

Design, Construction, Operation, Maintenance, and Inspection of Terminal & Tank Facilities

API STANDARD 2610
SECOND EDITION, MAY 2005



Design, Construction, Operation, Maintenance, and Inspection of Terminal & Tank Facilities

Downstream Segment

**API STANDARD 2610
SECOND EDITION, MAY 2005**



SPECIAL NOTES

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

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local, state, or federal laws.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. Sometimes a one-time extension of up to two years will be added to this review cycle. This publication will no longer be in effect five years after its publication date as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Standards department telephone (202) 682-8000. A catalog of API publications, programs and services is published annually and updated biannually by API, and available through Global Engineering Documents, 15 Inverness Way East, M/S C303B, Englewood, CO 80112-5776.

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

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

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

All rights reserved. No part of this work may be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, N.W., Washington, D.C. 20005.

Copyright © 2005 American Petroleum Institute

FOREWORD

This standard was developed to guide the management of terminals and tanks in a manner that protects the environment and the safety of workers and the public. This standard is intended for petroleum terminal and tank facilities associated with marketing, refining, pipeline, and other similar facilities. This standard may be used as a resource and management guide by those responsible for such facilities and by those working on their behalf. This standard is a compilation of industry knowledge, information, and management practices for all relevant aspects of terminal and tank operations aggregated into an overview document comprising best practices. In instances where greater detail or additional information may be helpful or needed, this standard references other API publications or similar industry guides and standards. It is intended to be consistent with, but is not a substitute for, any applicable local, state, or federal regulations.

The requirements of this standard represent minimum requirements applicable to all facilities within the scope of this document. Some provisions in this standard, as indicated by the use of the word shall, are mandatory and have to be followed to meet the intent of this standard. Some provisions are recommended, as denoted by the word should, but are not mandatory. These provisions will need to be considered based on site-specific factors. Still other provisions are optional, as denoted by the word may. Typically, these will be given where a range of good options exists.

To foster greater awareness and assist the industry in addressing environmental, health, and safety concerns, the API has undertaken the development of this single document aggregating the various standards, specifications, and recommended practices on the design, construction, operation, inspection, and maintenance of petroleum terminals and tanks. API also has significant research underway to assist members in addressing issues of groundwater protection and remediation of soil contamination. This research includes the evaluation of improved leak detection technology and the evaluation of better methods to detect and remediate groundwater and soil contamination.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

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

CONTENTS

	Page
1 GENERAL	1
1.1 Scope and Purpose	1
1.2 Nonapplicability and Retroactivity	2
1.3 Governmental Requirements and Reviews	2
2 REFERENCES	2
2.1 Standards	2
2.2 Other References	7
3 DEFINITIONS	7
4 SITE SELECTION AND SPACING REQUIREMENTS	8
4.1 Overview	8
4.2 Site Selection	8
4.3 Spacing Requirements	9
5 POLLUTION PREVENTION AND WASTE MANAGEMENT	10
5.1 Applicability	10
5.2 Waste Management Hierarchy	10
5.3 Pollution Prevention	11
5.4 Waste Management Practices	13
6 SAFE OPERATIONS OF TERMINALS & TANKS	14
6.1 General	14
6.2 Hazard Identification	14
6.3 Operating Procedures	14
6.4 Safe Work Practices	14
6.5 Emergency Response and Control Procedures	14
6.6 Management of Change	15
6.7 Training	15
6.8 Pre-Startup Safety and Operational Inspection	15
6.9 Incident Investigation	15
6.10 Contractor Safety	16
7 FIRE PREVENTION AND PROTECTION	16
7.1 General	16
7.2 Fire Prevention	16
7.3 Fire Fighting Equipment	17
7.4 Fire Extinguishment and Control	17
7.5 Fire Protection Water Supplies	18
7.6 Fire Emergency Plan	18
7.7 Exposure Protection	19
7.8 Special Product Considerations	19
8 TANKS	20
8.1 Aboveground Petroleum Storage Tanks	20
8.2 Operations, Inspections, Maintenance, and Repair for Aboveground Tanks	23
8.3 Fiberglass Aboveground Storage Tanks	24
8.4 Underground Tanks and Piping	24

	Page
8.5 Underground Storage Tank Vapor Emissions	24
9 DIKES AND BERMS	24
9.1 Overview	24
9.2 Dikes	24
9.3 Berms	26
10 PIPE, VALVES, PUMPS & PIPING SYSTEMS	26
10.1 General	26
10.2 Material Compatibility	26
10.3 Piping Systems	26
10.4 Piping Components	27
10.5 Pumps	29
10.6 Pipeline Integrity Assurance of Existing Piping Systems	29
10.7 Testing Following Construction	30
11 LOADING, UNLOADING AND PRODUCT TRANSFER FACILITIES	30
11.1 Scope	30
11.2 General Design	30
11.3 Truck Loading/Unloading	31
11.4 Rail Tank Car Loading and Unloading	33
11.5 Marine Loading/Unloading	34
11.6 Aviation Loading/Unloading	35
11.7 Vapor Control	35
11.8 Oxygenate Blending	37
11.9 Emergency Shutdown Systems and Procedures	37
11.10 Product Testing	37
11.11 Communication	37
11.12 Measurements	37
11.13 Valves, Lines, Loading Arms, and Hose Product Identification	38
11.14 Release Prevention System in Loading/Unloading Areas	38
11.15 Maintenance/Testing	38
11.16 Auxiliary Systems	38
12 CORROSION CONTROL	38
12.1 Scope	38
12.2 Protective Coatings	38
12.3 Internal Tank Lining	41
12.4 Cathodic Protection	42
13 STRUCTURES, UTILITIES, AND YARD	43
13.1 Structures	43
13.2 Utilities	44
13.3 Yard	49
14 REMOVALS AND DECOMMISSIONING OF FACILITY	51
14.1 General	51
14.2 Site Control and Protection	53
14.3 Preparations	53
14.4 Execution	53
14.5 Site Assessment and Remediation	53
14.6 Closeout and Cleanup	53

Figures

1	Typical Electric Service and Distribution System Terminals and Bulk Plants	45
2	Segregated Waste Stream in a Typical Terminal.	47
3	Tank Truck Loading Yard Layout without Garage.	50
4	Tank Truck Loading Yard Layout with Garage	51
5	Yard Dimensions for Trucks (See Table Above)	52

Design, Construction, Operation, Maintenance, and Inspection of Terminal & Tank Facilities

1 General

1.1 SCOPE AND PURPOSE

This standard covers the design, construction, operation, inspection, and maintenance of petroleum terminal and tank facilities associated with marketing, refining, pipeline, and other similar activities as stipulated in 1.1.1 through 1.1.7. This standard covers the issues of site selection and spacing, pollution prevention and waste management, safe operation, fire prevention and protection, tanks, dikes and berms, mechanical systems, product transfer, corrosion protection, structures, utilities and yard, and removals and decommissioning.

The purpose of this standard is to consolidate a wide base of current industry experience, knowledge, information, and management practices into a cohesive standard comprising a range of best practices.

Mandatory requirements in this standard are designated by the word "shall" or "must." Recommendations are designated by the use of the word "should." Optional items are designated by the word "may" (refer to Section 3). This standard incorporates by reference a number of other standards and recommended practices. The distinctions between mandatory, recommended, and optional provisions in the referenced documents are not changed by the nature of their reference in this standard.

The values stated for this standard are in U.S. Customary units with the International System of units (SI) provided in parentheses.

The petroleum industry is engaged in the manufacture, storage, transportation, blending, and distribution of crude oil and refined products. Individual terminal facilities and plants may perform one or more of these functions. These facilities represent diverse operations ranging from small distribution facilities (e.g., bulk plants and warehouses), to large storage and distribution facilities (e.g., pipeline and marine terminals and wholesale plants), and large integrated facilities (e.g., petroleum refineries, and grease production, oil blending and packaging plants). The specific application of this standard within those various types of operations is itemized in 1.1.1 through 1.1.7.

1.1.1 Petroleum Terminals

Petroleum terminals may include tank farms, loading and unloading areas, pipeline manifolds, storage areas, warehouses, docks, garages, laboratories, and office buildings. Products may be received and distributed by pipeline, marine transport, rail, or truck. Bulk quantities of refined products are stored in aboveground tanks for distribution in smaller quantities to industrial customers, to commercial consumers,

and to retail and wholesale marketing facilities. Petroleum terminals may also store petroleum products in consumer packaging, bulk containers, inside tanks and drums.

1.1.2 Pipeline Tankage Facilities

Pipeline tankage facilities consist of tanks and tank farms used to receive petroleum (crude oil and refined products) from pipelines, trucks, railcars, or marine facilities and to provide surge relief from pipeline operations (see Office of Pipeline Safety, Research and Special Programs Administration regulation 49 CFR Part 195 and the U.S. Coast Guard regulation 33 CFR Parts 154 and 156).

1.1.3 Refinery Facilities

Provisions for loading and unloading areas, docks, blending and packaging facilities, warehouses, and some refinery tankage facilities are included in this standard. Refinery tankage covered by this standard does not include those above-ground tanks or groups of tanks as defined in 1.2.c (e.g., process tanks).

Examples of covered refinery tankage include tanks that are used to accomplish the following:

- a. Receive incoming crude oil.
- b. Store intermediate products or components outside of the refinery process units.
- c. Store finished products for shipment by truck, marine transport, rail, or pipeline.

Examples of refinery tankage and other equipment specifically excluded are as follows:

- a. Tanks and equipment that are integral to refinery process equipment.
- b. Refinery tanks and other equipment located within the battery limits of process units.
- c. Process equipment located outside the process unit battery limits.
- d. Tanks that contain materials, such as additives, used in refinery processes or utility systems.

