.3.3:

- (1) Fired pressure vessels shall be designed and constructed in accordance with Section I (Power Boilers), or Section VIII, Division 1 or Division 2 (Pressure Vessels), as applicable, of the ASME *Boiler and Pressure Vessel Code*.
- (2) Unfired pressure vessels shall be designed and constructed in accordance with Section VIII, Division 1 or Division 2, of the ASME *Boiler and Pressure Vessel Code*.

4.2.3.3.2* Pressure vessels that do not meet the requirements of 4.2.3.3.1(1) or 4.2.3.3.1(2) shall be permitted to be used provided approval has been obtained from the state or other governmental jurisdiction in which they are to be used.

4.2.3.3.3 Pressure vessels shall not be operated above their design pressures. The normal operating pressure of the vessel shall not exceed the design pressure of the vessel.

4.2.4 Design of Tank Supports.

4.2.4.1* Supports for tanks shall be designed and constructed in accordance with recognized engineering standards or approved equivalents.

4.2.4.2 Tanks shall be supported in a manner that prevents excessive concentration of loads on the supported portion of the shell.

4.2.4.3 In areas subject to earthquakes, tank supports and connections shall be designed to resist damage as a result of such shocks.

4.2.5 Design of Tank Vents.

4.2.5.1 Normal Venting for Tanks.

4.2.5.1.1 Atmospheric storage tanks shall be adequately vented to prevent the development of vacuum or pressure that can distort the roof of a cone roof tank or that exceeds the design pressure of other atmospheric tanks when filling or emptying the tank or because of atmospheric temperature changes.

4.2.5.1.2 Normal vents shall be sized in accordance with either API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*, or another accepted standard. Alternatively, the normal vent shall be at least as large as the largest filling or withdrawal connection but in no case shall it be less than 32 mm (1.25 in.) nominal inside diameter.

4.2.5.1.3 Low-pressure tanks and pressure vessels shall be adequately vented to prevent the development of pressure or vacuum that exceeds the design pressure of the tank or vessel when filling or emptying the tank or vessel or because of atmospheric temperature changes. Means shall also be provided to prevent overpressure from any pump discharging into the tank or vessel when the pump discharge pressure can exceed the design pressure of the tank or vessel.

4.2.5.1.4 If any tank or pressure vessel has more than one fill or withdrawal connection and simultaneous filling or withdrawal can be made, the vent size shall be based on the maximum anticipated simultaneous flow.

4.2.5.1.5 For tanks equipped with vents that permit pressures to exceed a gauge pressure of 17 kPa (2.5 psig) and for low-pressure tanks and for pressure vessels, the outlet of all vents and vent drains shall be arranged to discharge in a manner that prevents localized overheating of or flame impingement on any part of the tank, if vapors from the vents are ignited.

4.2.5.1.6 Tanks and pressure vessels that store Class IA liquids shall be equipped with venting devices that are normally closed except when venting under pressure or vacuum conditions.

4.2.5.1.7 Tanks and pressure vessels that store Class IB and Class IC liquids shall be equipped with venting devices or with listed flame arrestors. When used, vent devices shall be normally closed except when venting under pressure or vacuum conditions.

4.2.5.1.8 Tanks of 475 m³ (126,000 gal or 3000 bbl) capacity or less that store crude petroleum in crude-producing areas and outside aboveground atmospheric tanks of less than 3785 L (1000 gal) capacity that contain other than Class IA liquids shall be permitted to have open vents. (See also *Exception to 4.2.5.2.1.*)

4.2.5.1.9* Flame arrestors or venting devices required in 4.2.5.1.6 and 4.2.5.1.7 shall be permitted to be omitted on tanks that store Class IB or Class IC liquids where conditions are such that their use can, in case of obstruction, result in damage to the tank.

4.2.5.2 Emergency Relief Venting for Fire Exposure for Aboveground Tanks.

4.2.5.2.1 Every aboveground storage tank shall have emergency relief venting in the form of construction or a device or devices that will relieve excessive internal pressure caused by an exposure fire. This requirement shall also apply to each compartment of a compartmented tank, the interstitial space (annulus) of a secondary containment-type tank, and the enclosed space of tanks of closed-top dike construction. This requirement shall also apply to spaces or enclosed volumes, such as those intended for insulation, membranes, or weather shields, that can contain liquid because of a leak from the primary vessel and can inhibit venting during fire exposure. The insulation, membrane, or weather shield shall not interfere with emergency venting.

Exception: Tanks storing Class IIIB liquids that are larger than 45,400 L (45.4 m³ or 12,000 gal or 285 bbl) capacity and are not within the diked area or the drainage path of tanks storing Class I or Class II liquids do not need to meet this requirement.

4.2.5.2.2 For vertical tanks, the emergency relief venting construction referred to in 4.2.5.2.1 shall be permitted to be a floating roof, a lifter roof, a weak roof-to-shell seam, or another approved pressure-relieving construction. If used, a weak roof-to-shell seam shall be constructed to fail preferential to any other seam and shall be designed in accordance with API Standard 650, *Welded Steel Tanks for Oil Storage*, or UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*.

4.2.5.2.3* Where entire dependence for emergency relief venting is placed upon pressure-relieving devices, the total venting capacity of both normal and emergency vents shall be sufficient to prevent rupture of the shell or bottom of a vertical tank or of the shell or heads of a horizontal tank. If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. If two-phase flow is anticipated during emergency venting, an engineering evaluation shall be conducted in order to properly size the pressure-relieving devices. The total emergency relief venting capacity of both normal and emergency venting devices shall be not less than that determined in Table 4.2.5.2.3. (See *Annex B for the square footage of typical tank sizes.*)

Exception: As provided for in 4.2.5.2.5 and 4.2.5.2.6.

(A) The following requirements shall also apply:

(1) Emergency relief vent devices shall be vaportight and shall be permitted to be any one of the following:

- (a) Self-closing manway cover
 - (b) Manway cover provided with long bolts that permit the cover to lift under internal pressure
 - (c) Additional or larger relief valve or valves
- (2) The wetted area of the tank shall be calculated on the basis of 55 percent of the total exposed area of a sphere or spheroid, 75 percent of the total exposed area of a horizontal tank, 100 percent of the exposed shell and floor area of a rectangular tank, but excluding the top surface of the tank, and the first 9 m (30 ft) above grade of the exposed shell area of a vertical tank.

Table 4.2.5.2.3 Wetted Area Versus Cubic Feet Free Air per Hour (CFH) [14.7 psia and 60°F (101.3 kPa and 15.6°C)]

ft ²	CFH	ft ²	CFH	ft ²	CFH
20	21,100	160	168,000	900	493,000
30	31,600	180	190,000	1,000	524,000
40	42,100	200	211,000	1,200	557,000
50	52,700	250	239,000	1,400	587,000
60	63,200	300	265,000	1,600	614,000
70	73,700	350	288,000	1,800	639,000
80	84,200	400	312,000	2,000	662,000
90	94,800	500	354,000	2,400	704,000
100	105,000	600	392,000	2,800	742,000
120	126,000	700	428,000	and over	
140	147,000	800	462,000		

Notes:

(1) For SI units, 10 ft² = 0.93 m²; 36 ft³ = 1.0 m³.

(2) Interpolation should be used for intermediate values not specified in the table.

4.2.5.2.4* The total emergency relief venting capacity for tanks and storage vessels designed to operate at pressures above a gauge pressure of 6.9 kPa (1.0 psig) shall be not less than that determined in Table 4.2.5.2.3.

Exception: When the exposed wetted area of the tank is greater than 260 m² (2800 ft²), the total emergency relief venting capacity shall be not less than that determined in Table 4.2.5.2.4 or shall be not less than that calculated by the following formula:

$$CFH = 1107(A)^{0.82}$$

where:

CFH = venting capacity requirement (ft³ of free air per hour)

A = exposed wetted surface (ft²)

4.2.5.2.5 The total emergency relief venting capacity for any specific stable liquid shall be permitted to be determined by the following formula:

$$CFH = V \frac{1337}{L\sqrt{M}}$$

where:

V = ft³ of free air per hour (CFH) value from Table 4.2.5.2.3

L = latent heat of vaporization of specific liquid (Btu/lb)

M = molecular weight of specific liquids

Table 4.2.5.2.4 Wetted Area over 2800 ft² (260 m²) and Pressures over 1 psig (gauge pressure of 6.9 kPa)

ft ²	CFH	ft ²	CFH
2,800	742,000	9,000	1,930,000
3,000	786,000	10,000	2,110,000
3,500	892,000	15,000	2,940,000
4,000	995,000	20,000	3,720,000
4,500	1,100,000	25,000	4,470,000
5,000	1,250,000	30,000	5,190,000
6,000	1,390,000	35,000	5,900,000
7,000	1,570,000	40,000	6,570,000
8,000	1,760,000		

Note: For SI units, 10 ft² = 0.93 m²; 36 ft³ = 1.0 m³.

4.2.5.2.6* For tanks containing stable liquids, the required emergency relief venting capacity determined by 4.2.5.2.3, 4.2.5.2.4, or 4.2.5.2.5 shall be permitted to be multiplied by one of the following reduction factors when protection is provided as indicated. Only one of the following factors shall be used for any one tank:

- (1) A reduction factor of 0.5 shall be allowed for tanks with wetted area greater than 19 m² (200 ft²) that are provided with drainage that meets the requirements of 4.3.2.3.1.
- (2) A reduction factor of 0.3 shall be allowed for tanks that are protected with a water spray system that meets the requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and that are provided with drainage that meets the requirements of 4.3.2.3.1.
- (3) A reduction factor of 0.3 shall be allowed for tanks that are protected with an automatically actuated water spray system that meets the requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*.
- (4) A reduction factor of 0.3 shall be allowed for tanks protected with insulation that meets the requirements of 4.2.5.2.7.
- (5) A reduction factor of 0.15 shall be allowed for tanks that are protected with a water spray system that meets the requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and tanks that have insulation that meets the requirements of 4.2.5.2.7.

Exception No. 1: Where water-miscible liquids whose heats of combustion and rates of burning are equal to or less than those of ethyl alcohol (ethanol) are stored, processed, or handled and where there is no potential fire exposure from liquids other than these liquids, the emergency relief venting capacity shall be permitted to be reduced by an additional 50 percent. Drainage shall not be required to obtain this reduction. In no case shall the factors in 4.2.5.2.6(1) through 4.2.5.2.6(5) be reduced to less than 0.15.

Exception No. 2: Where liquids that are not water-miscible and whose heats of combustion and rates of burning are equal to or less than those of ethyl alcohol (ethanol) are stored, processed, or handled and where there is no potential fire exposure from liquids other than these liquids, the emergency relief venting capacity determined by 4.2.5.2.6(1) or 4.2.5.2.6(3) shall be permitted to be reduced by an additional 50 percent. No further reduction shall be allowed for protection by means of water spray. Drainage shall not be required to obtain this reduction. In no case shall the factors in 4.2.5.2.6(1) through 4.2.5.2.6(5) be reduced to less than 0.15.

4.2.5.2.7 Insulation for which credit is taken in 4.2.5.2.6 shall meet the following performance criteria:

- (1) The insulation shall remain in place under fire exposure conditions.
- (2) The insulation shall withstand dislodgment when subjected to hose stream impingement during fire exposure.

Exception: This requirement shall not apply where use of solid hose streams is not contemplated or would not be practical.

- (3) The insulation shall maintain a maximum conductance value of 4.0 Btu per hr per ft² per degree Fahrenheit (Btu/hr/ft²/°F) when the outer insulation jacket or cover is at a temperature of 904°C (1660°F) and when the mean temperature of the insulation is 538°C (1000°F).

4.2.5.2.8 The outlets of all vents and vent drains on tanks equipped with emergency relief venting that permits pressures to exceed a gauge pressure of 17 kPa (2.5 psig) shall be arranged to discharge so that localized overheating or flame impingement on any part of the tank will not occur if vapors from the vents are ignited.

4.2.5.2.9 Each commercial tank venting device shall have stamped on it the start-to-open pressure, the pressure at which the valve reaches the full open position, and the flow capacity at the latter pressure. If the start-to-open pressure is less than a gauge pressure of 17 kPa (2.5 psig) and the pressure at the full open position is greater than a gauge pressure of 17 kPa (2.5 psig), the flow capacity at a gauge pressure of 17 kPa (2.5 psig) shall also be stamped on the venting device. The flow capacity shall be expressed in cubic feet per hour of air at 15.6°C (60°F) and 1 bar (14.7 psia or 760 mm Hg).

4.2.5.2.9.1 The flow capacity of tank venting devices less than 200 mm (8 in.) in nominal pipe size shall be determined by actual test. These tests shall be permitted to be conducted by a qualified, impartial outside agency or by the manufacturer if certified by a qualified, impartial observer.

4.2.5.2.9.2* The flow capacity of tank venting devices equal to or greater than 200 mm (8 in.) nominal pipe size, including manway covers with long bolts, shall be determined by test or by calculation. If determined by calculation, the opening pressure shall be measured by test, the calculation shall be based on a flow coefficient of 0.5 applied to the rated orifice, the rating pressure and corresponding free orifice area shall be stated, and the word *calculated* shall appear on the nameplate.

4.2.5.2.10* Extension of Emergency Vent Piping. Piping to or from approved emergency vent devices for atmospheric and low-pressure tanks shall be sized to provide emergency vent flows that limit the back pressure to less than the maximum pressure permitted by the design of the tank. Piping to or from approved emergency vent devices for pressure vessels shall be sized in accordance with the ASME *Boiler and Pressure Vessel Code*.

4.2.5.3* Normal Venting for Underground Storage Tanks. Tank venting systems shall be provided with sufficient capacity to prevent blowback of vapor or liquid at the fill opening while the tank is being filled. Vent pipes shall be sized in accordance with Table 4.2.5.3, but shall not be less than 32 mm (1.25 in.) nominal inside diameter. Where tank venting devices are installed in vent lines, their flow capacities shall be determined in accordance with 4.2.5.2.9.

4.2.5.4 Vent Piping. Piping for normal and emergency relief venting shall be designed in accordance with Chapter 5.

Table 4.2.5.3 Vent Line Diameters in Inches

Maximum Flow (gpm)	Pipe Length [†]		
	50 ft	100 ft	200 ft
100	1¼	1¼	1¼
200	1¼	1¼	1¼
300	1¼	1¼	1½
400	1¼	1½	2
500	1½	1½	2
600	1½	2	2
700	2	2	2
800	2	2	3
900	2	2	3
1000	2	2	3

Note: For SI units, 1 in. = 25 mm; 1 ft = 0.3 m; 1 gal = 3.8 L.

[†]Vent lines stated length pipe plus 7 ells.

4.2.6* Design of Storage Tank System Corrosion Protection.

Metal used to fabricate the tank shall be thick enough to compensate for internal corrosion expected during the design life of the tank or other approved means of corrosion protection shall be provided.

4.2.6.1 External Corrosion Protection for Underground Tanks.

4.2.6.1.1 Underground tanks and their piping shall be protected by either of the following:

- (1)*A properly engineered, installed, and maintained cathodic protection system in accordance with recognized engineering standards of design
- (2)*Approved or listed corrosion-resistant materials or systems

4.2.6.1.2* Selection of the type of protection to be employed shall be based upon the corrosion history of the area and the judgment of a qualified engineer. The authority having jurisdiction shall be permitted to waive the requirements for corrosion protection where evidence is provided that such protection is not necessary.

4.2.6.2 Internal Corrosion Protection for All Tanks. Where tanks are not designed in accordance with 4.2.6, or with standards of the American Petroleum Institute, American Society of Mechanical Engineers, or the Underwriters Laboratories Inc. or if corrosion is anticipated beyond that provided for in the design formulas or standards used, additional metal thickness or suitable protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank.

4.2.7 Vaults for Aboveground Tanks.

4.2.7.1 Scope. Subsection 4.2.7 shall apply to installation of aboveground tanks in vaults and design and installation of such vaults.

4.2.7.2 General. Aboveground tanks shall be permitted to be installed in vaults that meet the requirements of 4.2.7. Except as modified by the provisions of 4.2.7, vaults shall meet all other applicable provisions of this code. Vaults shall be constructed and listed in accordance with UL 2245, *Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks*. Vaults shall be permitted to be either above or below grade.

4.2.7.3 Vault Design and Construction. Vaults shall be designed and constructed to meet the following requirements:

- (1) The walls and floor of the vault shall be constructed of reinforced concrete at least 150 mm (6 in.) thick.
- (2) The top of an abovegrade vault that contains a tank storing Class I flammable liquid or Class II liquid when stored at temperatures above its flash point shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward before destructive internal pressure develops within the vault. The top of an at-grade or belowgrade vault that contains a tank storing Class I flammable liquid or Class II liquid when stored at temperatures above their flash points shall be designed to relieve or contain the force of any explosion occurring inside the vault.
- (3) The top and floor of the vault and the tank foundation shall be designed to withstand all anticipated loading, including loading from vehicular traffic, where applicable.
- (4) The walls and floor of a belowgrade vault shall be designed to withstand anticipated soil and hydrostatic loading. The vault shall be liquidtight.
- (5) Adjacent vaults shall be permitted to share a common wall.
- (6) The vault enclosure shall have no openings except those necessary for access to, inspection of, and filling, emptying, and venting of the tank.
- (7) Where required, the vault shall be designed to be wind and earthquake resistant, in accordance with recognized engineering standards.
- (8) The vault shall be provided with connections to permit ventilation to dilute, disperse, and remove any vapors prior to personnel entering the vault.
- (9) The vault shall be provided with a means for personnel entry.
- (10) The vault shall be provided with an approved means to admit a fire suppression agent.

4.2.7.4 Tank Selection and Arrangement. Tanks shall be listed for aboveground use. Each tank shall be in its own vault and shall be completely enclosed by the vault. Sufficient clearance between the tank and the vault shall be provided to allow for visual inspection and maintenance of the tank and its appurtenances. Backfill shall not be permitted around the tank.

4.2.7.5 Tank Appurtenances.

4.2.7.5.1 Vent pipes that are provided for normal tank venting shall terminate outside the vault and at least 3.6 m (12 ft) above ground level and shall meet the requirements of 5.7.1.

4.2.7.5.2 Emergency vents shall be vaportight and shall be permitted to discharge inside the vault. Long-bolt manhole covers shall not be permitted for this purpose.

4.2.7.5.3 An approved means of overfill protection shall be provided for the tanks in the vaults. The use of ball float valves shall be prohibited.

4.2.7.5.4 Fill connections for vaults installed inside buildings shall comply with 4.3.2.5.5.

4.2.7.6 Exhaust Ventilation Systems. Vaults that contain tanks storing Class I liquids shall be ventilated at a rate of not less than 0.3 m³/min per m² of floor area (1 cfm/ft²), but not less than 4 m³/min (150 cfm). Such ventilation shall operate continuously or shall be designed to operate upon activation of a vapor and liquid detection system. Failure of the exhaust airflow shall automatically shut down the dispensing system. The

exhaust system shall be designed to provide air movement across all parts of the vault floor. Supply and exhaust ducts shall extend to within 75 mm (3 in.), but not more than 300 mm (12 in.), of the floor. The exhaust system shall be installed in accordance with the provisions of NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*.

4.2.7.7 Vapor and Liquid Detection Systems.

4.2.7.7.1 The vault shall be provided with an approved vapor and liquid detection system and equipped with on-site audible and visual warning devices with battery back-up.

4.2.7.7.2 Vapor detection systems shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower flammable limit of the liquid stored. Vapor detectors shall be located no higher than 300 mm (12 in.) above the lowest point in the vault.

4.2.7.7.3 Liquid detection systems shall sound an alarm upon detection of any liquid, including water. Liquid detectors shall be located in accordance with the manufacturer's instructions.

4.2.7.7.4 Activation of either the vapor detection system or the liquid detection system shall cause a signal to be sounded at an approved, constantly attended location within the facility serving the tanks or at an approved location.

4.2.7.8 Vault Installation. The vault shall be installed in accordance with the following requirements:

- (1) Each vault and its tank shall be anchored to resist uplifting by groundwater or flooding, including when the tank is empty.
- (2) Vaults that are not resistant to damage from the impact of a motor vehicle shall be protected by collision barriers.
- (3) Dispensing devices shall be permitted to be installed on the tops of vaults.
- (4) Means shall be provided to recover liquid from the vault. If a pump is used to meet this requirement, the pump shall not be permanently installed in the vault. Electric-powered portable pumps shall be approved for use in Class I, Division 1 locations, as defined in NFPA 70, *National Electrical Code*.
- (5) At each entry point, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Each entry point shall be secured against unauthorized entry and vandalism.

4.2.7.9 In lieu of the separation distance requirements given in 4.3.2.1.1, separation distances between the vault and any of the following shall be permitted to be reduced to 0 ft (0 m), as measured from the outer perimeter of the vault wall:

- (1) Any property line that is or can be built upon
- (2) The near and far sides of a public way
- (3) The nearest important building on the same property

4.2.7.10 Vaults and their required equipment shall be maintained in accordance with the construction requirements of 4.2.7.

4.2.8 Fire-Resistant Tanks. (Reserved)

4.2.9 Protected Tanks. Protected tanks shall be listed and shall be tested in accordance with UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*. Protected tanks shall also meet both of the following requirements:

- (1) The construction that provides the required fire-resistive protection shall reduce the heat transferred to the primary tank and shall prevent release of liquid, failure of the primary tank, failure of the supporting structure, and impairment of venting for a period of not less than 2 hours when tested using the fire exposure specified in UL 2085.
- (2) The size of the emergency vent shall not be permitted to be reduced, as would otherwise be permitted by 4.2.5.2.6.

4.3 Installation of Tanks and Tank Appurtenances.

4.3.1 Foundations for and Anchoring of Tanks.

4.3.1.1* Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel. Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation.

4.3.1.2 Where tanks are supported above their foundations, tank supports shall be installed on firm foundations. Supports for tanks storing Class I, Class II, or Class IIIA liquids shall be of concrete, masonry, or protected steel.

Exception: Single wood timber supports (not cribbing), laid horizontally, shall be permitted to be used for outside aboveground tanks if not more than 0.3 m (12 in.) high at their lowest point.

4.3.1.3* Steel support structures or exposed piling for tanks storing Class I, Class II, or Class IIIA liquids shall be protected by materials having a fire resistance rating of not less than 2 hours.

Exception No. 1: Steel saddles do not need to be protected if less than 0.3 m (12 in.) high at their lowest point.

Exception No. 2: At the discretion of the authority having jurisdiction, water spray protection in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, or NFPA 13, *Standard for the Installation of Sprinkler Systems*, or equivalent shall be permitted to be used.

4.3.1.4 Where a tank is located in an area subject to flooding, provisions shall be taken to prevent tanks, either full or empty, from floating during a rise in water level up to the established maximum flood stage.

4.3.2* Installation of Aboveground Tanks.

4.3.2.1 Location with Respect to Property Lines, Public Ways, and Important Buildings on the Same Property.

4.3.2.1.1 Tanks storing Class I, Class II, or Class IIIA stable liquids and operating at pressures not in excess of a gauge pressure of 17 kPa (2.5 psig) shall be located in accordance with Table 4.3.2.1.1(a) and Table 4.3.2.1.1(b). Where tank spacing is based on a weak roof-to-shell seam design, the user shall present evidence certifying such construction to the authority having jurisdiction upon request.

Exception: Vertical tanks with weak roof-to-shell seams (see 4.2.5.2.2) that store Class IIIA liquids shall be permitted to be located at one-half the distances specified in Table 4.3.2.1.1(a), provided the tanks are not within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid.

4.3.2.1.2 Tanks storing Class I, Class II, or Class IIIA stable liquids and operating at pressures that exceed a gauge pressure of 17 kPa (gauge pressure) (2.5 psig), or are equipped with emergency venting that will permit pressures to exceed a gauge pressure of 17 kPa (2.5 psig), shall be located in accordance with Table 4.3.2.1.2 and Table 4.3.2.1.1(b).

Table 4.3.2.1.1(a) Stable Liquids [Operating Pressure: Not over gauge pressure of 17 kPa (2.5 psig)]

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way ¹	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property ¹
Floating roof	Protection for exposures ²	$\frac{1}{2} \times$ diameter of tank	$\frac{1}{6} \times$ diameter of tank
	None	Diameter of tank but need not exceed 175 ft	$\frac{1}{6} \times$ diameter of tank
Vertical with weak roof-to-shell seam	Approved foam or inerting system ³ on tanks not exceeding 150 ft in diameter ⁴	$\frac{1}{2} \times$ diameter of tank	$\frac{1}{6} \times$ diameter of tank
	Protection for exposures ²	Diameter of tank	$\frac{1}{3} \times$ diameter of tank
	None	$2 \times$ diameter of tank but need not exceed 350 ft	$\frac{1}{3} \times$ diameter of tank
Horizontal and vertical tanks with emergency relief venting to limit pressures to 2.5 psig (gauge pressure of 17 kPa)	Approved inerting system ² on the tank or approved foam system on vertical tanks	$\frac{1}{2} \times$ Table 4.3.2.1.1(b) value	$\frac{1}{2} \times$ Table 4.3.2.1.1(b) value
	Protection for exposures ²	Table 4.3.2.1.1(b) value	Table 4.3.2.1.1(b) value
	None	$2 \times$ Table 4.3.2.1.1(b) value	Table 4.3.2.1.1(b) value
Protected aboveground tank	None	$\frac{1}{2} \times$ Table 4.3.2.1.1(b) value	$\frac{1}{2} \times$ Table 4.3.2.1.1(b) value

Note: For SI units, 1 ft = 0.3 m.

¹The minimum distance shall not be less than 5 ft.

²See definition 3.3.35, Protection for Exposures.

³See NFPA 69, *Standard on Explosion Prevention Systems*.

⁴For tanks over 45 m (150 ft) in diameter, use "Protection for Exposures" or "None," as applicable.

Table 4.3.2.1.1(b) Reference Table for Use in Tables 4.3.2.1.1(a), 4.3.2.1.2, and 4.3.2.1.4

Tank Capacity (gal)	Minimum Distance (ft)	
	From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

Note: For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.

Table 4.3.2.1.2 Stable Liquids [Operating Pressure: Greater than gauge pressure of 17 kPa (2.5 psig)]

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Any type	Protection for exposures [†]	$1\frac{1}{2} \times$ Table 4.3.2.1.1(b) value but shall not be less than 25 ft	$1\frac{1}{2} \times$ Table 4.3.2.1.1(b) value but shall not be less than 25 ft
	None	$3 \times$ Table 4.3.2.1.1(b) value but shall not be less than 50 ft	$1\frac{1}{2} \times$ Table 4.3.2.1.1(b) value but shall not be less than 25 ft

Note: For SI units, 1 ft = 0.3 m.

[†]See definition 3.3.35, Protection for Exposures.

4.3.2.1.3 Tanks storing liquids with boil-over characteristics shall be located in accordance with Table 4.3.2.1.3. Liquids with boil-over characteristics shall not be stored in fixed roof tanks larger than 45 m (150 ft) in diameter, unless an approved inerting system is provided on the tank.

4.3.2.1.4 Tanks storing unstable liquids shall be located in accordance with Table 4.3.2.1.4 and Table 4.3.2.1.1(b).

4.3.2.1.5 Tanks storing Class IIIB stable liquids shall be located in accordance with Table 4.3.2.1.5.

Exception: If located within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid, the tank storing Class IIIB liquid shall be located in accordance with 4.3.2.1.1.

Table 4.3.2.1.3 Boil-Over Liquids

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way ¹	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property ¹
Floating roof [see Table 4.3.2.1.1(a)]	Protection for exposures ²	$\frac{1}{2} \times$ diameter of tank	$\frac{1}{6} \times$ diameter of tank
	None	Diameter of tank	$\frac{1}{6} \times$ diameter of tank
Fixed roof	Approved foam or inerting system ³	Diameter of tank	$\frac{1}{3} \times$ diameter of tank
	Protection for exposures ²	$2 \times$ diameter of tank	$\frac{2}{3} \times$ diameter of tank
	None	$4 \times$ diameter of tank but need not exceed 350 ft	$\frac{2}{3} \times$ diameter of tank

Note: For SI units, 1 ft = 0.3 m.