1.1.4 Bulk Plants

Although bulk plants typically handle smaller quantities of product, operations and facilities at these plants are similar to those at petroleum terminals. Bulk plants typically receive and distribute product by truck, although some are serviced by rail, marine transport, or pipeline. Bulk plants may also store an inventory of petroleum products in consumer packaging, bulk containers, inside tanks and drums.

1.1.5 Lube Blending and Packaging Facilities

Lube oil blending and packaging facilities blend refined base stock products with additives and then package the finished products in drums, pails, portable tanks, or consumer-size containers or ship to consumers in bulk. The additives and lube base stocks may be received and stored either in bulk or in containers. Lube blending and packaging facilities typically include warehouses, blending and packaging areas, quality control labs, base stock and additive storage areas, shipping and receiving areas, and office buildings.

1.1.6 Asphalt Plants

Asphalt plants receive asphalt from petroleum refineries and blend it with additives to produce paving, roofing, and industrial grade asphalt products. Asphalt facilities typically consist of a laboratory for quality control, a rail siding or marine dock, an aboveground tank farm, a warehouse, one or more unloading areas for raw materials and products, a manufacturing area, a package heating system, a truck scale, a loading rack, and an office.

1.1.7 Aviation Service Facilities

Aviation service facilities store light petroleum fuels in aboveground or underground storage tanks. Services provided may include the following: refueling, defueling, deicing, washing, maintenance, and repair of aircraft. Aircraft fuel may be loaded into refueling trucks that service the aircraft, or dispensed directly into aircraft from a fixed dispenser system or hydrant system cart.

1.2 NONAPPLICABILITY AND RETROACTIVITY

This standard does not apply to the following installations:

- Those covered by API Std 2510 and API RP 12R1.
- Retail facilities, such as service stations, garages, and automotive lubrication facilities.
- Refinery process equipment, refinery process tanks located within the battery limits of the process units, and gas processing equipment (see 1.1.3).
- Aboveground tanks and vessels less than 1320 gallons (5000 liters) in storage capacity.
- Tanks that are part of oil and gas production, natural gas processing plants, or offshore operations.
- Production, pipeline, and truck crude oil gathering facilities.

The design and construction provisions of this standard are intended for application at new facilities or installations. Application of the design and construction provisions of this standard to facilities, equipment, structures, or installations that are already in place, that are in the process of construction, or that are installed before the date of this publication should be evaluated when circumstances merit. Such an eval-

uation should consider the site specific circumstances and details accounting for both the potential and tolerance for risk, existing conditions at the installation, and overall benefit of applying the required design and construction provisions.

The operation, inspection, and maintenance provisions in various sections of this standard shall apply to both new and existing facilities or installations.

1.3 GOVERNMENTAL REQUIREMENTS AND REVIEWS

Reviews should be conducted on a periodic basis to help ensure that the facility meets applicable federal, state, or local requirements. These reviews should include but not be limited to the following:

- Spill Prevention Control and Countermeasure (SPCC) plans, 40 CFR 112 and other Environmental Protection Agency (EPA) requirements.
- Occupational Safety and Health Act (OSHA) requirements.
- Tank or vessel inspection records, registration, or files.
- Discharge or remediation permits.
- Air and water permits (such as the Clean Air Act [CAA] and Clean Water Act [CWA] and their amendments).
- Oil Pollution Act of 1990 (OPA 90) regulations and contingency plans including Office of Pipeline Safety (49 CFR 194), EPA, and Coast Guard response plans.
- State and local emergency plans (such as the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] and Emergency Planning and Community Right-to-Know [EPCRA] requirements).
- 49 CFR 195i. Superfund Amendments and Reauthorization Act (SARA) Title III requirements.
- United States Coast Guard (USCG) requirements, 33 CFR 154.
- Local or state permits (fire protection, building, zoning, etc.), as applicable.
- Resource Conservation and Recovery Act (RCRA) requirements.

2 References

2.1 STANDARDS

Unless otherwise specified, the most recent editions of the following standards, codes, and specifications shall be used. The provisions of these publications are incorporated into API Std 2610 only as explicitly specified in the text.

API

Spec 5L	<i>Specification for Line Pipe</i>
Spec 6FA	<i>Fire Test for Valves</i>
Spec 12F	<i>Shop Welded Tanks for Storage of Production Liquids</i>
Spec 12P	<i>Fiberglass Reinforced Plastic Tanks</i>

RP 12R1	<i>Setting, Maintenance, Inspection, Operation, and Repair of Tanks in Production Service</i>	RP 1110	<i>Pressure Testing of Liquid Petroleum Pipelines</i>
Publ 306	<i>An Engineering Assessment of Volumetric Methods of Leak Detection in Above-ground Storage Tanks</i>	RP 1124	<i>Ship, Barge, and Terminal Hydrocarbon Vapor Collection Manifolds</i>
Publ 307	<i>An Engineering Assessment of Acoustic Methods of Leak Detection in Above-ground Storage Tanks</i>	RP 1125	<i>Overfill Control Systems for Tank Barges</i>
Publ 315	<i>Assessment of Tankfield Dike Lining Materials and Methods</i>	Std 1529	<i>Aviation Fueling Hose</i>
Publ 334	<i>A Guide to Leak Detection for Above-ground Storage Tanks</i>	API 1581	<i>Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators</i>
Publ 340	<i>Liquid Release Prevention and Detection Measures for Aboveground Storage Facilities</i>	RP 1604	<i>Closure of Underground Petroleum Storage Tanks</i>
Publ 341	<i>A Survey of Diked-area Liner Use at Aboveground Storage Tank Facilities</i>	RP 1615	<i>Installation of Underground Petroleum Storage Systems</i>
Publ 351	<i>Overview of Soil Permeability Test Methods</i>	RP 1621	<i>Bulk Liquid Stock Control at Retail Outlets</i>
RP 500	<i>Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division I and Division 2</i>	RP 1626	<i>Storing and Handling Ethanol and Gasoline-Ethanol Blends at Distribution Terminals and Service Stations</i>
RP 520	<i>Design of Pressure Relieving Systems</i>	RP 1627	<i>Storage and Handling of Gasoline-Methanol/Cosolvent Blends at Distribution Terminals and Service Stations</i>
RP 540	<i>Electrical Installations in Petroleum Processing Plants</i>	Publ 1628	<i>A Guide to the Assessment and Remediation of Underground Petroleum Releases</i>
API 570	<i>Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-service Piping Systems</i>	Publ 1629	<i>Guide for Assessing and Remediating Petroleum Hydrocarbons in Soil</i>
RP 575	<i>Inspection of Atmospheric & Low Pressure Storage Tanks</i>	RP 1631	<i>Interior Lining and Periodic Inspection of Underground Storage Tanks</i>
Std 607	<i>Fire Test for Soft-seated Quarter Turn Valves</i>	RP 1632	<i>Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems</i>
Std 610	<i>Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries</i>	RP 1637	<i>Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Service Stations and Distribution Terminals</i>
Std 620	<i>Design and Construction of Large, Welded, Low-pressure Storage Tanks</i>	Publ 1638	<i>Waste Management Practices for Petroleum Marketing Facilities</i>
Std 650	<i>Welded Steel Tanks for Oil Storage</i>	RP 1639	<i>Owner/Operator's Guide to Operation and Maintenance of Vapor Recovery Systems at Gasoline Dispensing Facilities</i>
RP 651	<i>Cathodic Protection of Aboveground Storage Tanks</i>	Std 2000	<i>Venting Atmospheric and Low-pressure Storage Tanks: Nonrefrigerated and Refrigerated</i>
RP 652	<i>Lining of Aboveground Petroleum Storage Tank Bottoms</i>	RP 2001	<i>Fire Protection in Refineries</i>
Std 653	<i>Tank Inspection, Repair, Alteration, and Reconstruction</i>	RP 2003	<i>Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents</i>
Std 674	<i>Positive Displacement Pumps—Reciprocating</i>	RP 2009	<i>Safe Welding, Cutting and Hot Work Practices in the Petroleum and Petrochemical Industries</i>
Std 675	<i>Positive Displacement Pumps—Controlled Volume</i>	Std 2015	<i>Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks</i>
Std 676	<i>Positive Displacement Pumps—Rotary</i>	RP 2016	<i>Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks</i>
RP 1004	<i>Bottom Loading and Vapor Recovery for MC-306 Tank Motor Vehicles</i>	RP 2021	<i>Management of Atmospheric Storage Tank Fires</i>
RP 1007	<i>Loading and Unloading of MC306 DOT 406 Cargo Tank Motor Vehicles</i>		