¹The minimum distance shall not be less than 5 ft.

²See definition 3.3.35, Protection for Exposures.

³See NFPA 69, *Standard on Explosion Prevention Systems*.

Table 4.3.2.1.4 Unstable Liquids

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Horizontal and vertical tanks with emergency relief venting to permit pressure not in excess of a gauge pressure of 17 kPa (2.5 psig)	Tank protected with any one of the following: approved water spray, approved inerting, ¹ approved insulation and refrigeration, approved barricade	Table 4.3.2.1.1(b) value but not less than 25 ft	Not less than 25 ft
	Protection for exposures ²	$2\frac{1}{2} \times$ Table 4.3.2.1.1(b) value but not less than 50 ft	Not less than 50 ft
	None	$5 \times$ Table 4.3.2.1.1(b) value but not less than 100 ft	Not less than 100 ft
Horizontal and vertical tanks with emergency relief venting to permit pressure over a gauge pressure of 17 kPa (2.5 psig)	Tank protected with any one of the following: approved water spray, approved inerting, ¹ approved insulation and refrigeration, approved barricade	$2 \times$ Table 4.3.2.1.1(b) value but not less than 50 ft	Not less than 50 ft
	Protection for exposures ²	$4 \times$ Table 4.3.2.1.1(b) value but not less than 100 ft	Not less than 100 ft
	None	$8 \times$ Table 4.3.2.1.1(b) value but not less than 150 ft	Not less than 150 ft

Note: For SI units, 1 ft = 0.3 m.

¹See NFPA 69, *Standard on Explosion Prevention Systems*.

²See definition 3.3.35, Protection for Exposures.

Table 4.3.2.1.5 Class IIIB Liquids

Tank Capacity (gal)	Minimum Distance (ft)	
	From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
12,000 or less	5	5
12,001 to 30,000	10	5
30,001 to 50,000	10	10
50,001 to 100,000	15	10
100,001 or more	15	15

Note: For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.

4.3.2.1.6 Where two tank properties of diverse ownership have a common boundary, the authority having jurisdiction shall be permitted, with the written consent of the owners of the two properties, to substitute the distances provided in 4.3.2.2 for the minimum distances set forth in 4.3.2.1.

4.3.2.1.7 Where end failure of a horizontal pressure tank or vessel can expose property, the tank or vessel shall be placed with its longitudinal axis parallel to the nearest important exposure.

4.3.2.2 Shell-to-Shell Spacing Between Any Two Adjacent Aboveground Tanks.

4.3.2.2.1 Tanks storing Class I, Class II, or Class III stable liquids shall be separated by the distances given in Table 4.3.2.2.1.

Exception No. 1: Tanks storing crude petroleum that have individual capacities not exceeding 480 m³ (126,000 gal or 3000 bbl) and that are located at production facilities in isolated locations do not need to be separated by more than 0.9 m (3 ft).

Exception No. 2: Tanks used only for storing Class IIIB liquids need not be separated by more than 0.9 m (3 ft) provided they are not within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid.

4.3.2.2.2 A tank storing unstable liquid shall be separated from any other tank containing either an unstable liquid or a Class I, II, or III liquid by a distance not less than one-half the sum of their diameters.

4.3.2.2.3 Where tanks are in a diked area containing Class I or Class II liquids or in the drainage path of Class I or Class II liquids and are compacted in three or more rows or in an irregular pattern, greater spacing or other means shall be permitted to be required by the authority having jurisdiction to make tanks in the interior of the pattern accessible for fire-fighting purposes.

4.3.2.2.4 The minimum horizontal separation between an LP-Gas container and a Class I, Class II, or Class IIIA liquid storage tank shall be 6 m (20 ft). Suitable measures shall be taken to prevent the accumulation of Class I, Class II, or Class IIIA liquids under adjacent LP-Gas containers such as by dikes, diversion curbs, or grading. Where flammable or combustible liquid storage tanks are within a diked area, the LP-Gas containers shall be outside the diked area and at least 3 m (10 ft) away from the centerline of the wall of the diked area.

Exception No. 1: If a tank storing a Class I, Class II, or Class IIIA liquid operates at pressures exceeding a gauge pressure of 17 kPa (2.5 psig) or is equipped with emergency relief venting that will permit pressures to exceed a gauge pressure of 17 kPa (2.5 psig), it shall be separated from an LP-Gas container by the distance given in 4.3.2.2.1.

Exception No. 2: The requirements of 4.3.2.2.4 shall not apply where LP-Gas containers of 475 L (125 gal) or less capacity are installed adjacent to fuel oil supply tanks of 2500 L (660 gal) or less capacity.

4.3.2.3 Control of Spills from Aboveground Tanks. Every tank that contains a Class I, Class II, or Class IIIA liquid shall be provided with means to prevent an accidental release of liquid from endangering important facilities and adjoining property or from reaching waterways. Such means shall meet the requirements of 4.3.2.3.1, 4.3.2.3.2, or 4.3.2.3.3, whichever is applicable.

4.3.2.3.1 Remote Impounding. Where control of spillage is by means of drainage to a remote impounding area, so that impounded liquid will not be held against tanks, such systems shall comply with the following:

- (1) A slope of not less than 1 percent away from the tank shall be provided for at least 15 m (50 ft) toward the impounding area.

Table 4.3.2.2.1 Minimum Tank Spacing (Shell-to-Shell)

Tank Diameter	Floating Roof Tanks	Fixed or Horizontal Tanks	
		Class I or II Liquids	Class IIIA Liquids
All tanks not over 45 m (150 ft) in diameter	$\frac{1}{6} \times$ sum of adjacent tank diameters but not less than 0.9 m (3 ft)	$\frac{1}{6} \times$ sum of adjacent tank diameters but not less than 0.9 m (3 ft)	$\frac{1}{6} \times$ sum of adjacent tank diameters but not less than 0.9 m (3 ft)
Tanks larger than 45 m (150 ft) in diameter:			
If remote impounding is provided in accordance with 4.3.2.3.1	$\frac{1}{6} \times$ sum of adjacent tank diameters	$\frac{1}{4} \times$ sum of adjacent tank diameters	$\frac{1}{6} \times$ sum of adjacent tank diameters
If diking is provided in accordance with 4.3.2.3.2	$\frac{1}{4} \times$ sum of adjacent tank diameters	$\frac{1}{3} \times$ sum of adjacent tank diameters	$\frac{1}{4} \times$ sum of adjacent tank diameters

- (2) The impounding area shall have a capacity not less than that of the largest tank that can drain into it.

Exception: Where this is not possible because there is not enough open area around the tanks or is impractical, "partial" remote impounding for some percentage of the required capacity remote from any tank or adjoining property shall be permitted to be provided. The required volume exceeding the capacity of the partial remote impoundment shall be provided for by diking meeting the requirements of 4.3.2.3.2.

- (3) The route of the drainage system shall be so located that, if the liquid in the drainage system is ignited, the fire will not seriously expose tanks or adjoining property.
- (4) The confines of the impounding area shall be located so that, when filled to capacity, the liquid level will not be closer than 15 m (50 ft) from any property line that is or can be built upon or from any tank. Where partial remote impounding is used, the liquid level in the partial impounding shall meet the requirements of 4.3.2.3.1. The excess volume shall meet the requirements of impounding by diking as provided or as in 4.3.2.3.2. Tank spacing shall be determined based on the diked tank provisions of Table 4.3.2.2.1.

4.3.2.3.2 Impounding Around Tanks by Diking. Where protection of adjoining property or waterways is by means of impounding by diking around the tanks, such systems shall comply with 4.3.2.3.2(A) through 4.3.2.3.2(H).

(A) A slope of not less than 1 percent away from the tank shall be provided for at least 15 m (50 ft) or to the dike base, whichever is less.

(B)* The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike.

(C) To permit access, the outside base of the dike at ground level shall be no closer than 3 m (10 ft) to any property line that is or can be built upon.

(D)* Walls of the diked area shall be of earth, steel, concrete, or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. Earthen walls 0.9 m (3 ft) or more in height shall have a flat section at the top not less than 0.6 m (2 ft) wide. The slope of an earthen wall shall be consistent with the angle of repose of the material of which the wall is constructed.

(E) The walls of the diked area shall be restricted to an average interior height of 1.8 m (6 ft) above interior grade.

Exception: Dikes shall be permitted to exceed this height where provisions are made for normal access, necessary emergency access to tanks, valves, and other equipment, and safe egress from the diked enclosure, and where the following requirements are met:

- (1) Where the average height of the dike containing Class I liquids is over 3.6 m (12 ft) high, measured from interior grade, or where the distance between any tank and the top inside edge of the dike wall is less than the height of the dike wall, provisions shall be made for normal operation of valves and for access to tank roof(s) without entering below the top of the dike. These provisions shall be permitted to be met through the use of remote-operated valves, elevated walkways, or similar arrangements.

- (2) Piping passing through dike walls shall be designed to prevent excessive stresses as a result of settlement or fire exposure.
- (3) The minimum distance between tanks and toe of the interior dike walls shall be 1.5 m (5 ft).

(F) Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate dikes, in order to prevent spills from endangering adjacent tanks within the diked area as follows:

- (1) Where storing normally stable liquids in vertical cone roof tanks constructed with weak roof-to-shell seams or in floating roof tanks, or when storing crude petroleum in producing areas in any type of tank, one subdivision shall be provided for each tank greater than 1590 m³ (420,000 gal or 10,000 bbl) capacity. In addition, one subdivision shall be provided for each group of tanks [no individual tank exceeding 1590 m³ (420,000 gal or 10,000 bbl) capacity] having an aggregate capacity not greater than 2385 m³ (630,000 gal or 15,000 bbl).
- (2) Where storing normally stable liquids in tanks not covered in 4.3.2.3.2(F)(1), one subdivision shall be provided for each tank greater than 380 m³ (100,000 gal or 2380 bbl) capacity. In addition, one subdivision shall be provided for each group of tanks [no individual tank exceeding 380 m³ (100,000 gal or 2380 bbl) capacity] having an aggregate capacity not greater than 570 m³ (150,000 gal or 3570 bbl).
- (3)*Where storing unstable liquids in any type of tank, one subdivision shall be provided for each tank.

Exception: Tanks installed with drainage meeting the requirements of NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, need not meet this requirement.

- (4) Whenever two or more tanks storing Class I liquids, any one of which is over 45 m (150 ft) in diameter, are located in a common diked area, intermediate dikes shall be provided between adjacent tanks to hold at least 10 percent of the capacity of the tank so enclosed, not including the volume displaced by the tank.
- (5) The drainage channels or intermediate dikes shall be located between tanks so as to take full advantage of the available space with due regard for the individual tank capacities. Intermediate dikes, where used, shall be not less than 450 mm (18 in.) in height.

(G) Where provision is made for draining water from diked areas, such drains shall be controlled to prevent liquids from entering natural water courses, public sewers, or public drains. Control of drainage shall be accessible under fire conditions from outside the dike.

(H) Storage of combustible materials, empty or full drums, or barrels, shall not be permitted within the diked area.

4.3.2.3.3 Secondary Containment Tanks. Where a secondary containment tank is used to provide spill control, the tank shall meet all of the following requirements:

- (1) The capacity of the tank shall not exceed 45,400 L (45.4 m³ or 12,000 gal).
- (2) All piping connections to the tank shall be made above the normal maximum liquid level.
- (3) Means shall be provided to prevent the release of liquid from the tank by siphon flow.
- (4) Means shall be provided for determining the level of liquid in the tank. This means shall be accessible to the delivery operator.

- (5) Means shall be provided to prevent overfilling by sounding an alarm when the liquid level in the tank reaches 90 percent of capacity and by automatically stopping delivery of liquid to the tank when the liquid level in the tank reaches 95 percent of capacity. In no case shall these provisions restrict or interfere with the proper functioning of the normal vent or the emergency vent.
- (6) Spacing between adjacent tanks shall be not less than 0.9 m (3 ft).
- (7) The tank shall be capable of resisting the damage from the impact of a motor vehicle or suitable collision barriers shall be provided.
- (8) Where the means of secondary containment is enclosed, it shall be provided with emergency venting in accordance with 4.2.5.2.
- (9) Means shall be provided to establish the integrity of the secondary containment, in accordance with 4.4.2.3 and 4.4.2.4. The secondary containment shall be designed to withstand the hydrostatic head resulting from a leak from the primary tank of the maximum amount of liquid that can be stored in the primary tank.

4.3.2.3.4 Equipment, Piping, and Fire Protection Systems in Remote Impoundment Areas or Diked Areas.

4.3.2.3.4.1* Piping Location. Only piping for product, utility, or fire protection purposes directly connected to a tank or tanks within a single diked area shall be routed through a diked area, a remote impoundment area, a spillway draining to a remote impoundment area, or above a storage tank drainage area where the piping can be exposed to a fire.

Exception: Piping for other product lines and from adjacent tanks shall be permitted to be routed through such areas if engineering designs are provided to incorporate features to prevent the piping from creating an exposure hazard.

4.3.2.3.4.2 Drainage. Drainage shall be arranged to prevent accumulation of any liquid under the piping by sloping the grade in accordance with 4.3.2.3.2. Corrosion-resistant piping and piping that is protected against corrosion shall be permitted to be buried where such drainage is not provided or is not practical.

4.3.2.3.4.3* Equipment Location. If located in a remote impoundment area, a diked area, or a spillway draining to a remote impoundment area, process equipment, pumps, instrumentation, and electrical utilization equipment shall be located or protected so that a fire involving such equipment does not constitute an exposure hazard to the tank or tanks in the same area for a period of time consistent with the response and suppression capabilities of the fire-fighting operations available to the location.

4.3.2.3.4.4 Fire Protection Systems. Hose connections, controls, and control valves for application of fire protection foam or water to tanks shall be located outside remote impoundment areas, diked areas, or spillways draining to a remote impoundment area.

4.3.2.3.4.5 Combustible Materials. Structures such as stairways, walkways, instrumentation shelters, and supports for piping and equipment that are located in a remote impoundment area, diked area, or spillway draining to a remote impoundment area shall be constructed of noncombustible materials.

4.3.2.4 Vent Piping for Aboveground Tanks. Piping for normal and emergency relief venting shall be constructed in accordance with Chapter 5.

4.3.2.5 Tank Openings Other than Vents for Aboveground Tanks.

4.3.2.5.1 Each connection to an aboveground tank through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of the tank.

4.3.2.5.2 Each connection below the liquid level through which liquid does not normally flow shall be provided with a liquidtight closure such as a valve, plug, or blind, or a combination of these.

4.3.2.5.3 Openings for gauging on tanks storing Class I liquids shall be provided with a vaportight cap or cover.

4.3.2.5.4* Fill pipes that enter the top of a tank shall terminate within 150 mm (6 in.) of the bottom of the tank. Fill pipes shall be installed or arranged so that vibration is minimized.

Exception No. 1: Fill pipes in tanks whose vapor space under the expected range of normal operating conditions is not in the flammable range or is inerted need not meet this requirement.

Exception No. 2: Fill pipes in tanks handling liquids with minimal potential for accumulation of static electricity need not meet this requirement provided that the fill line is designed and the system is operated to avoid mist generation and an adequate level of residence time is provided downstream of filters or screens such that the charge generated is dissipated.

4.3.2.5.5 Filling and emptying connections for Class I, Class II, and Class IIIA liquids that are connected and disconnected shall be located outside of buildings at a location free from any source of ignition. They shall be located not less than 1.5 m (5 ft) away from any building opening. Such connections for any liquid shall be closed and liquidtight when not in use and shall be properly identified.

4.3.2.6 Requirements for Aboveground Tanks Located in Areas Subject to Flooding.

4.3.2.6.1 Vertical tanks shall be located so that the tops of the tanks extend above the maximum flood stage by at least 30 percent of their allowable storage capacity.

4.3.2.6.2 Horizontal tanks that are located where more than 70 percent of the tank's storage capacity will be submerged at the established flood stage shall be secured by one of the following methods:

- (1) Anchored to resist movement
- (2) Attached to a foundation of steel and concrete or of concrete having sufficient weight to provide adequate load for the tank when filled with liquid and submerged by flood water to the established flood stage
- (3) Adequately secured from floating by other means

4.3.2.6.3 Tank vents or other openings that are not liquidtight shall extend above the maximum flood stage water level.

4.3.2.6.4 A dependable water supply shall be available for filling an empty or partially filled tank.

Exception: Where filling the tank with water is impractical or hazardous because of the contents of the tank, the tank shall be protected by other means against movement or collapse.

4.3.2.6.5 Spherical or spheroid tanks shall be protected by any of the methods specified in this 4.3.2.6.

4.3.2.7 Collision Protection. Where a tank might be exposed to vehicular impact, protection shall be provided to prevent damage to the tank.

4.3.2.8 Installation Instructions. Factory-built aboveground tanks shall be provided with instructions for testing and for installation of the normal and emergency vents.

4.3.3 Installation of Underground Tanks.

4.3.3.1 Location. Excavation for underground tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks or tanks under buildings shall be so located with respect to existing building foundations and supports that the loads carried by the latter cannot be transmitted to the tank. The distance from any part of a tank storing Class I liquids to the nearest wall of any basement or pit shall be not less than 0.3 m (1 ft), and to any property line that can be built upon, not less than 0.9 m (3 ft). The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit, or property line shall be not less than 0.3 m (1 ft).

4.3.3.2 Burial Depth and Cover.

4.3.3.2.1* All underground tanks shall be installed in accordance with the manufacturer's instructions and shall be set on firm foundations and surrounded with at least 150 mm (6 in.) of noncorrosive inert material such as clean sand or gravel well-tamped in place. The tank shall be placed in the hole with care.

4.3.3.2.2 Underground tanks shall be covered with not less than 600 mm (24 in.) of earth, or with not less than 300 mm (12 in.) of earth on top of which shall be placed a slab of reinforced concrete not less than 100 mm (4 in.) thick. Where the tanks are, or are likely to be, subjected to traffic, they shall be protected against damage from vehicles passing over them by at least 900 mm (36 in.) of earth cover, or 450 mm (18 in.) of well-tamped earth plus either 150 mm (6 in.) of reinforced concrete or 200 mm (8 in.) of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least 300 mm (12 in.) horizontally beyond the outline of the tank in all directions.

4.3.3.2.3 Maximum depth of cover shall be specified by the tank manufacturer and marked on the tank. When the depth of cover is greater than the diameter of the tank or if the pressure at the bottom of the tank can exceed a gauge pressure of 69 kPa (10 psig), the manufacturer of the tank shall be consulted to determine if reinforcement of the tank is required. The specific gravity of the liquid to be stored shall be a design factor.

4.3.3.3 Vent Piping for Underground Tanks. Vent pipes from underground tanks shall be installed in accordance with Chapter 5.

4.3.3.4 Tank Openings Other than Vents for Underground Tanks.

4.3.3.4.1 Connections for all tank openings shall be liquidtight.

4.3.3.4.2 Openings for manual gauging, if independent of the fill pipe, shall be provided with a liquidtight cap or cover. Covers shall be kept closed when not gauging. If inside a building, each such opening shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device.

4.3.3.4.3 Fill and discharge lines shall enter tanks only through the top. Fill lines shall be sloped toward the tank. Underground tanks for Class I liquids having a capacity of

more than 3800 L (1000 gal) shall be equipped with a tight fill device for connecting the fill hose to the tank.

4.3.3.4.4 Fill pipes that enter the top of a tank shall terminate within 150 mm (6 in.) of the bottom of the tank. Fill pipes shall be installed or arranged so that vibration is minimized.

Exception No. 1: Fill pipes in tanks whose vapor space under the expected range of normal operating conditions is not in the flammable range or is inerted need not meet this requirement.

Exception No. 2: Fill pipes in tanks handling liquids with minimal potential for accumulation of static electricity need not meet this requirement provided that the fill line is designed and the system operated to avoid mist generation and an adequate level of residence time is provided downstream of filters or screens such that the charge generated is dissipated. (See A.4.3.2.5.4.)

4.3.3.4.5 Filling and emptying and vapor recovery connections for Class I, Class II, or Class IIIA liquids that are connected and disconnected shall be located outside of buildings at a location free from any source of ignition and not less than 1.5 m (5 ft) away from any building opening. Such connections shall be closed and liquidtight when not in use and shall be properly identified.

4.3.3.4.6 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection, or other approved device, unless the opening is pipe-connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. All connections shall be vaportight.

4.3.3.5 Requirements for Underground Tanks Located in Areas Subject to Flooding.

4.3.3.5.1 At locations where an ample and dependable water supply is available, underground tanks containing flammable or combustible liquids, placed so that more than 70 percent of their storage capacity will be submerged at the maximum flood stage, shall be so anchored, weighted, or secured as to prevent movement when filled or loaded with water and submerged by floodwater to the established flood stage. Tank vents or other openings that are not liquidtight shall be extended above maximum flood stage water level.

4.3.3.5.2 At locations where an ample and dependable water supply is not available or where filling of underground tanks with water is impractical because of the contents, each tank shall be safeguarded against movement when empty and submerged by high groundwater or floodwater by anchoring or by securing by other means. Each such tank shall be so constructed and installed that it will safely resist external pressures if submerged.

4.3.4 Storage Tank Buildings.

4.3.4.1* Scope. Subsection 4.3.4 shall apply to installations of tanks storing Class I, Class II, and Class IIIA liquids in storage tank buildings. This subsection shall not specifically apply to such tanks in process areas. (See Chapter 7.) Tanks storing Class IIIB liquids shall not be required to comply with the provisions of this subsection. A tank installation that has a canopy or roof that does not limit the dissipation of heat or dispersion of flammable vapors and does not restrict fire-fighting access and control shall be treated as an outside aboveground tank. (See 3.3.6.3.)

Exception: Tanks that meet the requirements of Section 7.5.

4.3.4.2 Location. Tanks and any associated equipment within the storage tank building shall be so located that a fire in the area shall not constitute an exposure hazard to adjoining buildings or tanks for a period of time consistent with the response and suppression capabilities of the fire-fighting operations available to the location. Compliance with 4.3.4.2.1 through 4.3.4.2.5 shall be deemed as meeting the requirements of 4.3.4.2.

4.3.4.2.1 The minimum distance from exposed property lines and buildings for tank installations within structures having walls with a fire resistance rating of less than 2 hours shall be in accordance with Table 4.3.4.2.1. Capacity of any individual tank shall not exceed 380 m³ (100,000 gal or 2380 bbl) without the approval of the authority having jurisdiction.

Exception: As modified by 4.3.4.2.2.

4.3.4.2.2 Where a storage tank building has an exterior wall facing an exposure, the distances in Table 4.3.4.2.1 shall be permitted to be modified as follows:

- (1) Where the wall is a blank wall having a fire resistance rating of not less than 2 hours, separation distance between the storage tank building and its exposure need not be greater than 7.6 m (25 ft).
- (2)*Where a blank wall having a fire resistance rating of not less than 4 hours is provided, the distance requirements of Table 4.3.4.2.1 shall not apply. In addition, where Class IA or unstable liquids are stored, the exposing wall shall have explosion resistance in accordance with recognized engineering standards, and adequate deflagration venting shall be provided in the nonexposing walls and roof.

4.3.4.2.3 Other equipment associated with tanks, such as pumps, heaters, filters, and exchangers, shall not be located closer than 7.6 m (25 ft) to property lines where the adjoining property is or can be built upon or to the nearest important building on the same property that is not an integral part of the storage tank building.

Exception: This spacing requirement shall not apply where exposures are protected as outlined in 4.3.4.2.2.

4.3.4.2.4 Tanks in which unstable liquids are stored shall be separated from potential fire exposures by a clear space of at least 7.6 m (25 ft) or by a wall having a fire resistance rating of not less than 2 hours.

4.3.4.2.5 Each storage tank building and each tank within the building shall be accessible from at least two sides for fire fighting and fire control.

4.3.4.3 Construction of Tank Buildings.

4.3.4.3.1 Storage tank buildings shall be constructed so as to maintain structural integrity for 2 hours under fire exposure conditions and to provide adequate access and egress for unobstructed movement of all personnel and fire protection equipment. Compliance with 4.3.4.3.2 through 4.3.4.3.7 shall be deemed as meeting the requirements of 4.3.4.3.1.

4.3.4.3.2* Buildings or structures shall be of at least 2-hour fire resistance rating except that noncombustible or combustible construction shall be permitted when protected by automatic sprinklers or equivalent protection subject to the approval of the authority having jurisdiction.

4.3.4.3.3 Class I liquids and Class II or Class IIIA liquids heated above their flash points shall not be stored in basements. Means shall be provided to prevent liquid spills from running into basements. Where Class I liquids are stored above grade within buildings with basements or other below-grade areas into which flammable vapors can travel, such below-grade areas shall be provided with mechanical ventilation designed to prevent the accumulation of flammable vapors. Enclosed storage tank pits shall not be considered basements.

4.3.4.3.4* Storage tanks shall be separated from other occupancies within the building by construction having at least a 2-hour fire resistance rating. As a minimum, each opening shall be protected by either a listed, self-closing fire door or a listed fire damper having a minimum 1-hour fire protection rating. The fire door or fire damper shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*; NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*; or NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, whichever is applicable. Where Class IA or unstable liquids are being stored, deflagration vents shall be provided to the exterior of the building, and any walls separating this storage from other occupancies shall have explosion resistance in accordance with recognized engineering standards. Adequate deflagration venting shall be provided for the non-exposing walls.

Table 4.3.4.2.1 Location of Storage Tank Buildings with Respect to Property Lines, Public Ways, and the Nearest Important Building on the Same Property[†]

Largest Tank — Operating Liquid Capacity (gal)	Minimum Distance from Property Line that Is or Can Be Built Upon, Including Opposite Side of Public Way (ft)				Minimum Distance from Nearest Side of Any Public Way or from Nearest Important Building on Same Property (ft)			
	Stable Liquid Emergency Relief		Unstable Liquid Emergency Relief		Stable Liquid Emergency Relief		Unstable Liquid Emergency Relief	
	Not over 2.5 psig	Over 2.5 psig	Not over 2.5 psig	Over 2.5 psig	Not over 2.5 psig	Over 2.5 psig	Not over 2.5 psig	Over 2.5 psig
Up to 12,000	15	25	40	60	5	10	15	20
12,001 to 30,000	20	30	50	80	5	10	15	20
30,001 to 50,000	30	45	75	120	10	15	25	40
50,001 to 100,000	50	75	125	200	15	25	40	60

Note: For SI units, 1 gal = 3.8 L; 1 ft = 0.3 m; 1 psig = 6.9 kPa.

[†]Double all distances shown if protection for exposures is not provided. Distances need not exceed 90 m (300 ft).

4.3.4.3.5* Storage tank buildings shall have exit facilities arranged to prevent occupants from being trapped in the event of fire. Exits shall not be exposed by the drainage facilities described in 4.3.4.5.

4.3.4.3.6 Access aisles of at least 0.9 m (3 ft) shall be maintained for movement of fire-fighting personnel and fire protection equipment.

4.3.4.3.7 Clearance between the top of the tank and the building structure shall be a minimum of 0.9 m (3 ft) for buildings protected in accordance with 4.3.4.12.3. For buildings without fixed fire suppression systems, space shall be provided to allow for the application of hose streams to the top of the tank(s) for cooling purposes.

4.3.4.4 Ventilation of Tank Buildings.

4.3.4.4.1 Storage tank buildings storing Class I liquids, or Class II or Class IIIA liquids at temperatures above their flash points, shall be ventilated at a rate sufficient to maintain the concentration of vapors within the building at or below 25 percent of the lower flammable limit. Compliance with 4.3.4.4.2 through 4.3.4.4.5 shall be deemed as meeting the requirements of 4.3.4.4.1.

4.3.4.4.2* Ventilation requirements shall be confirmed by one of the following procedures:

- (1) Calculations based on the anticipated fugitive emissions. (*See Annex F for calculation methods.*)
- (2) Sampling of the actual vapor concentration under normal operating conditions. The sampling shall be conducted at a distance of 1.5 m (5 ft) radius from each potential vapor source extending to or toward the bottom and the top of the enclosed storage area. The vapor concentration used to determine the required ventilation rate shall be the highest measured concentration during the sampling procedure.
- (3) Ventilation at a rate of not less than $0.3 \text{ m}^3/\text{min}$ of exhaust air for each m^2 of solid floor area ($1 \text{ cfm}/\text{ft}^2$).