Publ 2021A	<i>Interim Study—Prevention and Suppression of Storage Tank Fires in Large Aboveground Atmospheric Storage Tanks</i>	AAR ² <i>Mechanical Division Standards</i>
Publ 2026	<i>Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service</i>	ABS ³ <i>Rules for Building and Classing Steel Vessels</i>
RP 2027	<i>Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service</i>	ACI ⁴ 318 <i>Building Code Requirements for Structural Concrete and Commentary</i>
Publ 2030	<i>Application of Water Spray Systems for Fire Protection in the Petroleum Industry</i>	AISC ⁵ 335 <i>Specification for Structural Steel Buildings Allowable Stress Design, and Plastic Design</i>
Publ 2202	<i>Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks</i>	AREMA ⁶ <i>Manual for Railway Engineering</i>
Publ 2207	<i>Preparing Tank Bottoms for Hot Work</i>	ASM International ⁷ <i>ASM Metals Handbook, Volume 13, Corrosion</i>
Publ 2217A	<i>Guidelines for Work in Inert Confined Spaces in the Petroleum Industry</i>	ASME ⁸ B16.5 <i>Pipe Flanges and Flanged Fittings</i>
Publ 2219	<i>Safe Operation of Vacuum Trucks in Petroleum Service</i>	B16.9 <i>Factory Made Wrought Steel Butt welding Fittings</i>
RP 2220	<i>Improving Owner and Contractor Safety Performance</i>	B16.11 <i>Forged Fittings Socket Welding and Threaded</i>
RP 2350	<i>Overfill Protection for Petroleum Tanks in Petroleum Facilities</i>	B16.20 <i>Metallic Gaskets for Pipe Flanges, Ring-Joint Spiral Wound and Jacketed</i>
Std 2510	<i>Design and Construction of LPG Installations</i>	B16.21 <i>Non-metallic Flat Gaskets for Pipe Flanges</i>
Publ 2557	<i>Vapor Collection and Control Operations for Storage and Transfer Operations in the Petroleum Industry</i>	B16.28 <i>Wrought-Steel Butt welding Short-Radius Elbows and Returns</i>
Publ 4588	<i>Development of Fugitive Emission Factors and Emission Profiles for Petroleum Marketing Terminals, Volume 1</i>	B16.47 <i>Large Diameter Steel Flanges</i>
Publ 4602	<i>Minimization, Handling, Treatment, and Disposal of Petroleum Products Terminal Wastewaters</i>	B31.3 <i>Process Piping</i>
<i>Manual of Petroleum Measurement Standards (MPMS)</i>		B31.4 <i>Pipeline Transportation Systems for Liquid hydrocarbons and Other Liquids</i>
Ch. 2	<i>Tank Calibration</i>	B31.5 <i>Refrigeration Piping</i>
Ch. 3.1B	<i>Standard Practice for Level Measurement of Liquid Hydrocarbons in Stationary Tanks by Automatic Tank Gauging</i>	B73.1M <i>Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process</i>
Ch. 19.1	<i>Evaporative Loss from Fixed Roof Tanks</i>	
Ch. 19.2	<i>Evaporative Loss from Floating-roof Tanks</i>	
<i>Security Guidance for the Petroleum Industry</i>		
<i>Security Vulnerability Assessment Methodology for the Petroleum and Petrochemical Industries</i>		

AAI¹

ADM-1-516166 *Aluminum Design Manual—Specifications & Guidelines for Aluminum Structures*

¹Aluminum Association Inc, 900 19th St., N.W. Washington, D.C. 20006. www.aluminium.org

²Association of American Railroads, 50 F Street, N.W., Washington, D.C. 20001-1564. www.aar.org

³American Bureau of Shipping, ABS Plaza, 16855 Northchase Drive, Houston, Texas 77060. www.eagle.org

⁴American Concrete Institute, P.O. Box 9094, Farmington Hills, Michigan 48333. www.aci-int.org

⁵American Institute of Steel Construction, One East Wacker Drive, Suite 3100, Chicago, Illinois 60601-2001. www.aisc.org

⁶American Railway Engineering and Maintenance of Way Association, 8201 Corporate Drive, Suite 1125, Landover, Maryland 20785-2230. www.arema.org

⁷ASM International, 9639 Kinsman Road, Materials Park, Ohio 44073-0002. www.asminternational.org

⁸ASME International, 3 Park Avenue, New York, New York 10016-5990. www.asme.org

ASTM ⁹		40 CFR 52	<i>Approval and Promulgation of Implementation Plans</i>
A193	<i>Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service</i>	40 CFR 60	<i>Standards of Performance for New Stationary Sources</i>
A194	<i>Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both</i>	40 CFR 61	<i>National Emission Standards for Hazardous Air Pollutants</i>
A325	<i>Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength</i>	40 CFR 63	<i>National Emission Standards for Hazardous Air Pollutants for Source Categories</i>
AWS ¹⁰		40 CFR 112	<i>Oil Pollution Prevention</i>
D-1.1	<i>Structural Welding Code—Steel</i>	40 CFR 122	<i>EPA Administered Permit Programs: The National Pollutant Discharge Elimination System</i>
AWWA ¹¹		40 CFR 123	<i>State Program Requirements</i>
C110	<i>American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids</i>	40 CFR 125	<i>Criteria and Standards for the National Pollutant Discharge Elimination System</i>
C115	<i>American National Standard for Flanged Ductile-Iron Pipe With Threaded Flanges</i>	40 CFR 262	<i>Standards Applicable to Generators of Hazardous Waste</i>
C150	<i>American National Standard for Thickness Design of Ductile-Iron Pipe</i>	40 CFR 264	<i>Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities</i>
C151	<i>American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water</i>	40 CFR 265	<i>Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities</i>
C153	<i>American National Standard for Ductile-Iron Compact Fittings, 3 in. through 24 in. (76 mm through 610 mm) and 54 in. through 64 in. (1,400 mm through 1,600 mm), for Water Service</i>	40 CFR 268	<i>Land Disposal Restrictions</i>
BOCA ¹²		40 CFR 270	<i>EPA Administered Permit Programs: The Hazardous Waste Permit Program</i>
	<i>BOCA National Building Code</i>	40 CFR 279	<i>Standards for the Management of Used Oil</i>
	<i>BOCA National Fire Code</i>	40 CFR 280	<i>Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)</i>
DOJ ¹³		40 CFR 311	<i>Worker Protection</i>
28 CFR 36	<i>Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities</i>	40 CFR 403	<i>General Pretreatment Regulations for Existing and New Sources of Pollution</i>
EPA ¹⁴			
40 CFR 51	<i>Requirements for Preparation, Adoption, and Submittal of Implementation Plans</i>		
ICBO ¹⁵			
	<i>International Building Code</i>		
	<i>International Fire Code</i>		
	<i>Uniform Building Code</i>		
	<i>Uniform Fire Code</i>		
ICOS/OCIMF/IAPH ¹⁶			
	<i>International Safety Guide for Oil Tankers and Terminals</i>		

⁹ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959. www.astm.org

¹⁰American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126. www.aws.org

¹¹American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235. www.awwa.org

¹²Building Officials Code Administrators, 4051 W. Flossmoor Road, Country Club Hills, Illinois 60478. www.bocai.org

¹³U.S. Department of Justice, 950 Pennsylvania Avenue, N.W., Washington, D.C. 20530-0001. www.usdoj.gov

¹⁴Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20460. EPA Regulations are posted on, and can be downloaded from, the EPA web site: www.epa.gov

¹⁵International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601. www.icbo.org

IES ¹⁷		30A	<i>Motor Fuel Dispensing Facilities</i>
	<i>IES Lighting Handbook</i>	45	<i>Fire Protection for Laboratories Using Chemicals</i>
ISA ¹⁸		69	<i>Standard on Explosion Prevention Systems</i>
84.00.01	<i>Functional Safety: Safety Instrumented Systems for the Process Industry Sector</i>	70	<i>National Electrical Code</i>
MSS ¹⁹		70E	<i>Electrical Safety Requirements for Employee Workplaces</i>
SP-75	<i>Specification for High Test Wrought Butt Welding Fittings</i>	77	<i>Recommended Practice on Static Electricity</i>
SP-83	<i>Class 3000 Steel Pipe Unions, Socket-Welding and Threaded</i>	101	<i>Safety to Life From Fire in Buildings and Structures</i>
NACE ²⁰		111	<i>Standard on Stored Electrical Energy</i>
RP 0169	<i>Control of External Corrosion on Underground or Submerged Metallic Piping Systems</i>	307	<i>Emergency and Standby Power Systems</i>
RP 0193	<i>External Cathodic Protection of On Grade Metallic Storage Tank Bottoms</i>	403	<i>Marine Terminals, Piers and Wharves</i>
RP 0285	<i>Corrosion Control of Underground Storage Tank Systems by Cathodic Protection</i>	407	<i>Standard for Aircraft Rescue and Fire Fighting Services at Airports</i>
NFPA ²¹		415	<i>Standard for Aircraft Fuel Servicing</i>
1	<i>Fire Prevention Code (Last Edition 2000)</i>	496	<i>Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways</i>
10	<i>Standard for Portable Fire Extinguishers</i>	497	<i>Standard on Purged and Pressurized Enclosures for Electrical Equipment</i>
11	<i>Standard for Low-Expansion Foam</i>	600	<i>Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas</i>
15	<i>Standard for Water Spray Fixed Systems</i>	780	<i>Standard on Industrial Fire Brigades</i>
16	<i>Standard for Deluge Foam-Water Sprinkler Systems and Foam Water Spray Systems</i>	1081	<i>Standard for the Installation of Lightning Protection Systems</i>
17	<i>Standard for Dry Chemical Extinguishing Systems</i>	5000	<i>Industrial Fire Brigade Member Professional Qualifications</i>
20	<i>Standard for Installation of Stationary Fire Pumps for Fire Protection</i>		<i>Building Construction and Safety Code</i>
22	<i>Standard for Water Tanks for Private Fire Protection</i>		<i>Uniform Fire Code (Effective 2003)</i>
24	<i>Private Fire Service Mains</i>		
25	<i>Water Based Fire Protection Systems</i>		
30	<i>Flammable and Combustible Liquids Code</i>		
OCIMF ²²			
	<i>Design and Construction Specification for Marine Loading Arms</i>		
OPS RSPA ²³			
	<i>Response Plans for On-Shore Oil Pipelines</i>		
	<i>Transportation of Hazardous Liquids by Pipeline</i>		
OSHA ²⁴			
	<i>29 CFR 1910.36</i>		<i>Design and Construction Requirements for Exit Routes</i>

¹⁶International Chamber of Shipping, Carthusian Court, 12 Carthusian Street, London, EC1M 6EZ, England; Oil Companies International Marine Forum, 27 Queen Anne's Gate, London, SW1H9BU, England, www.marisec.org; International Association of Ports and Harbors, 5th Floor, North Tower New Pier Takeshiba, 1-11-1 Kaigan, Minato-ku, Tokyo, 105-0022, Japan.