4.3.4.4.3 Ventilation shall be accomplished by natural or mechanical ventilation, with discharge or exhaust to a safe location outside the building, without recirculation of the exhaust air.

Exception: Recirculation is permitted where it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor-air mixtures having concentrations over 25 percent of the lower flammable limit are detected.

4.3.4.4.4* Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation. Ventilation shall be arranged to include all floor areas or pits where flammable vapors can collect. Where natural ventilation is inadequate, mechanical ventilation shall be provided and shall be kept in operation while flammable liquids are being handled. Local or spot ventilation, if provided, shall be permitted to be used for up to 75 percent of the required ventilation.

4.3.4.4.5 For storage tank buildings with the interior grade more than 300 mm (1 ft) below the average exterior grade, continuous mechanical ventilation in accordance with 4.3.4.4.2(3) shall be provided or a vapor detection system shall be provided and set to give a warning alarm at 25 percent of the lower flammable limit and to start the mechanical ventilation system. The alarm shall sound at a constantly attended location.

4.3.4.5 Drainage from Tank Buildings.

4.3.4.5.1 Drainage systems shall be designed to minimize fire exposure to other tanks and adjacent properties or waterways. Compliance with 4.3.4.5.2 through 4.3.4.5.6 shall be deemed as meeting the requirements of 4.3.4.5.1.

4.3.4.5.2 A facility shall be designed and operated to prevent the normal discharge of flammable or combustible liquids to public waterways, public sewers, or adjoining property.

4.3.4.5.3 Except for drains, solid floors shall be liquidtight and the room shall be liquidtight where the walls join the floor and for at least 100 mm (4 in.) above the floor.

4.3.4.5.4 Openings in interior walls to adjacent rooms or buildings shall be provided with noncombustible, liquidtight raised sills or ramps at least 100 mm (4 in.) in height or shall be otherwise designed to prevent the flow of liquids to the adjoining areas. An open-grated trench across the width of the opening inside of the room that drains to a safe location shall be permitted to be used as an alternative to a sill or ramp.

4.3.4.5.5* The containment area shall have a capacity not less than that of the largest tank that can drain into it. Emergency drainage systems shall be provided to direct flammable or combustible liquid leakage and fire protection water to a safe location. Curbs, scuppers, or special drainage systems shall be permitted to be used. (*See 4.3.2.3.*)

4.3.4.5.6 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators.

4.3.4.6 Vents for Tanks Inside Tank Buildings.

4.3.4.6.1 Vents for tanks inside tank buildings shall be designed to ensure that vapors are not released inside the building. Compliance with 4.3.4.6.2 and 4.3.4.6.3 shall be deemed as meeting the requirements of 4.3.4.6.1.

4.3.4.6.2 Vents for tanks inside tank buildings shall be as required in 4.2.5.1 and 4.2.5.2, except that emergency venting by the use of weak roof-to-shell seam shall not be permitted. Automatic sprinkler systems designed in accordance with the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be accepted by the authority having jurisdiction as equivalent to water spray systems for purposes of calculating the required airflow rates for emergency vents in 4.2.5.2.6, provided the density and coverage requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, are met. Vents shall terminate outside the building.

4.3.4.6.3 Piping for normal and emergency relief venting shall meet the requirements of Chapter 5.

4.3.4.7 Tank Openings Other than Vents for Tanks Inside Tank Buildings.

4.3.4.7.1 Tank openings other than vents for tanks inside tank buildings shall be designed to ensure that flammable liquids or vapors are not released inside the building. Compliance with 4.3.4.7.2 through 4.3.4.7.9 shall be deemed as meeting the requirements of 4.3.4.7.1.

4.3.4.7.2 All tank openings that are located at or below the maximum liquid level shall be liquidtight; those that are located above the maximum liquid level shall be normally closed and shall be mechanically secured to prevent release of vapors.

4.3.4.7.3 Each connection through which liquid can gravity flow from a tank inside a building shall be provided with an internal or an external valve located as close as practical to the shell of the tank.

4.3.4.7.4 Each liquid transfer connection on any tank storing Class I or Class II liquids inside buildings shall be provided with one of the following:

- (1) A normally closed remotely activated valve
- (2) An automatic-closing, heat-activated valve
- (3) Another approved device

Exception: Connections used for emergency disposal or to provide for quick cutoff of flow in the event of fire in the vicinity of the tank need not meet this requirement.

4.3.4.7.4.1 The requirements of 4.3.4.7.4 shall be permitted to be met by the valve required in 4.3.4.7.3. If a separate valve is used, it shall be located adjacent to the valve required in 4.3.4.7.3.

4.3.4.7.5* Openings for manual gauging of Class I or Class II liquids, if independent of the fill pipe, shall be provided with a vaportight cap or cover. Openings shall be kept closed when not in use. Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device.

4.3.4.7.6 Fill pipes that enter the top of a tank shall terminate within 150 mm (6 in.) of the bottom of the tank. Fill pipes shall be installed or arranged so that vibration is minimized.

Exception No. 1: Fill pipes in tanks whose vapor space under the expected range of normal operating conditions is not in the flammable range or is inerted need not meet this requirement.

Exception No. 2: Fill pipes in tanks handling liquids with minimal potential for accumulation of static electricity need not meet this requirement provided that the fill line is designed and the system operated to avoid mist generation and an adequate level of residence time is provided downstream of filters or screens such that the charge generated is dissipated. (See A.4.3.2.5.4.)

4.3.4.7.7 The inlet of the fill pipe and the outlet of a vapor recovery line for which connections to tank vehicles and tank cars are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 1.5 m (5 ft) away from any building opening. Such connections shall be closed tight and protected against tampering when not in use and shall be identified.

4.3.4.7.8* Tanks storing Class I, Class II, or Class IIIA liquids inside buildings shall be equipped with a device, or other means shall be provided, to prevent overflow into the building.

4.3.4.7.9 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection or other approved device, unless the opening is pipe-connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. All connections shall be vaportight.

4.3.4.8 Electrical Systems for Tank Buildings. Installation of electrical utilization equipment and wiring shall meet the requirements of Chapter 8. Chapter 8 shall be used to determine the extent of classified locations for the purpose of installation of electrical equipment. In establishing the extent of a classified location, it shall not extend beyond a

floor, wall, roof, or other solid partition that has no openings, within the classified area.

4.3.4.9 Inspection and Maintenance for Tank Buildings.

4.3.4.9.1 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily.

4.3.4.9.2 Storage of combustible materials and empty or full drums or barrels shall not be permitted within the storage tank building.

4.3.4.10 Detection and Alarm for Tank Buildings.

4.3.4.10.1 An approved means shall be provided to promptly notify those within the plant and the available public or mutual aid fire department of any fire or other emergency.

4.3.4.10.2 Those areas, including buildings, where the potential exists for a flammable liquid spill shall be monitored as appropriate. Such methods shall include both of the following:

- (1) Personnel observation or patrol
- (2) Monitoring equipment that indicates a spill or leak has occurred in an unattended area

4.3.4.11 Portable Fire Control Equipment for Tank Buildings.

4.3.4.11.1* Listed portable fire extinguishers shall be provided for facilities in such quantities, sizes, and types as could be needed for special storage hazards as determined in accordance with 4.5.2.

4.3.4.11.2* Where the need is indicated in accordance with 4.5.4, water shall be utilized through standpipe and hose systems, or through hose connections from sprinkler systems using combination spray and straight stream nozzles to permit effective fire control.

4.3.4.11.3 Where the need is indicated in accordance with 4.5.4, mobile foam apparatus shall be provided.

4.3.4.11.4 Automotive and trailer-mounted fire apparatus, where determined necessary, shall not be used for any purpose other than fire fighting or training.

4.3.4.12 Fixed Fire Control Equipment for Tank Buildings.

4.3.4.12.1 A reliable water supply or other suitable fire control agent shall be available in pressure and quantity to meet the fire demands indicated by special storage hazards or exposure as determined by 4.5.4.

4.3.4.12.2* Hydrants, with or without fixed monitor nozzles, shall be provided in accordance with accepted practice. The number and placement shall depend on the hazard of the storage, or exposure, as determined by 4.5.4.

4.3.4.12.3* Where the need is indicated by the hazards of storage or exposure as determined by 4.5.4, fixed protection shall be required utilizing approved foam, foam-water sprinkler systems, sprinkler systems, water spray systems, deluge systems, fire-resistive materials, or a combination of these. When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria for selected foam discharge devices, the foam concentrate, and the specific flammable or combustible liquids to be protected.

4.3.4.12.4 If provided, fire control systems shall be designed, installed, and maintained in accordance with the following NFPA standards:

- (1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (2) NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*
- (3) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
- (4) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
- (5) NFPA 13, *Standard for the Installation of Sprinkler Systems*
- (6) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
- (7) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
- (8) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
- (9) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

4.4 Testing Requirements for Tanks.

4.4.1 Initial Testing. All tanks, whether shop-built or field-erected, shall be tested before they are placed in service in accordance with the applicable requirements of the code under which they were built.

4.4.1.1 An approved listing mark on a tank shall be considered to be evidence of compliance with this requirement. Tanks not so marked shall be tested before they are placed in service in accordance with recognized engineering standards or in accordance with the requirements for testing in the codes listed in 4.2.3.1.1, 4.2.3.2.1, or 4.2.3.3.1.

4.4.1.2 Where the vertical length of the fill and vent pipes is such that, when filled with liquid, the static head imposed on the bottom of the tank exceeds a gauge pressure of 70 kPa (10 psi), the tank and its related piping shall be tested hydrostatically to a pressure equal to the static head thus imposed. In special cases where the height of the vent above the top of the tank is excessive, the hydrostatic test pressure shall be determined by using recognized engineering standards.

4.4.1.3 Before the tank is initially placed in service, all leaks or deformations shall be corrected in an acceptable manner. Mechanical caulking shall not be permitted for correcting leaks in welded tanks except for pinhole leaks in the roof.

4.4.1.4 Tanks to be operated at pressures below their design pressure shall be tested by the applicable provisions of 4.4.1.1 or 4.4.1.2 based upon the pressure developed under full emergency venting of the tank.

4.4.2* Tightness Testing. In addition to the tests called for in 4.4.1, all tanks and connections shall be tested for tightness after installation and before being placed in service in accordance with 4.4.2.1 through 4.4.2.4, as applicable. Except for underground tanks, this test shall be made at operating pressure with air, inert gas, or water. Air pressure shall not be used to test tanks that contain flammable or combustible liquids or vapors. (See Section 6.6 for testing pressure piping.)

Exception: For field-erected tanks, the tests required by 4.4.1.1 or 4.4.1.2 shall be permitted to be considered the test for tank tightness.

4.4.2.1 Horizontal shop-fabricated aboveground tanks shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 20 kPa (3 psig) and not more than a gauge pressure of 35 kPa (5 psig). Vertical shop-fabricated aboveground tanks shall be tested for tightness either hydrostatically or with air pressure at not less than

a gauge pressure of 10 kPa (1.5 psig) and not more than a gauge pressure of 17 kPa (1.5 psig).

4.4.2.2 Single-wall underground tanks and piping, before being covered, enclosed, or placed in use, shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 20 kPa (3 psig) and not more than a gauge pressure of 35 kPa (5 psig).

4.4.2.3 Underground secondary containment tanks and horizontal aboveground secondary containment tanks shall have the primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 20 kPa (3 psig) and not more than a gauge pressure of 35 kPa (5 psig). The interstitial space (annulus) of such tanks shall be tested either hydrostatically or with air pressure at a gauge pressure of 20 to 35 kPa (3 to 5 psig), by vacuum at 18 kPa (5.3 in. Hg), or in accordance with the tank's listing or manufacturer's instructions. The pressure or vacuum shall be held for not less than 1 hour or for the duration specified in the listing procedures for the tank. Care shall be taken to ensure that the interstitial space is not overpressured or subjected to excessive vacuum.

4.4.2.4 Vertical aboveground secondary containment-type tanks shall have their primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 10 kPa (1.5 psig) and not more than a gauge pressure of 17 kPa (2.5 psig). The interstitial space (annulus) of such tanks shall be tested either hydrostatically or with air pressure at a gauge pressure of 10 to 17 kPa (1.5 to 2.5 psig), by vacuum at 18 kPa (5.3 in. Hg), or in accordance with the tank's listing or manufacturer's instructions. The pressure or vacuum shall be held for 1 hour without evidence of leaks. Care shall be taken to ensure that the interstitial space is not overpressured or subjected to excessive vacuum.

4.4.3* Additional Testing. Tanks that have been relocated, structurally damaged, repaired, or are suspected of leaking shall be tested in a manner acceptable to the authority having jurisdiction.

4.5 Fire Prevention and Control.

4.5.1 Scope. Section 4.5 shall apply to the commonly recognized management techniques and fire control methods used to prevent or minimize the loss from fire or explosion in tank storage facilities. The wide range in size, design, and location of tank storage facilities shall preclude the inclusion of detailed fire prevention and control methods applicable to all such facilities. The authority having jurisdiction shall be permitted to be consulted on specific cases, where applicable; otherwise, qualified engineering judgment shall be exercised.

4.5.2 General Requirements. Tank storage facilities shall have fire prevention and control for life safety, for minimizing property loss, and for reducing fire exposure to adjoining facilities resulting from fire and explosion. Compliance with 4.5.3 through 4.5.7 shall be deemed as meeting the requirements of 4.5.2.

4.5.3 Control of Ignition Sources.

4.5.3.1 Precautions shall be taken to prevent the ignition of flammable vapors from sources such as the following:

- (1) Open flames
- (2) Lightning
- (3) Hot surfaces
- (4) Radiant heat

- (5) Smoking
- (6) Cutting and welding
- (7) Spontaneous ignition
- (8) Frictional heat or sparks
- (9) Static electricity
- (10) Electrical sparks
- (11) Stray currents
- (12) Ovens, furnaces, and heating equipment

4.5.3.2 Smoking shall be permitted only in designated and properly identified areas.

4.5.3.3* Welding, cutting, and similar spark-producing operations shall not be permitted in areas containing flammable liquids until a written permit authorizing such work has been issued. The permit shall be issued by a person in authority following inspection of the area to assure that proper precautions have been taken and will be followed until the job is completed.

4.5.3.4* Static Electricity. All equipment such as tanks, machinery, and piping shall be designed and operated to prevent electrostatic ignitions. All metallic equipment where an ignitable mixture could be present shall be bonded or grounded. The bond or ground or both shall be physically applied or shall be inherently present by the nature of the installation. Any electrically isolated section of metallic piping or equipment shall be bonded or grounded to prevent hazardous accumulation of static electricity. All nonmetallic equipment and piping where an ignitable mixture could be present shall be given special consideration.

4.5.3.5 Electrical Installations. Design, selection, and installation of electrical wiring and electrical utilization equipment shall meet the requirements of Chapter 8.

4.5.4 Management of Fire Hazards. The extent of fire prevention and control provided for tank storage facilities shall be determined by an engineering evaluation of the installation and operation, followed by the application of sound fire protection and process engineering principles. The evaluation shall include, but not be limited to, the following:

- (1) Analysis of fire and explosion hazards of the facility
- (2) Analysis of local conditions, such as exposure to and from adjacent properties, flood potential, or earthquake potential
- (3) Fire department or mutual aid response

4.5.5 Fire Control. A fire-extinguishing system in accordance with an applicable NFPA standard shall be provided or shall be available for vertical atmospheric fixed-roof storage tanks larger than 190 m³ (50,000 gal or 1190 bbl) capacity, storing Class I liquids, if located in a congested area where there is an unusual exposure hazard to the tank from adjacent property or to adjacent property from the tank. Fixed-roof tanks storing Class II or III liquids at temperatures below their flash points and floating-roof tanks storing any liquid generally shall not require protection when installed in compliance with Section 4.3.

4.5.6 Emergency Planning and Training.

4.5.6.1 An emergency action plan, consistent with the available equipment and personnel, shall be established to respond to fire or other emergencies. This plan shall address the following:

- (1) Procedures to be used in case of fire, such as sounding the alarm, notifying the fire department, evacuating personnel, and controlling and extinguishing the fire
- (2) Appointment and training of persons to carry out fire safety duties

- (3) Maintenance of fire protection equipment
- (4) Holding fire drills
- (5) Shutdown or isolation of equipment to reduce the escape of liquid
- (6) Alternate measures for the safety of personnel while any fire protection equipment is shut down

4.5.6.2 Personnel responsible for the use and operation of fire protection equipment shall be trained in the use of that equipment. Refresher training shall be conducted at least annually. The personnel responsible shall be able to demonstrate knowledge of the use or operation of the fire protection equipment.

4.5.6.3 Planning of effective fire control measures shall be coordinated with local emergency response agencies. This planning shall include, but not be limited to, the identification of all tanks by location, contents, size, and hazard identification as required in 4.6.2.1.

4.5.6.4 Procedures shall be established to provide for safe shutdown of tank storage facilities under emergency conditions. Provisions shall be made for periodic training, inspection, and testing of associated alarms, interlocks, and controls.

4.5.6.5 The emergency procedures shall be kept readily available in an operating area and updated regularly.

4.5.6.6 Where premises are likely to be unattended for considerable periods of time, a summary of the emergency plan shall be posted or located in a strategic and accessible location.

4.5.7 Inspection and Maintenance.

4.5.7.1 All fire protection equipment shall be properly maintained and periodic inspections and tests shall be done in accordance with both standard practice and equipment manufacturer's recommendations.

4.5.7.2 Maintenance and operating practices at tank storage facilities shall control leakage and prevent spillage of liquids.

4.5.7.3 Ground areas around tank storage facilities shall be kept free of weeds, trash, or other unnecessary combustible materials.

4.5.7.4 Accessways established for movement of personnel shall be maintained clear of obstructions to permit orderly evacuation and ready access for manual fire fighting.

4.5.7.5 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily.

4.6 Operations and Maintenance of Tanks.

4.6.1 Prevention of Overfilling of Tanks.

4.6.1.1 Aboveground tanks at terminals that receive and transfer Class I liquids from mainline pipelines or marine vessels shall follow formal written procedures to prevent overfilling of tanks utilizing one of the following methods of protection:

- (1) Tanks gauged at frequent intervals by personnel continuously on the premise during product receipt with frequent acknowledged communication maintained with the supplier so flow can be promptly shut down or diverted.
- (2) Tanks equipped with a high-level detection device that is independent of any gauging equipment. Alarm shall be located where personnel who are on duty throughout product transfer can promptly arrange for flow stoppage or diversion.

- (3) Tanks equipped with an independent high-level detection system that will automatically shut down or divert flow.
- (4) Alternatives to instrumentation described in 4.6.1.1(2) and 4.6.1.1(3) where approved by the authority having jurisdiction as affording equivalent protection.

4.6.1.2 Instrumentation systems covered in 4.6.1.1(2) and 4.6.1.1(3) shall be electrically supervised or equivalent.

4.6.1.3 Formal written procedures required by 4.6.1.1 shall include the following:

- (1) Instructions covering methods to check for proper lineup and receipt of initial delivery to tank designated to receive shipment.
- (2) Provision for training and monitoring the performance of operating personnel by terminal supervision.
- (3) Schedules and procedures for inspection and testing of gauging equipment and high-level instrumentation and related systems. Inspection and testing intervals shall be acceptable to the authority having jurisdiction but shall not exceed 1 year.

4.6.1.4 An underground tank shall be equipped with overflow prevention equipment that will operate as follows:

- (1) Automatically shut off the flow of liquid into the tank when the tank is no more than 95 percent full
- (2) Alert the transfer operator when the tank is no more than 90 percent full by restricting the flow of liquid into the tank or triggering the high-level alarm
- (3) Other methods approved by the authority having jurisdiction

4.6.1.5 Shop-fabricated aboveground atmospheric storage tanks, constructed to the recognized standards of 4.2.3.1 or approved equivalents, shall meet the requirements of 4.6.1.5.1 through 4.6.1.5.4 and 4.5.7 whenever the vertical length from the tank bottom to the top of the fill, normal vent, or emergency vent exceeds 3.7 m (12 ft).

4.6.1.5.1 An approved means shall be provided to promptly notify the tank filling operator of the pending completion of the tank fill operation at the fill connection.

4.6.1.5.2 An approved means shall be provided to stop delivery of liquid to the tank prior to the complete filling of the tank.

4.6.1.5.3 In no case shall these provisions restrict or interfere with the proper functioning of the normal vent or emergency vent.

4.6.1.5.4 The manufacturer of the tank shall be consulted to determine if reinforcement of the tank is required. If reinforcement is deemed necessary, it shall be done.

4.6.2 Identification and Security.

4.6.2.1 Emergency Response Identification. A sign or marking that meets the requirements of NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, or an equivalent system, shall be applied to storage tanks containing liquids. The marking shall not need to be applied directly to the tank but shall be located where it can readily be seen, such as on the shoulder of an accessway or walkway to the tank or tanks or on the piping outside of the diked area. If more than one tank is involved, the markings shall be so located that each tank can readily be identified.

4.6.2.2 Unsupervised, isolated aboveground storage tanks shall be secured and marked in such a manner as to identify the fire hazards of the tank and the tank's contents to the general public. The area in which the tank is located shall be protected from tampering or trespassing, where necessary.

4.6.3 Tanks in Areas Subject to Flooding.

4.6.3.1 Water Loading. The filling of a tank to be protected by water loading shall be started as soon as floodwaters are predicted to reach a dangerous flood stage. Where independently fueled water pumps are relied upon, sufficient fuel shall be available at all times to permit continuing operations until all tanks are filled. Tank valves shall be locked in a closed position when water loading has been completed.

4.6.3.2 Operating Instructions. Operating instructions or procedures to be followed in a flood emergency shall be readily available.

4.6.3.3 Personnel Training. Personnel relied upon to carry out flood emergency procedures shall be informed of the location and operation of valves and other equipment necessary to effect the intent of these requirements.

4.6.4 Temporary or Permanent Removal from Service of Aboveground Tanks.

4.6.4.1* Closure of Storage Tanks. Aboveground tanks taken out of service or abandoned shall be emptied of liquid, rendered vapor-free, and safeguarded against trespassing.

4.6.4.2 Reuse of Aboveground Storage Tanks. Only those used tanks that comply with the applicable sections of this code and are approved by the authority having jurisdiction shall be installed for flammable or combustible liquids service.

4.6.5 Temporary or Permanent Removal from Service of Underground Tanks.

4.6.5.1 General. The procedures outlined in 4.6.5 shall be followed when taking underground tanks temporarily out of service, closing them in place permanently, or removing them. All applicable safety procedures associated with working in proximity to flammable and combustible materials shall be strictly adhered to. (*See Annex C for additional information.*)

4.6.5.2 Temporary Closure. Tanks shall be rendered temporarily out of service only when it is planned that they will be returned to active service, closed in place permanently, or removed within a reasonable period not exceeding 1 year. The following requirements shall be met:

- (1) Corrosion protection and release detection systems shall be maintained in operation.
- (2) The vent line shall be left open and functioning.
- (3) The tank shall be secured against tampering.
- (4) All other lines shall be capped or plugged.

4.6.5.3 Tanks remaining temporarily out of service for more than 1 year shall be permanently closed in place or removed in accordance with 4.6.5.4 or 4.6.5.5, as applicable.

4.6.5.4 Permanent Closure in Place. Tanks shall be permitted to be permanently closed in place if approved by the authority having jurisdiction. All of the following requirements shall be met:

- (1) All applicable authorities having jurisdiction shall be notified.
- (2)*A safe workplace shall be maintained throughout the prescribed activities.

- (3) All flammable and combustible liquids and residues shall be removed from the tank, appurtenances, and piping and shall be properly disposed of.
- (4) The tank shall be made safe by either purging it of flammable vapors or inerting the potential explosive atmosphere in the tank. Confirmation that the atmosphere in the tank is safe shall be by periodic testing of the atmosphere using a combustible gas indicator, if purging, or an oxygen meter, if inerting.
- (5) Access to the tank shall be made by careful excavation to the top of the tank.
- (6) All exposed piping, gauging and tank fixtures, and other appurtenances, except the vent, shall be disconnected and removed.
- (7) The tank shall be completely filled with an inert solid material.
- (8) The tank vent and remaining underground piping shall be capped or removed.
- (9) The tank excavation shall be backfilled.

4.6.5.5 Removal and Disposal. Underground tanks shall be removed in accordance with the following requirements:

- (1) The steps described in 4.6.5.4(1) through 4.6.5.4(5) shall be followed.
- (2) All exposed piping, gauging and tank fixtures, and other appurtenances, including the vent, shall be disconnected and removed.
- (3) All openings shall be plugged, leaving a 6 mm (¼ in.) opening to avoid buildup of pressure in the tank.
- (4) The tank shall be removed from the excavated site and shall be secured against movement.
- (5) Any corrosion holes shall be plugged.
- (6) The tank shall be labeled with its former contents, present vapor state, vapor-freeing method, and a warning against reuse.
- (7) The tank shall be removed from the site promptly, preferably the same day.

4.6.5.6 Temporary Storage of Removed Tanks. If it is necessary to temporarily store a tank that has been removed, it shall be placed in a secure area where public access is restricted. A 6 mm (¼ in.) opening shall be maintained to avoid buildup of pressure in the tank.

4.6.5.7 Disposal of Tanks. Disposal of tanks shall meet the following requirements:

- (1) Before a tank is cut up for scrap or landfill, the atmosphere in the tank shall be tested in accordance with 4.6.5.4(4) to ensure that it is safe.
- (2) The tank shall be made unfit for further use by cutting holes in the tank heads and shell.

4.6.5.8 Documentation. All necessary documentation shall be prepared and maintained in accordance with all federal, state, and local rules and regulations.

4.6.5.9 Reuse of Underground Tanks. Only those used tanks that comply with the applicable sections of this code and are approved by the authority having jurisdiction shall be installed for flammable or combustible liquids service.

4.6.5.10 Change of Service of Underground Tanks. Tanks that undergo any change of stored product shall meet the requirements of Section 4.2.

4.6.6* Leak Detection and Inventory Records for Underground Tanks. Accurate inventory records or a leak detection program shall be maintained on all Class I liquid storage tanks for indication of possible leakage from the tanks or associated piping.

4.6.7 Tank Maintenance.

4.6.7.1* Each tank shall be inspected and maintained to ensure compliance with the requirements of this code. Testing requirements for tanks shall be in accordance with Section 4.4.

4.6.7.2 Each tank shall be maintained liquidtight. Each tank that is leaking shall be emptied of liquid or repaired in a manner acceptable to the authority having jurisdiction.

4.6.7.3 Tanks that have been structurally damaged, have been repaired or reconstructed, or are suspected of leaking shall be tested in accordance with 4.4.1 or in a manner acceptable to the authority having jurisdiction.

4.6.7.4* Tanks and all tank appurtenances, including normal vents and emergency vents and related devices, shall be properly maintained to ensure that they function as intended.

4.6.7.5 Openings for gauging on tanks storing Class I liquids shall be provided with a vaportight cap or cover. Such covers shall be closed when not gauging.

Chapter 5 Piping Systems

5.1 Scope.

5.1.1 This chapter shall apply to piping systems consisting of pipe, tubing, flanges, bolting, gaskets, valves, fittings, flexible connectors, the pressure-containing parts of other components such as expansion joints and strainers, and devices that serve such purposes as mixing, separating, snubbing, distributing, metering, controlling flow, or secondary containment of liquids and associated vapors.

5.1.2 This chapter shall not apply to any of the following:

- (1) Tubing or casing on any oil or gas wells and any piping connected directly thereto
- (2) Motor vehicles, aircraft, boats, or piping that are integral to a stationary engine assembly
- (3) Piping within the scope of any applicable boiler and pressure vessel code

5.2 General Requirements.

5.2.1 Performance Standards. The design, fabrication, assembly, test, and inspection of piping systems shall be suitable for the expected working pressures and structural stresses. Compliance with applicable sections of ASME B31, *Code for Pressure Piping*, and the provisions of this chapter shall be considered prima facie evidence of compliance with the foregoing provisions.