¹⁷Illuminating Engineering Society of North America, 120 Wall Street, 17th Floor, New York, New York 10005. www.iesna.org

¹⁸The Instrumentation, Systems, and Automation Society, 67 Alexander Drive, Research Triangle Park, North Carolina 27709. www isa org

¹⁹Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park Street, N.E., Vienna, Virginia 22180-4602. www mss-hq com

²⁰NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, P.O. Box 218340, Houston, Texas 77218-8340. www nace org

²¹National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169. www nfpa org

²²Oil Companies International Marine Forum, 27 Queen Anne's Gate, London, SW1H9BU, England. www.ocimf.com

²³Office of Pipeline Safety, Research and Special Programs Administration, 400 Seventh Street, S.W., Room 21, Washington D.C. 20590-0001. <http://ops.dot.gov>

²⁴U.S. Department of Labor, Occupational Safety and Health Administration, 200 Constitution Ave., N.W., Washington, D.C. 20210. OSHA Regulations are posted on, and can be downloaded from: www.osha.gov

29 CFR 1910.56	<i>Illumination</i>	33 CFR 126	<i>Handling of Class 1 (Explosives) or Other Dangerous Cargoes within or Contiguous to Waterfront Facilities</i>
29 CFR 1910.66	<i>Powered Platforms for Building Maintenance</i>	33 CFR 154	<i>Facilities Transferring Oil or Hazardous Material in Bulk</i>
29 CFR 1910.119	<i>Process Safety Management of Highly Hazardous Chemicals</i>	33 CFR 155	<i>Oil or Hazardous Material Pollution Prevention Regulations for Vessels</i>
29 CFR 1910.120	<i>Hazardous Waste Operations and Emergency Response</i>	33 CFR 156	<i>Oil and Hazardous Material Transfer Operations</i>
29 CFR 1919.134	<i>Respiratory Protection</i>	46 CFR 39	<i>Vapor Control Systems</i>
29 CFR 1910.146	<i>Permit-Required Confined Spaces</i>		
29 CFR 1910.147	<i>The Control of Hazardous Energy (Lockout/Tagout)</i>		
29 CFR 1910.156	<i>Fire Brigades</i>		
29 CFR 1910.157	<i>Portable Fire Extinguishers</i>		
29 CFR 1910.1200	<i>Hazard Communication</i>		
29 CFR 1910, Subpart D	<i>Walking-Working Surfaces</i>		
29 CFR 1910, Subpart L	<i>Fire Protection</i>		
29 CFR 1910, Subpart S	<i>Electrical</i>		
29 CFR 1926, Subpart M	<i>Fall Protection</i>		
29 CFR 1926.62	<i>Lead</i>		
29 CFR 1926.64	<i>Process Safety Management of Highly Hazardous Chemicals</i>		
SBCCI ²⁵			
	<i>Standard Building Code</i>		
	<i>Standard Fire Protection Code</i>		
SSPC ²⁶			
SP1	<i>Solvent Cleaning</i>		
SP2	<i>Hand Tool Cleaning</i>		
SP3	<i>Power Tool Cleaning</i>		
SP5	<i>White Metal Blast Cleaning</i>		
SP6	<i>Commercial Blast Cleaning</i>		
SP7	<i>Brush-Off Blast Cleaning</i>		
SP10	<i>Near-White Metal Blast Cleaning</i>		
	<i>Steel Structures Painting Manual, Volume 1, Good Painting Practice</i>		
	<i>Steel Structures Painting Manual, Volume 2, Systems and Specifications</i>		
UL ²⁷			
UL-142	<i>Standard for Safety for Steel Aboveground Tanks for Flammable and Combustible Liquids</i>		
USCG ²⁸			
33 CFR 26	<i>Bridge-to-Bridge Radiotelephone Regulations</i>		

²⁵Southern Building Code Congress International, Inc., 900 Montclair Road, Birmingham, Alabama 35213-1206. www.sbcc.org

²⁶The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, Pennsylvania 15222-4656. www.sspc.org

²⁷Underwriters Laboratories, 333 Pfingsten Road, Northbrook, Illinois 60062. www.ul.com

2.2 OTHER REFERENCES

API		
Std 579	<i>Fitness-for-Service</i>	
Publ 4716	<i>Buried Pressurized Piping Systems Leak Detection Guide</i>	
AISC ⁵		
LRFD	<i>Manual of Steel Construction—Load & Resistance Factor Design</i>	
NFPA ²¹		
76	<i>Recommended Practice for the Fire Protection of Telecommunications Facilities</i>	

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 aboveground storage tank (AST): Atmospheric vertical or horizontal, cylindrical, closed-top, open-top, or covered open-top steel or fiberglass aboveground storage containers of various sizes and capacities over 1320 gallons (4997 liters) and whose entire bottom is supported uniformly on the ground, completely on saddles, or other supports. ASTs may be either shop fabricated or field erected.

3.2 berm: The area around the tank, inside the dike, normally used to contain spills and to provide access to the tank and surrounding equipment. Also known as a “bund.”

3.3 combustible liquid: A liquid having a flash point at or above 100°F (37.8°C). See NFPA 30 for discussion of combustible liquid classification.

3.4 external floating-roof tank: An aboveground tank with a floating roof, which has no fixed roof and has an open top.

²⁸U.S. Coast Guard Marine Safety Center (part of DOT), 2100 Second Street, S.W., Washington D.C. 20593. Available from the U.S. Government Printing Office, Washington, D.C. 20036. www.uscg.mil

3.5 facility: Any building, structure, installation, equipment, pipeline, or other physical feature used in petroleum refining, storage, transportation, and distribution. The boundaries of a facility may depend on several site specific factors, including but not limited to, the ownership or operation of buildings, structures, and equipment on the same site, and the types of activity at the site.

3.6 fixed-roof tank: An aboveground tank with no internal floating roof (IFR) that is covered by either a steel roof or an aluminum dome.

3.7 flammable liquid: A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psi (absolute) (2069 mm Hg) at 100°F (37.8°C). This is also classified as Class I liquid (see NFPA 30 for additional definitions and sub-classifications).

3.8 installations: Tanks, pumps, compressors, accessories, controls, piping, and all other associated equipment required for the receipt, transfer, storage, blending, packaging, and shipment of petroleum products.

3.9 internal floating-roof tank: An aboveground fixed-roof tank with a floating roof inside the tank.

3.10 may: The use of the word "may" indicates provisions that are optional and, consequently, are at the discretion of the designer or operator.

3.11 must: The use of the word "must" indicates important legal or safety considerations and are mandatory.

3.12 petroleum: Any crude oil, petroleum liquid, or gaseous complex combination of hydrocarbons and related derivatives (natural or manmade) that may be processed from crude oil for fractions, including the following: natural gas, gasoline, naphtha, kerosene, fuel and lubricating oils, paraffin wax, additives, asphalt, and various derivative products. Note that EPA 40 CFR 60, Subpart Kb, defines "petroleum" as crude oil removed from the earth and the oils derived from the tar sands, shale, and coal, while "petroleum liquids" is defined as any finished or intermediate product manufactured in a petroleum refinery.

3.13 petroleum contact wastewater (PCW): Water-containing product such as condensate from underground and aboveground petroleum storage tanks; water bottoms or drawdown water removed from a petroleum storage tank, petroleum tank filler sump, and dispenser sump water; recovered product or water in contact with product that does not contain hazardous constituents other than petroleum.

3.14 process tank: An aboveground or underground tank that forms a part of a refining process through which there is a steady, variable, recurring, or intermittent flow of materials during the operation of the process. This definition excludes tanks used for the storage of products or raw materi-

als before their introduction into the refining process or for the storage of finished products or by-products from the refining process.

3.15 release prevention barrier (RPB): The second lined bottom of double steel bottom tanks, synthetic materials, clay liners, and all other barriers or combination of barriers (such as a reinforced concrete slab under the full bottom of the tank without a membrane liner) placed in the bottom of or under an aboveground storage tank that have these functions: (a) preventing the escape of contaminated material, and (b) containing or channeling released material for leak detection. See nonmandatory Appendix I of API Std 650.

3.16 shall: The use of the word "shall" indicates provisions that are mandatory to meet the requirements of this standard.

3.17 should: The use of the word "should" indicates provisions that are recommended but not mandatory. Implementation of these provisions will be made based upon consideration of the following, as appropriate: (a) risk/benefit analysis, (b) company standards, (c) company experience, and (d) company philosophy.

3.18 underground tank: A buried container that has a capacity of more than 110 gallons (416 liters) and is used to store petroleum, additives, or other products for later use.

4 Site Selection and Spacing Requirements

4.1 OVERVIEW

This section covers the site selection and spacing requirements for the design and construction of new terminal facilities.

4.2 SITE SELECTION

A site selection criteria should be established that minimizes the potential risk to property adjacent to the terminal facility and the risk presented to the terminal facility by an incident on the adjacent property. The following factors should be considered when selecting a site for a new terminal facility:

- a. Proximity to public ways.
- b. Proximity to waterways, other surface waters, and wetland protection.
- c. Proximity and risk (to and from) adjacent facilities.
- d. Types and quantities of products to be stored.
- e. Proximity and risk to populated areas.
- f. Present and predicted development or rezoning of adjacent properties and the terminal property.
- g. Topography of the site including elevation, slope, and drainage.

- h. Assessment of site environmental conditions including soil and groundwater conditions, such as depth of the water table and type of aquifer. Refer to API Publ 1628 for information on assessment technology.
- i. Availability of off-site emergency services and access for emergency response.
- j. Location and availability of required utilities including the following: electricity, sewers, potable water, firewater, steam, air, and natural gas.
- k. Requirements for receipt and shipment of products including the following: over-the-road, rail, marine, and pipeline facilities.
- l. Codes, permits, license requirements, and regulations applicable to construction, operation, and environmental requirements including these: zoning requirements; building permits and codes; operating permits; fire marshal permits; and air, water, and waste discharge permits.
- m. Proximity to existing supply and distribution facilities.
- n. Existence of threatened and endangered species.
- o. Possible cultural resources located in the site selection.

4.3 SPACING REQUIREMENTS

4.3.1 General

4.3.1.1 The spacing provisions presented in this section are intended to minimize the fire hazard (see 7.2) and the exposure risk to adjacent tanks, equipment, and important buildings if a fire or other incident were to occur. The specific spacing distances necessary for safe operations require identification of the hazards involved (see 6.2).

4.3.1.2 Site-specific reviews of the potential risks should be used to estimate setback distances needed to limit the exposure to or from adjacent facilities. Sources of information on this subject may be found in NFPA 30 or other locally recognized requirements, such as the ICBO *Uniform Fire Code, International Fire Code*.

4.3.2 Spacing of Aboveground Storage Tanks

4.3.2.1 The provisions for the location of aboveground storage tanks with respect to property lines, public ways, and important buildings on the same property are listed in NFPA 30, or other locally recognized requirements, such as the ICBO *Uniform Fire Code, International Fire Code*. The type of floating roof used in an AST may affect spacing requirements. For example, pan roofs, which do not contain closed compartments for buoyancy, are subject to flooding or sloshing during earthquakes or the application of fire fighting foam/water solutions. In addition, without bracing of the rim provided by the pontoon top plate, the design of the rim to resist buckling must be evaluated. Tanks with pan roofs are considered fixed-roof tanks with no internal floating roof (IFR) for the purpose of siting requirements in NFPA 30.

4.3.2.2 The requirements for spacing (shell-to-shell) between any two adjacent aboveground storage tanks are listed in NFPA 30, or other locally recognized requirements, such as the ICBO *Uniform Fire Code, International Fire Code*. The type of floating roof used in an AST may affect spacing requirements.

4.3.2.3 The impact on spacing requirements by the use of dikes, berms, and drainage swales shall be considered during the initial layout (see Section 9).

4.3.3 Spacing of Tank Truck Loading Racks

Tank truck loading racks for flammable and combustible liquids should be located near the terminal access way and should be oriented to provide a one-way traffic pattern for entrance and exit with clear and direct access to the terminal exit. The requirements for the spacing or location of truck loading racks from aboveground tanks, warehouses, and other facility buildings or adjoining property lines are listed in NFPA 30 or other locally recognized requirements, such as the ICBO *Uniform Fire Code, International Fire Code*. Refer to 11.3 for additional requirements. Two-way drives may be provided to accommodate trucks with manifolds on both sides; however, these locations require larger paved areas.

4.3.4 Spacing of Rail Tank Car Loading Racks

Rail tank car loading racks for flammable and combustible liquids should be located to avoid road blockage when spotting rail cars. This precaution will help ensure the passage of fire trucks or other emergency vehicles. The requirements for rail facility design are found in the AAR *Manual for Railway Engineering*, Volumes 1 & 2 and AAR *Mechanical Division Standards*. Other requirements by local railroads or as stipulated in the ICBO *Uniform Fire Code, International Fire Code*, or other locally adopted and applicable fire code may apply. Refer to 11.4 for rail tank car loading and unloading requirements.

4.3.5 Spacing Of Marine Facilities

The requirements for the spacing and location of marine facilities handling flammable and combustible liquids are listed in NFPA 30, USCG 33 CFR 154, or other locally recognized requirements, such as the ICBO *Uniform Fire Code, International Fire Code*. Refer to 11.5 for marine loading and unloading requirements.

4.3.6 Spacing of Vapor-control Equipment

Combustion vapor-control units are a potential ignition source. Some terminals may use fuel source tanks (e.g., liquid petroleum gas [LPG] tanks) in conjunction with combustion vapor-control units. Electrical classification in areas where such ignition source equipment is to be located shall be in

accordance with NFPA 70, NFPA 496, NFPA 497A, and API RP 500, or other applicable local requirements. See 7.2.1 and 11.7 for additional requirements.

4.3.7 Spacing of Pumps and other Miscellaneous Equipment

The requirements for the spacing of pumps for the handling of flammable and combustible liquids and other miscellaneous equipment, such as diesel generators and internal combustion engines are found in NFPA 30, or other locally recognized equivalent requirements, such as the ICBO *Uniform Fire Code*. Refer to 9.2.8 and 10.5 for additional pump requirements.

Pumps inside secondary containment are considered ignition sources due to the possibility of mechanical seal failures and should be located outside the secondary containment area. If pumps are located within containment areas, sound risk management principles should be used to mitigate the risks of locating the pump inside the secondary containment area. Risk reduction measures include heat sensors to provide early warning of a seal fire and automated isolation valves among other measures. Refer to NFPA 30 for guidance. Note that API RP 500 should also be consulted when locating new pumps for the electric motor portion of the pump or electrical instrumentation.

4.3.8 Spacing of Buildings

Location of buildings and spacing between buildings should be based on the type of construction, the intended use, and the applicable NFPA fire codes. Other locally recognized requirements, such as the ICC *International Fire Code*, NFPA 5000 *Building Code*, ICBO *Uniform Fire Code*, the BOCA *National Building Code*, the ICBO *Uniform Building Code*, the SBCC *Standard Building Code*, or applicable state, municipal or locally adopted building code should also be consulted. Refer to 13.1 for structure requirements.

4.3.9 Spacing of Electrical Equipment

Spacing and location of electrical equipment should consider the requirements of the area's electrical classification. Recommendations for determining the electrical area classification are given in NFPA 30, NFPA 497A, Article 513 and Article 515 of the *National Electrical Code* (NFPA 70), API RP 500, or other applicable state/local requirements. Refer to 13.2.2 for electrical utility requirements.

4.3.10 Alternatives to Spacing Requirements

If the layouts at some sites are such that the recommended spacing requirements may not be met, consideration should be given using sound risk management and engineering practices to increase the fire preventive aspects of design, such as improved drainage, equipment isolation, increased fire sup-

pression equipment, or an alternative, such as locating equipment in pressurized enclosures. Examples of such applications would be enclosures for motor control centers, diesel generators, or vapor-control units. Further information on this subject may be found in NFPA 496.

5 Pollution Prevention and Waste Management

5.1 APPLICABILITY

This section addresses the methods of pollution prevention and waste management practices in the design, maintenance, and operation of petroleum terminal and tank facilities.

5.1.1 Regulatory Trends

Federal, state, and local regulations continue to increase pollution prevention and waste minimization requirements for petroleum terminal and tank facilities. Regulatory requirements involve use of the following:

- a. Placement of limits on air emissions, water discharges, waste generation, waste handling, and waste disposal.
- b. Collection of fees for emissions, discharges, and waste disposal.
- c. Identification, record keeping, and reporting requirements for sources and amounts of air emissions, water discharges, waste generation, waste handling, and waste disposal. Refer to 1.3 and 1.5 for referenced environmental regulations and governmental requirements.

Use of a waste management hierarchy provides a practical means of pollution prevention. Cost savings may accrue from reduction of waste generated and reduced levels of treatment or disposal.

5.2 WASTE MANAGEMENT HIERARCHY

A waste management hierarchy serves as a guide to pollution prevention activities. The waste management practices described in this section should be considered in the design, operation, and maintenance of facilities.

The four categories within the hierarchy are prioritized in order of general acceptance: Source Reduction/Waste Elimination, Recycling/Reuse, Treatment, and Disposal. The following sections briefly describe each of the four categories and provide examples, where appropriate.

5.2.1 Source Reduction/Waste Elimination

Changes in facility design, operation, and maintenance that reduce, avoid, prevent, or eliminate waste generation are regarded as source reduction/waste elimination. Source reduction/waste elimination refers to a variety of activities that prevent (waste elimination) or decrease (source reduction) the amount of waste created or the toxicity of waste gen-

erated. Source reduction and waste elimination activities include, but are not necessarily limited to, the following:

- a. Equipment or technology modifications.
- b. Procedure and operations modifications.
- c. Substitution of materials.
- d. Improved housekeeping, training, and inventory control.

Before initiation of significant facility operation modifications, a management of change review may be required (refer to 6.6). Additionally, the proposed modifications may be subject to regulatory review including permit modifications or new permits.

5.2.2 Recycling/Reuse

Resource recovery and other similar practices may be implemented to beneficially reclaim, recycle, reuse, or reprocess materials from a facility.

5.2.3 Treatment

Any physical, chemical, biological, or thermal process that reduces the volume or toxicity of waste is regarded as treatment.

5.2.4 Disposal

Discharges of waste into air, water, or onto land may constitute disposal of waste. Solid, liquid, and some gaseous waste disposal must be handled at properly permitted disposal facilities. Refer to 40 CFR 60, 40 CFR 61, 40 CFR 63, 40 CFR 122, 40 CFR 123, 40 CFR 264, 40 CFR 265, and other appropriate federal, state, and local requirements.

5.3 POLLUTION PREVENTION

Pollution prevention is a multi-faceted concept designed to reduce or eliminate pollutant discharges to air, water, or land. Pollution prevention includes changes in practices, source reduction, beneficial use, and environmentally sound recycling. It should be recognized that pollution prevention is typically far more effective than emergency response, remediation or mitigation of initiating events. The aim of pollution prevention programs is to prevent equipment failures, minimize the generation of waste products, as well as minimize inventory loss to the air, water, and land. It is the responsibility of management to enact appropriate pollution prevention strategies that are protective of human health (see Section 4) and the environment, as appropriate. Factors to recognize during the development of pollution prevention programs include facility design, operation procedures (see 6.3), maintenance (see 11.15), training (see 6.7), record keeping, and inventory control (see 11.12). Pollution prevention should be implemented through source reduction or elimination, recycling, or re-use. Additionally, the implementation of pre-startup safety and operational inspections

(see 6.8) may assist in determining the effectiveness of pollution prevention programs. The benefits of effective pollution prevention programs may include the following:

- a. Reduced potential exposure to workers and community.
- b. Lower cost of waste disposal and treatment.
- c. Reduced risk to the environment.
- d. Reduced or simplified regulatory reporting and record keeping.
- e. Lower material and operating costs.
- f. Reduced long-term liabilities.
- g. Improved image and public relations.
- h. Reduced need for prescriptive regulations.