5.2.2 Tightness of Piping. Piping systems shall be maintained liquidtight. A piping system that has leaks that constitute a hazard shall be emptied of liquid or repaired in a manner acceptable to the authority having jurisdiction.

5.3 Materials for Piping Systems.

5.3.1 Material Specifications. Pipe, valves, faucets, couplings, flexible connectors, fittings, and other pressure-containing parts shall meet the material specifications and pressure and temperature limitations of ASME B31, *Code for Pressure Piping*, except as provided for in 5.3.2, 5.3.3, and 5.3.4.

5.3.2 Ductile Iron. Ductile (nodular) iron shall meet the specifications of ASTM A 395, *Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*.

5.3.3 Materials of Construction of Valves. Valves at storage tanks, as required by 4.3.2.5.1 and 4.3.4.7.3, and their connections to the tank shall be of steel or ductile iron, except as provided for in 5.3.3.1, 5.3.3.2, or 5.3.4.

5.3.3.1 Valves at storage tanks shall be permitted to be other than steel or ductile iron where the chemical characteristics of the liquid stored are not compatible with steel or where the valves are installed internally to the tank. Valves installed externally to the tank shall be permitted to be other than steel or ductile iron if the material of construction has a ductility and melting point comparable to steel or ductile iron and is capable of withstanding the stresses and temperatures involved in fire exposure or the valves are otherwise protected from fire exposures, such as by materials having a fire resistance rating of not less than 2 hours.

5.3.3.2 Cast iron, brass, copper, aluminum, malleable iron, and similar materials shall be permitted to be used on tanks described in 4.3.2.2.1 or on tanks storing Class IIIB liquids where the tanks are located outdoors and not within a diked area or drainage path of a tank storing a Class I, Class II, or Class IIIA liquid.

5.3.4 Low Melting Point Materials. Low melting point materials such as aluminum, copper, and brass; materials that soften on fire exposure such as plastics; or nonductile material such as cast iron shall be permitted to be used underground within the pressure and temperature limitations of ASME B31, *Code for Pressure Piping*.

5.3.4.1 Such materials shall be permitted to be used outdoors above ground or inside buildings provided they meet one of the following conditions:

- (1) They are resistant to damage by fire.
- (2) They are located so that any leakage resulting from failure will not unduly expose persons, important buildings, or structures.
- (3) They are located where leakage can readily be controlled by operation of one or more accessible remotely located valves.

5.3.4.2 The piping materials chosen shall be compatible with the liquids being handled. Piping systems of these materials shall be designed and built in accordance with recognized standards of design for the particular materials chosen or with acceptable equivalent standards or shall be listed.

5.3.5 Lining Materials. Piping, valves, and fittings shall be permitted to have combustible or noncombustible linings.

5.3.6 Nonmetallic Piping. Piping systems of nonmetallic materials, including piping systems incorporating secondary containment, shall be designed and built in accordance with recognized standards of design or approved equivalents and shall be installed in accordance with 5.3.4. Nonmetallic piping shall be built and used within the scope of their approvals or within the scope of UL 971, *Standard for Nonmetallic Underground Piping for Flammable Liquids*. Nonmetallic piping systems and components shall be installed in accordance with manufacturer's instructions.

5.4 Pipe Joints.

5.4.1 Tightness of Pipe Joints. Joints shall be made liquidtight and shall be welded, flanged, threaded, or mechanically attached. They shall be designed and installed so that the mechanical strength of the joint will not be impaired if exposed

to a fire. Threaded joints shall be made with a suitable thread sealant or lubricant. Joints in piping systems handling Class I liquids shall be welded when located in concealed spaces within buildings.

5.4.2 Flexible Connectors. Listed flexible connectors shall be permitted to be used where installed in accordance with 5.4.3.

5.4.3 Friction Joints. Pipe joints dependent upon the friction characteristics or resiliency of combustible materials for mechanical continuity or liquidtightness of piping shall only be used outside of buildings above ground or below ground. Where used above ground, either the piping shall be secured to prevent disengagement at the fitting, or the piping system shall be so designed that any spill resulting from disengagement could not unduly expose persons, important buildings, or structures and could be readily controlled by remote valves.

Exception: Pipe joints that depend on friction characteristics of their components shall be permitted to be used inside buildings provided both of the following are met:

- (1) They are located where leakage can be readily controlled by operation of an accessible remotely located valve that is outside the fire risk area.
- (2) The mechanical strength and liquidtightness of the joint is not dependent on the resiliency of a combustible material or component.

5.5 Installation of Piping Systems.

5.5.1 General. Piping systems shall be substantially supported and protected against physical damage and excessive stresses arising from settlement, vibration, expansion, or contraction. The installation of nonmetallic piping shall be in accordance with the manufacturer's instructions.

5.5.2* Load-Bearing Supports. Load-bearing piping supports that are located in areas with a high fire exposure risk shall be protected by one or more of the following:

- (1) Drainage to a safe location to prevent liquid from accumulating under pipeways
- (2) Fire-resistive construction
- (3) Fire-resistant protective coatings or systems
- (4) Water spray systems designed and installed in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
- (5) Other alternate means acceptable to the authority having jurisdiction

5.5.3 Pipe Penetrations. Piping that passes through or pierces a dike wall or the wall of a structure shall be designed to prevent excessive stresses and leakage due to settlement or fire exposure.

5.5.4* Protection Against Corrosion. Aboveground piping systems that are subject to external corrosion shall be suitably protected. Underground piping systems shall be protected against corrosion in accordance with 4.2.6.

5.5.5 Underground Piping.

5.5.5.1 Underground piping shall be installed on a bedding of at least 150 mm (6 in.) of well-compacted backfill material.

5.5.5.2 In areas subject to vehicle traffic, the pipe trench shall be of sufficient depth to permit a cover of at least 450 mm (18 in.) of well-compacted backfill material and pavement. In paved areas where a minimum 50 mm (2 in.) of asphalt is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 200 mm (8 in.) minimum. In paved

areas where a minimum 100 mm (4 in.) of reinforced concrete is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 100 mm (4 in.) minimum.

5.5.5.3 In areas not subject to vehicle traffic, the pipe trench shall be of sufficient depth to permit a cover of at least 150 mm (6 in.) of well-compacted backfill material. A greater burial depth shall be provided when required by the manufacturer's instructions or where frost conditions are present.

5.5.5.4 Piping within the same trench shall be separated by two pipe diameters. Piping shall not need to be separated horizontally by more than 230 mm (9 in.).

5.5.5.5 Two or more levels of pipes within the same trench shall be separated vertically by a minimum 150 mm (6 in.) of well-compacted backfill.

5.5.6 Valves. Piping systems shall contain a sufficient number of valves to operate the system properly and to protect the equipment. Piping systems in connection with pumps shall contain a sufficient number of valves to properly control the flow of liquid both in normal operation and in the event of physical damage. Each connection to a piping system by which equipment such as tank cars, tank vehicles, or marine vessels discharges liquids into storage tanks shall be provided with a check valve for automatic protection against back-flow if the piping arrangement is such that back-flow from the system is possible. (See also 4.3.2.5.1.)

5.5.7 Common Loading and Unloading Piping. If loading and unloading is done through a common pipe system, a check valve shall not be required. However, an isolation valve shall be provided. This valve shall be located so that it is readily accessible or shall be remotely operable.

5.6 Testing.

5.6.1 Initial Testing. Unless tested in accordance with the applicable sections of ASME B31, *Code for Pressure Piping*, all piping shall be tested before being covered, enclosed, or placed in use. Testing shall be done hydrostatically to 150 percent of the maximum anticipated pressure of the system or pneumatically to 110 percent of the maximum anticipated pressure of the system, and the test pressure shall be maintained for a sufficient time to conduct a complete visual inspection of all joints and connections. In no case shall the test pressure be less than a gauge pressure of 35 kPa (5 psig) measured at the highest point of the system, and in no case shall the test pressure be maintained for less than 10 minutes.

5.6.2 Initial Testing of Secondary Containment Piping. The interstitial (annular) space of secondary containment-type piping shall be tested hydrostatically or with air pressure at a gauge pressure of 35 kPa (5 psig) or shall be tested in accordance with its listing or with the manufacturer's instructions. The pressure source shall be disconnected from the interstitial space to ensure that the test is being conducted on a closed system. The pressure shall be maintained for a minimum of 1 hour.

5.6.3 Testing During Maintenance. Existing piping shall be tested in accordance with this subsection if there is indication that the piping is leaking. Piping that could contain a Class I, Class II, or Class IIIA liquid or vapor shall not be tested using air.

5.7 Vent Piping. Vent piping shall be designed, constructed, and installed in accordance with Section 5.7.

5.7.1 Vent Piping for Aboveground Tanks.

5.7.1.1 Where the outlets of vent pipes for tanks storing Class I liquids are adjacent to buildings or public ways, they shall be located so that vapors are released at a safe point outside of buildings and not less than 3.6 m (12 ft) above the adjacent ground level. Vapors shall be discharged upward or horizontally away from adjacent walls. Vent outlets shall be located so that vapors will not be trapped by eaves or other obstructions and shall be at least 1.5 m (5 ft) from building openings.

5.7.1.2 Manifolding of vent piping shall be avoided except where required for special purposes such as vapor recovery, vapor conservation, or air pollution control. Where vent piping is manifolded, pipe sizes shall be capable of discharging, within the pressure limitations of the system, the vapors they are required to handle when all manifolded tanks are subject to the same fire exposure.

5.7.1.3 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the following:

- (1) Vapors of Class I liquids from entering tanks storing Class II or Class III liquids
- (2) Contamination (see A.1.2)
- (3) Possible change in classification of the less volatile liquid

5.7.1.4* Extension of Emergency Vent Piping. Piping to or from approved emergency vent devices for atmospheric and low-pressure tanks shall be sized to provide emergency vent flows that limit the back pressure to less than the maximum pressure permitted by the design of the tank. Piping to or from approved emergency vent devices for pressure vessels shall be sized in accordance with the ASME *Boiler and Pressure Vessel Code*.

5.7.2 Vent Piping for Underground Tanks.

5.7.2.1 Vent pipes from underground tanks storing Class I liquids shall be located so that the discharge point is outside of buildings, higher than the fill pipe opening, and not less than 3.6 m (12 ft) above the adjacent ground level. Vent pipe outlets shall be located and directed so that vapors will not accumulate or travel to an unsafe location, enter building openings, or be trapped under eaves, and shall be at least 1.5 m (5 ft) from building openings and at least 4.5 m (15 ft) from powered ventilation air intake devices.

5.7.2.2 Vent pipes shall not be obstructed by devices provided for vapor recovery or other purposes unless the tank and associated piping and equipment are otherwise protected to limit back-pressure development to less than the maximum working pressure of the tank and equipment by the provision of pressure-vacuum vents, rupture discs, or other tank-venting devices installed in the tank vent lines. Vent outlets and devices shall be protected to minimize the possibility of blockage from weather, dirt, or insect nests.

5.7.2.3 Vent piping shall be sized in accordance with 4.2.5.3.

5.7.2.4 Vent pipes from tanks storing Class II or Class IIIA liquids shall terminate outside of the building and higher than the fill pipe opening. Vent outlets shall be above normal snow level. They shall be permitted to be fitted with return bends, coarse screens, or other devices to minimize ingress of foreign material.

5.7.2.5 Vent pipes and vapor return piping shall be installed without sags or traps in which liquid can collect. Condensate tanks, if utilized, shall be installed and maintained so that blocking of the vapor return piping by liquid is prevented. Vent pipes and condensate tanks shall be located so that they will not be subjected to physical damage. The tank end of the vent pipe shall enter the tank through the top.

5.7.2.6 Where tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they can be required to handle when manifolded tanks are filled simultaneously. Float-type check valves installed in tank openings connected to manifolded vent piping to prevent product contamination shall be permitted to be used provided that the tank pressure will not exceed that permitted by 4.3.3.2.3 when the valves close.

5.7.2.7 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the following:

- (1) Vapors of Class I liquids from entering tanks storing Class II or Class III liquids
- (2) Contamination (*see A.1.2*)
- (3) Possible change in classification of the less volatile liquid

5.8 Static Electricity. Piping systems shall be bonded and grounded in accordance with 4.5.3.4.

5.9* Identification. Each loading and unloading riser shall be marked to identify the product for which it is to be used.

Chapter 6 Container and Portable Tank Storage

6.1 Scope.

6.1.1 This chapter shall apply to the storage of liquids in drums or other containers that do not exceed 450 L (119 gal) individual capacity, in portable tanks that do not exceed 2500 L (660 gal) individual capacity, and in intermediate bulk containers that do not exceed 3000 L (793 gal) and to limited transfers incidental thereto. This chapter shall also apply to overpack drums when used for temporary containment of containers that do not exceed 230 L (60 gal) capacity. Such overpack containers shall be treated as containers as defined in 3.3.7.

6.1.2 This chapter shall not apply to the following:

- (1) Containers, intermediate bulk containers, and portable tanks that are used in process areas, as covered by Chapter 5
- (2) Liquids in the fuel tanks of motor vehicles, aircraft, boats, or portable or stationary engines
- (3) Beverages, where packaged in individual containers that do not exceed 5 L (1.3 gal) capacity
- (4) Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50 percent by volume of water-miscible liquids, with the remainder of the solution not being flammable where packaged in individual containers that do not exceed 5 L (1.3 gal) capacity
- (5) Liquids that have no fire point when tested by ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, up to the boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change
- (6) Liquids with a flash point greater than 35°C (95°F) in a water-miscible solution or in dispersion with a water and inert (noncombustible) solids content of more than 80 percent by weight, which do not sustain combustion when tested using the "Method of Testing for Sustained Combustibility," per 49 CFR 173, Appendix H, or the UN *Recommendations on the Transport of Dangerous Goods*
- (7) Distilled spirits and wines in wooden barrels or casks

6.1.3 General Provisions.

6.1.3.1 For the purpose of this chapter, unstable liquids shall be treated as Class IA liquids.

6.1.3.2 For the purposes of this chapter, protected storage installed after January 1, 1997, shall mean storage installed after January 1, 1997 that is protected in accordance with Section 6.8. All other storage shall be considered to be unprotected storage unless an alternate means of protection has been approved by the authority having jurisdiction. (*See 6.8.2.4 and 6.8.3.*)

Exception: As provided for in Section 6.5.