5.3.1 Air

Emissions to the atmosphere of volatile organic compounds (VOCs) and toxic, or hazardous air pollutants (HAP) are subject to regulations promulgated in the Clean Air Act (CAA) and its amendments, and the regulations of state and local agencies. Federal air emission standards applicable to bulk gasoline and petroleum terminal and tank facilities are included in EPA 40 CFR 60, Subparts K, Ka, Kb, and XX. These regulations apply to all new, modified, or reconstructed facilities as defined within the CAA. Facilities that are major HAP emission sources are regulated under the Gasoline Distribution Industry Maximum Achievable Control Technology (MACT) that is part of the National Emissions Standards for Hazardous Air Pollutants (NESHAP) of EPA 40 CFR 61 and 63. Other MACT rules may also apply. Individual State Implementation Plans (SIP) are authorized per EPA 40 CFR 51 and 52 for implementation of stricter state and local rules for areas that have not attained the federal standards for air quality. The control of air emissions at facilities is listed in 5.3.1.1 through 5.3.1.5. Specific methods used to control emissions will be dependent upon site-specific conditions including the applicable regulatory requirements.

5.3.1.1 Loading Operations

Air emission control requirements for regulated product transfer operations include vapor collection and processing systems, as specified by various federal, state, and local requirements, such as 40 CFR 60 and 63. Refer to 11.3.3 and 11.7 for additional information on loading operations and vapor control.

5.3.1.2 Product Storage—Aboveground Tanks

Air emissions of VOCs from aboveground tanks may be controlled by using an external floating roof with primary and secondary seals, an IFR with seals, a closed-vent vapor collection and control system, or other methods. See 5.3.1.4, 5.4.1, and 6.1.3.3 for additional information on aboveground storage tank vapor emissions. Refer also to 40 CFR 60 (NSPS); 40 CFR 61 and 63 (NESHAP); and other federal, state, and local

requirements for air emission control of aboveground storage tanks.

5.3.1.3 Product Storage—Underground Tanks

Air emissions of VOCs from underground tanks, such as vapors emitted during filling, are generally regulated by SIP and local regulations. Refer to 40 CFR 51 and 40 CFR 52 and state regulations for applicable controls. Refer to 8.4 and API RP 1615.

5.3.1.4 Fugitive Emissions

Methods for controlling or reducing fugitive vapor emissions from vents, pumps, valves, flanges, and other connecting points should be considered in the design, operation, and maintenance of facilities. Refer to API Publ 4588 for development of fugitive emission factors and emission profiles for petroleum (marketing) terminals.

5.3.1.5 Asbestos, Lead and Other Regulated Airborne Contaminants

Air emissions of dust as a result of removal of asbestos insulation or lead-based paint or the use of other regulated toxic materials shall be controlled in accordance with federal, state, and local requirements (see 6.4 and 12.2.5.2).

5.3.2 Water

Pollution prevention may be accomplished by reducing the sources and volume of petroleum contact wastewater and the concentrations and toxicity of petroleum compounds in the petroleum contact wastewater. These reductions are addressed in 5.3.2.1 and 5.3.2.2.

API Publ 4602 provides a range of options for wastewater management and treatment at petroleum (marketing) terminals.

5.3.2.1 Petroleum Contact Water

Effective spill-containment design and operating procedures reduce the volume of petroleum contact water that must be treated and discharged or disposed. For example, storm water may be segregated from sources of contamination to prevent petroleum contact, thereby, reducing the volume of wastewater that must be managed. Refer to 8.2, 10.5.3, 11.3.1, 11.3.2, 11.4.1, 11.4.2, 11.14, 13.3.4, and 13.3.5 for operating procedures and design considerations for wastewater management. Refer to API Publ 4602 for design considerations at petroleum (marketing) terminals. SPCC Plan requirements (40 CFR 112) for regulated facilities provide additional guidance. For facilities with marine docks, refer to USCG 33 CFR 126, 33, 154, 155, 156, and EPA 40 CFR 311 that regulate transfer of petroleum products across navigable waterways. Refer also to 8.1.7 regarding tank water drawoff.

5.3.2.2 Wastewater Management

Wastewater may require treatment to reduce pollutants before discharge, under a National Pollutant Discharge Elimination System (NPDES) permit issued under Federal Regulations 40 CFR 122 and 125 or state permits (SPDES) issued under the authority of 40 CFR 123. Some wastewater discharge permits for petroleum terminals may impose discharge limits on specific compounds and impose toxic monitoring or limits on toxic parameters for wastewater discharge. Wastewater facilities may also be subject to RCRA requirements for Treatment, Disposal, and Storage Facilities (TSDF) under EPA 40 CFR 264 and 265.

Discharge to a Publicly-owned Treatment Works (POTW) may require pretreatment or other conditions to achieve POTW permit standards before discharge. Refer to EPA 40 CFR 403 for additional information on discharges to POTWs.

Additional opportunities for reduction of wastewater pollutants may become evident upon further evaluation of the discharge. Furthermore, toxicity based permits may require further reduction of wastewater constituents through pre-treatment or post-treatment.

5.3.2.3 Facility Design

Additional facility design guidance is provided for petroleum terminals in API Publ 4602. This API publication addresses tank farm drainage, tank bottom water, ballast water, storm water, process and containment water, wastewater, and test water (refer also to 7.2, 8.3.7, and 13.3). Where appropriate, wastewater treatment may include one or more of the following:

- a. Gravity Separator.
- b. Carbon.
- c. Air Stripping.
- d. Biological Treatment.
- e. UV/Oxidation.
- f. Dissolved Air Floatation.
- g. Other Technologies.

5.3.3 Solid Waste Management

Solid waste reduction or elimination may be accomplished through facility design, product substitution, maintenance, and operation.

5.3.3.1 Waste Minimization Certification

All hazardous waste manifests require certification that a program is in place to reduce the volume or toxicity of waste generated to the degree economically practical (per 40 CFR 262, 40 CFR 264 and 40 CFR 265). Implementation of pollution prevention designs, maintenance, and operating practices will support this certification.

5.3.3.2 Facility Operation

Facility operation guidance to minimize solid waste in petroleum (marketing) terminals is suggested in API Publ 1638. Additionally, the stipulations of dikes and berms (see Section 9), corrosion control (see Section 10), release prevention (see 8.1.3.1), and proper handling of recovered petroleum product support waste reduction.

5.4 WASTE MANAGEMENT PRACTICES

After consideration of pollution prevention practices, each facility should develop waste management practices that serve to minimize the amount of waste generated on site from normal routine facility operation and maintenance. Waste management may be subject to the RCRA requirements of EPA 40 CFR 268, 40 CFR 270, and 40 CFR 279. API Publ 1638 provides guidance and additional information for waste management in support of pollution prevention for petroleum terminals. The waste streams addressed in this standard are grouped into four categories:

- a. Waste produced by handling and storage facilities.
- b. Waste produced by waste treatment facilities.
- c. Vehicular waste.
- d. Miscellaneous waste.

Waste management options for wastes identified within each of the above-listed categories are covered in API Publ 1638.

Refer to 5.4.1 through 5.4.3 for suggested waste management practices that are applicable for the facilities covered in this standard.

5.4.1 Product Storage

Source reduction opportunities exist in the design, modification, maintenance, and operation of tanks. Examples of source reduction opportunities are described in 5.4.1.1 and 5.4.1.2. Refer also to 8.1.3.

5.4.1.1 Internal Floating-roof Tanks

The use of an IFR (i.e., the fixed-roof component may be a steel or aluminum geodesic dome) will minimize possible damage to the floating roof as a result of snow, ice, or water accumulation on the floating roof. Fixed roofs over floating roofs may reduce air emissions depending on the base conditions, such as the type and condition of the floating roof and seals (see 8.1.3.3). Fixed roofs may also minimize the amount of petroleum contact water generated from precipitation.

5.4.1.2 Tank Cleaning

Improved procedures may reduce the volume of solid waste generated during tank cleaning operations. Procedures include:

- a. Extracting recoverable product for re-use prior to the start of tank cleaning and vapor (gas) freeing.
- b. Use of high pressure/low volume water wash methods.
- c. In-situ sludge reduction/reclamation systems or procedures.
- d. Recycling of wash water or recycling of other cleaning materials.
- e. Extraction of liquids from the products of tank cleaning operations before disposal of solids.

Tank design features, such as sloped bottom design and tank bottom coatings, may reduce the amount of cleaning required as well as the sludge volume generated. Refer to API Std 2015 and API RP 2016 for further tank cleaning information and requirements.

5.4.2 Wastewater Management

The design, maintenance, and operation of wastewater collection and treatment systems offer opportunities for waste minimization. Several options for wastewater management are given in 5.4.2.1 through 5.4.2.3. Additional considerations for petroleum terminals are presented in API Publ 1638 and API Publ 4602. Refer also to 8.1.7, 8.1.8, 11.3.1, 11.3.2, 11.4.1, 11.4.2, and 13.3.

5.4.2.1 Hydrostatic Test Water

Cleaning tanks before performing hydrostatic tests may reduce the generation of contaminated wastewater. When disposal of the test water is necessary, its handling should be reviewed with the authorities having jurisdiction before placement of test water in the tank. Unnecessary hydrostatic testing should be avoided as it may produce large volumes of potentially contaminated water that may have to be treated or disposed. Specific exemptions for hydrostatic testing for in-service tanks are given in API Std 653.

5.4.2.2 Spill Containment

Properly designed spill-containment systems at product transfer and storage areas will minimize the volume of storm water that becomes commingled with contaminants within the containment system. A properly designed spill-containment system should enclose the minimum area required for containment. A fixed roof (steel or aluminum geodesic dome) will also minimize the precipitation entering the containment area (refer to 8.1.3, 10.5, 11.3.1, 11.4.1, 11.5.1, 11.6.1, 11.14, 13.3, Section 9, and NFPA 30). Refer to 7.4.4 for consideration for fire protection water/water foam run-off.