6.2 Design, Construction, and Capacity of Containers.

6.2.1 Only the following approved containers, intermediate bulk containers, and portable tanks shall be used:

- (1) Metal containers, metal intermediate bulk containers, and metal portable tanks meeting the requirements of, and containing products authorized by, the U. S. Department of Transportation Hazardous Materials Regulations, 49 CFR or by Part 6 of the UN *Recommendations on the Transport of Dangerous Goods* shall be acceptable.
- (2) Plastic containers meeting the requirements of, and used for petroleum products within the scope of, one or more of the following specifications shall be acceptable:
 - (a) ASTM F 852, *Standard for Portable Gasoline Containers for Consumer Use*
 - (b) ASTM F 976, *Standard for Portable Kerosene Containers for Consumer Use*
 - (c) ANSI/UL 1313, *Nonmetallic Safety Cans for Petroleum Products*
- (3) Plastic containers meeting the requirements of and containing products authorized by the U. S. Department of Transportation Hazardous Materials Regulations, 49 CFR or by Part 6 of the UN *Recommendations on the Transport of Dangerous Goods* shall be acceptable.
- (4) Fiber drums that meet the following shall be acceptable:
 - (a) Requirements of Item 296 of the *National Motor Freight Classification* (NMFC) or Rule 51 of the *Uniform Freight Classification* (UFC) for Types 2A, 3A, 3B-H, 3B-L, or 4A
 - (b) Requirements of, and containing liquid products authorized by, either the U. S. Department of Transportation Hazardous Materials Regulations, 49 CFR Chapter I, 49 CFR or U.S. Department of Transportation exemption
- (5)*Rigid nonmetallic intermediate bulk containers that meet the requirements of and containing products authorized by the U. S. Department of Transportation Hazardous Materials Regulations, 49 CFR, or by Part 6 of the UN *Recommendations on the Transport of Dangerous Goods* for Classes 31H1, 31H2, and 31HZ1 shall be acceptable. For protected storage, rigid nonmetallic intermediate bulk containers shall be subjected to a standard fire test that demonstrates acceptable inside storage fire performance and shall be listed and labeled.

6.2.2 Each portable tank or intermediate bulk container shall be provided with one or more devices installed in the top with sufficient emergency venting capacity to limit internal pressure under fire exposure conditions to a gauge pressure of 70 kPa (10 psig) or 30 percent of the bursting pressure of the portable tank, whichever is greater. The total venting capacity shall be not less than that specified in 4.2.5.2.3 or 4.2.5.2.5. At least one pressure-actuated vent having a minimum capacity of 170 m³ (6000 ft³) of free air per hour at 1 bar (14.7 psia) and 15.6°C (60°F) shall be used. It shall be set to open at not less than a gauge pressure of 35 kPa (5 psig). If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding 150°C (300°F). Where plugging of a pressure-actuated vent can occur, such as when used for paints, drying oils, and similar materials, fusible plugs or venting devices that soften to failure at a maximum of 150°C (300°F) under fire exposure shall be permitted to be used for the entire emergency venting requirement.

6.2.3 The maximum allowable size of a container or metal portable tank shall not exceed that specified in Table 6.2.3.

Exception: As provided for in Section 6.1, 6.2.3.1, 6.2.3.2, and 6.2.3.3.

6.2.3.1 Medicines, beverages, foodstuffs, cosmetics, and other common consumer products, where packaged according to commonly accepted practices for retail sales, shall be exempt from the requirements of 6.2.1 and 6.2.3.

6.2.3.2 Class IA and Class IB liquids shall be permitted to be stored in glass containers of not more than 5 L (1.3 gal) capacity, if the required liquid purity (such as ACS analytical reagent grade or higher) would be affected by storage in metal containers or if the liquid can cause excessive corrosion of the metal container.

6.2.3.3 Leaking or damaged containers up to 230 L (60 gal) capacity shall be permitted to be stored temporarily in accordance with this chapter, provided they are enclosed in overpack containers. To be considered protected in accordance with Section 6.8, the overpack container shall be constructed of the same material as the leaking or damaged container. Metal overpack containers shall be considered nonrelieving containers.

6.3 Design, Construction, and Capacity of Storage Cabinets.

6.3.1 The volume of Class I, Class II, and Class IIIA liquids stored in a storage cabinet shall not exceed 454 L (120 gal).

6.3.2 The number of storage cabinets located in any one fire area shall not exceed three.

Exception No. 1: In an industrial occupancy, additional storage cabinets, in groups of not more than three cabinets, shall be permitted to be located in the same fire area, if a minimum separation of 30 m (100 ft) is maintained between each group.

Exception No. 2: In an industrial occupancy that is protected by an automatic sprinkler system that is designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, the number of cabinets in any one group shall be permitted to be increased to six.

6.3.3 Storage cabinets that meet at least one of the following sets of requirements shall be acceptable for storage of liquids:

- (1) Storage cabinets that are designed and constructed to limit the internal temperature at the center of the cabinet and 25 mm (1 in.) from the top of the cabinet to not more than 163°C (325°F), when subjected to a 10-minute fire test that simulates the fire exposure of the standard time-temperature curve specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*, shall be acceptable. All joints and seams shall remain tight and the door shall remain securely closed during the test.
- (2) Metal storage cabinets that are constructed in the following manner shall be acceptable:
 - (a) The bottom, top, door, and sides of the cabinet shall be at least No. 18 gauge sheet steel and shall be double-walled, with 38 mm (1½ in.) air space.
 - (b) Joints shall be riveted, welded, or made tight by some equally effective means.
 - (c) The door shall be provided with a three-point latch arrangement, and the door sill shall be raised at least 50 mm (2 in.) above the bottom of the cabinet to retain spilled liquid within the cabinet.
- (3) Wooden cabinets constructed in the following manner shall be acceptable:
 - (a) The bottom, sides, and top shall be constructed of exterior grade plywood that is at least 25 mm (1 in.) thick and of a type that will not break down or delaminate under fire conditions.
 - (b) All joints shall be rabbetted and shall be fastened in two directions with wood screws. Where more than one door is used, there shall be a rabbetted overlap of not less than 25 mm (1 in.).
 - (c) Doors shall be equipped with a means of latching and hinges shall be constructed and mounted in such a manner as to not lose their holding capacity when subjected to fire exposure.
 - (d) A raised sill or pan capable of containing a 50 mm (2 in.) depth of liquid shall be provided at the bottom of the cabinet to retain spilled liquid within the cabinet.
- (4) Listed storage cabinets that have been constructed and tested in accordance with 6.3.3(1) shall be acceptable.

6.3.4* The storage cabinet shall not be required by this code to be vented for fire protection purposes, and vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the cabinet manufacturer. However, if the storage cabinet is vented for any reason, the cabinet shall be vented directly to outdoors in such a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to the authority having jurisdiction.

6.3.5 Storage cabinets shall be marked in conspicuous lettering:

FLAMMABLE — KEEP FIRE AWAY.

6.4* Design, Construction, and Operation of Inside Liquid Storage Areas.

6.4.1 Scope. Section 6.4 shall apply to inside areas where the primary function is the storage of liquids. This shall include inside rooms, cutoff rooms, attached buildings, liquid warehouses, and hazardous material storage lockers that are used as inside storage areas. (See Section 6.5 for storage of liquids in other types of occupancies.)

Table 6.2.3 Maximum Allowable Size — Containers, Intermediate Bulk Containers, and Portable Tanks

Type	Flammable Liquids			Combustible Liquids	
	Class IA	Class IB	Class IC	Class II	Class III
Glass	0.5 L (1.05 pt)	1 L (1.05 qt)	5 L (1.3 gal)	5 L (1.3 gal)	20 L (5.3 gal)
Metal (other than drums) or approved plastic	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
Safety cans	10 L (2.6 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
Metal drum (e.g., UN 1A1 or 1A2)	450 L (119 gal)	450 L (119 gal)	450 L (119 gal)	450 L (119 gal)	450 L (119 gal)
Approved metal portable tanks and IBCs	3000 L (793 gal)	3000 L (793 gal)	3000 L (793 gal)	3000 L (793 gal)	3000 L (793 gal)
Rigid plastic IBCs (UN 31H1 or 31H2) and composite IBCs with rigid inner receptacle (UN31HZ1)	NP	NP	NP	3000 L (793 gal)	3000 L (793 gal)
Composite IBCs with flexible inner receptacle (UN31HZ2) and flexible IBCs (UN13H, UN13L, and UN13M)	NP	NP	NP	NP	NP
Bag-in-Box Nonbulk	NP	NP	NP	NP	NP
Polyethylene UN 1H1, or as authorized by DOT exemption	5 L (1.3 gal)	20 L (5.3 gal) [†]	20 L (5.3 gal) [†]	450 L (119 gal)	450 L (119 gal)
Fiber drum NMFC or UFC Type 2A; Types 3A, 3B-H, or 3B-L; or Type 4A	NP	NP	NP	450 L (119 gal)	450 L (119 gal)

Note: NP — Not permitted.

[†]For Class IB and IC water-miscible liquids, the maximum allowable size of plastic container is 230 L (60 gal), if stored and protected in accordance with Table 6.8.2(g).

6.4.2 Design and Construction Requirements.

6.4.2.1 All storage areas shall be constructed to meet the specified fire resistance ratings in Table 6.4.2.1. Such construction shall comply with the test specifications given in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*.

Table 6.4.2.1 Fire Resistance Ratings for Inside Liquid Storage Areas

Type of Storage Area	Fire Resistance Rating (hr)		
	Interior Walls, ^a Ceilings, Intermediate Floors	Roofs	Exterior Walls
Inside rooms			
Floor area ≤150 ft ²	1	—	—
Floor area >150 ft ² and ≤500 ft ²	2	—	—
Cutoff rooms and attached buildings			
Floor area ≤300 ft ²	1	1 ^b	—
Floor area >300 ft ²	2	2 ^b	2 ^c
Liquid warehouses ^{d,e}	4 ^f	—	2 ^g or 4 ^h

Note: For SI units, 1 ft² = 0.09 m².

^aBetween liquid storage areas and any adjacent areas not dedicated to liquid storage.

^bRoofs of attached buildings, one story in height, shall be permitted to be of lightweight, noncombustible construction if the separating interior walls have minimum 0.9 m (3 ft) parapets.

^cWhere other portions of buildings or other properties are exposed.

^dFire resistance ratings for liquid warehouses storing only Class IIIB liquids, which are not heated above their flash point, shall be permitted to be reduced to 2 hours.

^eFire resistance ratings for liquid warehouses protected in accordance with 6.8.2 shall be permitted to be reduced to 2 hours.

^fThis shall be a fire wall as defined in NFPA 221, *Standard for Fire Walls and Fire Barrier Walls*.

^gFor exposing walls that are located more than 3 m (10 ft) but less than 15 m (50 ft) from an important building or line of adjoining property that can be built upon.

^hFor exposing walls that are located 3 m (10 ft) or less from an important building or line of adjoining property that can be built upon.

6.4.2.2 Openings in interior walls to adjacent rooms or buildings and openings in exterior walls with fire resistance ratings shall be provided with normally closed, listed fire doors with fire protection ratings corresponding to the fire resistance rating of the wall as specified in Table 6.4.2.2. Such doors shall be permitted to be arranged to stay open during material handling operations if the doors are designed to close automatically in a fire emergency by provision of listed closure devices. Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*.

6.4.2.3 Exterior walls shall be constructed to provide ready access for fire-fighting operations by means of access openings, windows, or lightweight noncombustible wall panels.

Exception: This shall not apply to inside rooms.

Table 6.4.2.2 Fire Protection Ratings for Fire Doors

Fire Resistance Rating of Wall ^a (hr)	Fire Protection Rating of Door (hr)
1	¾
2	1½
4	3 ^b

^aAs required by Table 6.4.2.1.

^bOne fire door required on each side of interior openings for attached liquid warehouses.

6.4.2.4* Where Class IA liquids or unstable liquids are dispensed or stored in containers larger than 1 L (1 gal), rooms shall be designed to direct flame, combustion gases and pressures resulting from a deflagration away from important buildings or occupied areas through the use of damage-limiting construction. The damage-limiting construction design shall be in accordance with recognized engineering standards and shall be acceptable to the authority having jurisdiction.

Exception: This shall not apply to inside rooms.

6.4.2.5* Curbs, scuppers, special drains, or other suitable means shall be provided to prevent the flow of liquids under emergency conditions into adjacent building areas. If a drainage system is used, it shall have sufficient capacity to carry the expected discharge of water from fire protection systems and hose streams.

Exception No. 1: Where none of the containers stored in a storage area exceed 38 L (10 gal), the storage area need not meet this requirement.

Exception No. 2: Where only Class IIIB liquids are stored in a storage area, regardless of container size, the storage area need not meet this requirement.

Exception No. 3: Where unsaturated polyester resins (UPRs) containing not more than 50 percent by weight of Class IC, Class II, or Class IIIA liquid constituents are protected in accordance with Table 6.8.2(k), the storage area need not meet this requirement.

6.4.2.6 In inside storage rooms, electrical wiring and utilization equipment for Class I liquid storage shall be Class I, Division 2, and electrical wiring and utilization equipment in inside storage rooms used for the storage of Class II and Class III liquids shall be suitable for general purpose.

Exception: Class I, Division 2 requirements shall apply to Class II and III liquids when stored at temperatures above their flash points.

6.4.2.6.1 Installation of electrical wiring and utilization equipment shall meet the requirements of Chapter 8.

6.4.2.7 Liquid storage areas where dispensing is conducted shall be provided with either a gravity or a continuous mechanical exhaust ventilation system. Mechanical ventilation shall be used if Class I liquids are dispensed within the room.

6.4.2.7.1 Exhaust air shall be taken from a point near a wall on one side of the room and within 300 mm (12 in.) of the floor, with one or more make-up inlets located on the opposite side of the room within 300 mm (12 in.) of the floor. The location of both the exhaust and inlet air openings shall be arranged to provide, as far as practicable, air movements across all portions of the floor to prevent accumulation of flammable vapors. Exhaust from the room shall be directly to the exterior of the building without recirculation.