5.4.2.3 Oil/Water Separators

The installation of sand/grit traps or protective mud sumps at the separator inlet or at source points, such as catch basins or manholes, will reduce the volume of petroleum contact sediments generated in the separator.

5.4.3 Storm Water

Facility designs that segregate uncontaminated storm water from petroleum contact water through the use of curbing, hard-piped systems, and other methods will provide source reduction (see 7.1.3 and 13.3.4).

6 Safe Operations of Terminals & Tanks

6.1 GENERAL

Safe operation of facilities is not only primarily a management responsibility, but the responsibility of all employees as well as contractors working at the site. Management programs shall be established to assure conformance with applicable safety and operational standards, compliance with applicable regulations, and the use of appropriate work practices and procedures.

This section covers the elements most often used in the safe operations of terminals and tanks, and provides guidance to assist this effort, including, but not limited to hazard identification, operating procedures, safe work practices, emergency response and control, management of change, training, pre-start up safety and operational inspections, incident investigation, and contractor safety.

The API documents *Security Guidance for the Petroleum Industry* and *Security Vulnerability Assessment Methodology for the Petroleum and Petrochemical Industries* provide information to help facilities evaluate and respond appropriately to their potential and real security threats.

6.2 HAZARD IDENTIFICATION

Programs shall be in effect and information on safety hazards shall be available to facilitate communication with employees, contractors, subcontractors, on-site vendors, emergency response personnel, and visitors. The information provided should be consistent with federal, state, and local hazard communication, right-to-know requirements, and include provisions for ready access to Material Safety Data Sheets (MSDS).

Hazard identification information shall include operational hazards involved with the layout (see 2.1), specific equipment hazards, and other potential hazards, such as the release of a flammable liquid from a facility storage tank that has the potential for personal injury, environmental impact, or property damage.

In addition, hazard identification should consider the potential for reasonably foreseeable influences from outside

the facility. These may include the following: natural occurrences (such as hurricanes, floods, and earthquakes), hazardous emissions from neighboring facilities, or physical hazards from traffic or neighboring occupancies.

OSHA 29 CFR 1910.1200 contains the minimum federal requirements for communication of hazards to personnel. Other federal, state, and local regulations may also apply in addition to specific facility requirements.

6.3 OPERATING PROCEDURES

Written operating procedures shall be developed to address the routine and non-routine activities, such as emergency shutdown and startup that are conducted during the course of the facility's business. These procedures specifically include product storage and handling within the facility and all transfer operations. For those activities where significant deviation from procedures could lead to a loss of containment of flammable or combustible materials, the potential consequences should be highlighted and safeguards explained in detail in the procedure.

Management of change review is required before substantial revisions to operating procedures or the initiation of "temporary" operations (refer to 6.6).

6.4 SAFE WORK PRACTICES

Written facility safe work practices (e.g., hotwork, lockout/tagout, and confined space entry) applicable to employees, contractors, subcontractors, and on-site vendors shall be established. Safe work practices shall address the safe conduct of administrative, operating, and maintenance activities as well as construction, removal, or idling activities (see 14.2). For new and modified facilities, these practices must be in place before startup or other work is performed.

Specific issues that shall be addressed by written procedures and permits are as follows: work authorization, hot work, confined space entry, lockout/tagout, and contractor orientation to owner safety rules and practices. Primary consideration in development of these procedures must be given to the health and safety of employees, contractors, and the public; the protection of the environment; and to the applicable regulatory requirements. Minimum requirements for lockout/tagout are identified in OSHA 29 CFR 1910.147. Safe work practices for tank entry and cleaning are addressed in API Std 2015 and API RP 2016. The minimum requirements for confined space entry are identified in OSHA 29 CFR 1910.146. Also refer to API RP 2009 for safe welding practices.

6.5 EMERGENCY RESPONSE AND CONTROL PROCEDURES

A written emergency response plan and procedures in compliance with relevant federal, state, and local regulatory requirements shall be in place for each facility to address

response to anticipated emergencies. First aid medical treatment must be available, either on-site or from a public or private emergency response service. Response for major medical situations should be planned in advance.

Written plans for emergencies involving accidental release of hazardous substances shall address specific actions to be taken by employees and others, such as contractors and public or private emergency responders, to control or mitigate the release or evacuate, as appropriate. These emergencies may include spills, fires, toxic exposures, contamination, mixing of non-compatible materials and abnormal conditions involving flammable and combustible materials. Refer to 7.6 for fire emergency plan elements. Emergency or contingency plans are required by several federal regulatory agencies including EPA 40 CFR 112 (SPCC) and OPA 90 Plans.

Emergency response procedures should address facility management and employee and contractor responsibilities including communication requirements both for internal purposes and for notification of and coordination with regulatory, governmental, public, or mutual aid organizations. Emergency response procedures should comply with OSHA 29 CFR 1910.120.

6.6 MANAGEMENT OF CHANGE

Systems shall be established for each facility to review potential health, safety, and environmental considerations resulting from proposed additions, modifications, or other changes that may periodically occur in a facility. The following changes should be properly managed by identifying and reviewing them before implementation:

- a. Materials or products handled.
- b. Equipment used or installed.
- c. Operations and procedures.

The system should ensure that designs and operating procedures are reviewed before implementation and should be revised, as appropriate, with the intent of minimizing adverse effects on the safety of the community, environment, and workforce. Minimum requirements for specific facilities are identified in OPS RSPA 49 CFR 195 and OSHA 29 CFR 1910.119.

6.7 TRAINING

All employer and contractor personnel working at the facility shall receive training appropriate to their duties and as required by the applicable regulations and facility procedures and policy.

The employer is responsible for ensuring proper training of their employees. Training shall include pertinent portions of the operating, hazard awareness, emergency response, and safe work procedures for that facility. Systems shall be established by each employer to ensure that their employees possess the required knowledge and skills to do their assigned

duties. Requirements for training and documentation of training for contract personnel shall be determined by agreement between the facility management and the contract employer.

Systems shall be established by the operators and contractors to assure conformance to the appropriate training requirements. Trainers shall be qualified, and training programs documented as required in the appropriate EPA, USCG, OSHA and DOT regulations. Periodic refresher training or revalidation of skills shall be incorporated in the overall training program as necessary or as required by regulations. API RP 2220 contains additional guidance for contractor safety programs. At a minimum, training and documentation shall meet the applicable requirements of OSHA 29 CFR 1910.119 and other regulations to which the facility is subject.

6.8 PRE-STARTUP SAFETY AND OPERATIONAL INSPECTION

Pre-startup safety and operational inspection shall be conducted for new or modified facilities and equipment that involve a change that would likely have an influence or effect on the facilities' design or operation (the appropriate items from 6.1 to 6.7 should be reviewed). The pre-startup safety and operational inspection shall consider the following items, as appropriate:

- a. Safety procedures and equipment are in place and function properly.
- b. Construction or modifications meet design and manufacturer specifications.
- c. Construction is in conformance with plans, codes, and applicable standards.
- d. Operating and emergency response procedures are in place or have been reviewed and updated.
- e. Any required training is complete.
- f. Mechanical integrity and maintenance programs are in place or have been reviewed and updated, if necessary.
- g. Equipment check out has been completed in accordance with manufacturer and company requirements.

If applicable, a management of change review (see 6.6) shall be performed.

6.9 INCIDENT INVESTIGATION

Incidents and significant "near misses" should be investigated and the findings made available for use in prevention programs. A near miss is an incident that could have resulted in a release, accident, or other unplanned event. The investigation should be conducted by personnel familiar with the facility activities and specific work operations. Some incidents may warrant the formation of an incident investigation team that includes personnel skilled in investigation techniques and specialized technical skills. The investigation process may require that specific personnel or job categories be included as part of an investigation team.

The reporting, investigation, and documentation shall satisfy regulatory and facility requirements and, if applicable, insurance requirements and may include mandatory reporting requirements. The goal of an investigation should be to determine “what happened” (the nature of the incident) and “why” (contributing causes), and to recommend the corrective actions or changes in procedures that the facility management may consider to prevent a recurrence. Records of the incident, investigation findings, recommendations, and actions taken (or explanations for inaction) should be kept on file at the facility (or as otherwise required). Consideration should be given to the benefits of sharing pertinent investigation findings and associated corrective action(s) with other similar facilities.

6.10 CONTRACTOR SAFETY

To help ensure the safety of the facility and all personnel, the use of contractors should be in accordance with procedures outlined in API RP 2220. Additionally, contractor personnel shall adhere to the facility operating procedures, safe work practices (see 6.4), and training requirements (see 6.7). Minimum federal requirements for contractor safety are identified in OSHA 29 CFR 1926.64 and OSHA 29 CFR 1910.119.

7 Fire Prevention and Protection

7.1 GENERAL

Fire prevention and protection is an important consideration for facilities handling flammable or combustible liquids. In a “hierarchy of importance,” protection of personnel and the public, the environment, and equipment should dictate the amount of time and resources dedicated to identify, control, and mitigate potential incidents.

The practices and procedures addressed in this section are considered to be an effective means of preventing, controlling, and extinguishing fires. This section is specifically directed to fire prevention and protection provisions for tanks (see Section 6) and loading activities (see Section 11). Some of these provisions apply to the design and construction of new facilities or installations while others apply to operation, inspection, and maintenance for both new and existing facilities. Fire protection for other facility operations and structures, such as marine docks, warehouses, offices, and laboratories are not addressed in this standard. Refer to the appropriate NFPA code or other applicable standards, such as NFPA 30, ICBO *Uniform Fire Code*, for requirements addressing these structures, equipment, or operations.

7.2 FIRE PREVENTION

7.2.1 Vapor Control

There is the potential for fire or explosion whenever a flammable vapor-air mixture exists. Flammable vapor-air mix-

tures may occur when handling flammable liquids with an intermediate vapor pressure of 1.5 psia – 4.5 psia (10.3 kPa – 31 kPa) True Vapor Pressure (TVP) and higher (e.g., gasoline), and within 20°F (– 6.7°C) of the flash point. Areas typically associated with flammable vapor-air mixtures include but are not limited to the following:

- a. Within the vapor space of tanks.
- b. Within the vapor space of barges and tank cars/trucks, when loading or unloading.
- c. Within portions of vapor-recovery and vapor-disposal systems.
- d. Near the discharge of atmospheric vents on tanks.
- e. Near the discharge of pressure/vacuum vents on trucks, railcars, and barges.
- f. Near a leak or spill.
- g. When a tank receipt is in progress within the secondary containment area.

7.2.1.1 Control of a flammable vapor-air mixture may be accomplished through these means:

- a. Proper design and maintenance of facility system components.
- b. Proper selection of storage tank type for the product being stored.
- c. Use of safe work practices.
- d. Operating procedures.

Note: Use of inerting or gas padding is typically uncommon for large tanks. Refer to NFPA 30, NFPA 69, and API RP 2003 for further information on this subject.

7.2.2 Control of Ignition Sources

Sources of ignition must be controlled in areas where the potential exists for the presence of flammable vapor-air mixtures. Common ignition sources include, but are not limited to: lightning, static electricity, stray currents, hot work, internal combustion engines, smoking, and improperly classified or unprotected electrical equipment.

Refer to API RP 500 for classifications of locations for electrical installations at petroleum facilities. Control of vapor ignition from lightning and static electricity is accomplished through proper design, maintenance, and operation as covered in API RP 2003. Ignition from hot work is controlled by following established hot work permit procedures. Refer to OSHA 29 CFR 1910.119 for regulatory requirements governing hot work and to 6.4 for information on safe work practices. Preventing ignition from electrical equipment is accomplished by:

- a. Following appropriate electrical standards;
- b. Assuring that electrical equipment is in good operating condition, is properly installed, and is suitable for the area electrical hazards classification;

- c. Following appropriate operating procedures, especially when opening electrical enclosures in hazardous areas, and;
- d. Ensuring that specific procedures are in place when tank receipts are taking place.

7.2.3 Tank Overfill Protection

Tank overfills that allow flammable liquids to spill from tanks into the dike or surrounding area, may create a potential for fire hazards.

API RP 2350 and NFPA 30 recommend specific overfill protection for terminals receiving flammable liquids from pipelines or marine vessels. Refer to 6.3 for the requirements for operating procedures, 8.1.9 for tank alarm requirements, Section 9 for dike berm requirements, and Section 11 for product transfer and control system requirements. Additionally, NFPA 30, UFC, and IFC address these and other issues related to the handling of flammable and combustible liquids.

7.2.4 Inspection and Maintenance Programs

Maintaining the integrity of storage tanks and piping systems containing flammable or combustible liquids is essential to the prevention of fires in and around tanks and terminals. Priority shall be given to correcting situations that would allow the release of vapor or liquid from the tank or piping system. See 8.2, 10.6, 10.7, 11.15, 12.2.2, 12.4.5, API Std 653, and API 570 for further information on inspection, maintenance, and testing.

7.2.5 Housekeeping

The dike area and the area around storage tanks shall be kept clean of combustible materials that potentially could be a source of fire exposure to the tank (see 7.2.11).

7.3 FIRE FIGHTING EQUIPMENT

Although fires in facilities are unusual, the use of specific fire protection equipment may be required by local regulatory agencies or by the facility owner. The emphasis should, however, be on fire prevention.

7.3.1 Portable Fire Extinguishers

All facilities shall have portable fire extinguishers available at or near areas where fires may occur. Extinguishers shall be of suitable class and of an appropriate size for the nature of the fire that might occur. Refer to NFPA 10 for portable extinguisher classifications and requirements. Regulatory requirements for portable extinguishers are contained in OSHA 29 CFR 1910.157.

7.3.2 Mobile and Portable Fire Fighting Equipment

Larger facilities with trained fire brigades will often have specialized pieces of mobile and portable fire fighting equip-

ment. Such equipment may include, but is not limited to, foam towers, large flow pumps and monitors, equipment trailers and foam trailers, and specialized fire fighting trucks. The nature and amount of such equipment will depend on local circumstances and the emergency plan. The need to provide fire fighting brigades and equipment, either on-site or through mutual aid, should be evaluated for facilities where local public fire fighting services are inadequate.

7.4 FIRE EXTINGUISHMENT AND CONTROL

7.4.1 Controlled Burn

With fires involving flammable and combustible liquids, rapid extinguishment may not always be possible or prudent. Where heat impingement on other vessels or facilities may be controlled and there is no danger to the public, it may be acceptable and sometimes safer to allow the fire to burn itself out under controlled conditions. This practice usually involves controlling the flow or otherwise limiting the amount of materials involved in the fire (e.g., pumping out the tank), while providing cooling water on surrounding equipment or structures that may be exposed to the heat of the fire or flame impingement. The decision to select this method of fire control should be made with the advice of qualified fire control personnel and the authority having jurisdiction (referred to as the incident command system) and should be included as an option in the facility fire preplan.

7.4.2 Manual Control & Extinguishment

Manually fighting flammable and combustible liquid fires usually involves the use of portable fire extinguishers on fires in their incipient or initial stages. Larger fires usually require the application of water for control and cooling or application of foam for fire extinguishment. Extinguishment of large fires, particularly those involving tanks, requires special techniques, material, equipment, and trained personnel.

Manual attack of large fires should be supervised and conducted only by properly trained and qualified personnel, such as facilities that have trained, equipped, and qualified fire brigades or municipal fire departments. Refer to API RP 2021 and API Publ 2021A for additional information. The minimum requirements for industrial fire brigades are identified in OSHA 29 CFR 1910.156 and NFPA 600.

7.4.3 Fire Protection Systems for Tanks

When used, fire protection systems for tanks typically use fire-fighting foams as the extinguishing agent. The need for these systems shall be consistent with the requirements of NFPA 30. Such systems require (a) an adequate water supply, (b) an adequate supply of correct foam solution, (c) a means of generating foam solution by mixing foam concentrate and water with a proportioner, and (d) a means of foam applica-

tion to the tank in the proper amount and proportion for the required amount of time.

The specific design of each foam system will vary based upon the size and type of tank being protected, the type of system (fixed, semi-fixed, or portable) to be used on the tank, and the product being stored in the tank. The recommendations of NFPA 11 should be followed in the design and installation of foam systems for tank protection. Facility staff should be trained in the operation, maintenance, and testing of systems (see 6.7).

7.4.4 Truck/Rail Loading Systems

The need for fixed fire control or fire protection systems for tank truck or rail loading facilities should be based on a consideration of the specific risks involved. When provided, systems are usually water spray or foam-water spray. Alternatives to water-based fire protection systems, such as dry chemical, may be considered when the use or availability of water is not practical. Design considerations may include climate, complexity of fire protection system and operations, long-term maintenance, types of hazards, as well as other factors. The systems and extinguishing agents are designed for the potential exposures and the types of products loaded at the rack. The system nozzles are fixed and aimed to cover a pre-determined area or surface with a calculated amount of water, foam, or dry chemical powder (see 11.3 and 11.4). As a minimum, a 40BC listed portable fire extinguisher shall be strategically placed, to allow visible and safe access in the event of a fire (see NFPA 10) (reference API Publ 2030).

These loading rack fire protection systems may be designed to activate automatically (through detection systems), manually, or both (automatic with manual activation). The detection system may include thermal or flame fire detection devices as well as combustible vapor (gas) detection devices. Facility staff, as well as drivers, shall be trained in fire system activation. Facility staff shall be trained in the operation, maintenance, and testing of the system (refer to 6.7).

NFPA 11, NFPA 15, NFPA 16 and NFPA 17 should be consulted for the design and installation of these systems. Proper drainage of the loading rack area is necessary to prevent spreading of a fire under a truck or by floating burning product towards other areas of the facility.

7.5 FIRE PROTECTION WATER SUPPLIES

The handling and storage of flammable or combustible liquids does not, in itself, require the availability of a fire protection water supply. The need for fire protection is a function of the potential exposure to the public, employees, and the environment. Additionally, the risk to the facility, local jurisdictions, and the specific requirements to supply fire protection systems or equipment may require that a fire protection water supply be provided.

The fire protection water supply should be based on consideration of the specific risks involved. Many facilities will need some emergency source of water, but specific needs will vary as some facilities are located in areas where inadequate or no water is available.

Fire protection water may be from any source that is capable of providing the required flow rate, at the necessary pressure, and for sufficient duration to either extinguish the largest expected fire or allow it to safely burn out by providing for cooling of exposed equipment and tanks. Such sources include utility water systems, public water supplies, dedicated in-plant fire protection water supplies, such as firewater ponds and water tanks, or nearby natural water sources, such as rivers, lakes, and ponds.

The actual flow rate and volume of water required for a fire will depend upon the method of fire control and extinguishment desired, as well as the type, amount, and size of fire systems, extinguishing materials, and equipment provided. The flow rate and pressure required should be capable of accommodating the equipment and systems expected to be operated simultaneously considering layout, spacing, and drainage for the single largest credible fire.

Additional information on related subjects may be found in the following standards:

- a. NFPA 11 *Low Expansion Foam and Combined Agent Systems*.
- b. NFPA 15 *Water Spray Fixed Systems*.
- c. NFPA 20 *Installation of Centrifugal Fire Pumps*.
- d. NFPA 22 *Water Tanks for Private Fire Protection*.
- e. NFPA 24 *Installation of Private Fire Service Mains and Their Appurtenances*.
- f. NFPA 25 *Water Based Fire Protection*.
- g. NFPA 30 *Flammable and Combustible Liquids Code*.

7.5.1 Hose and Monitors

For those facilities that have an adequate supply of water available for manual fire fighting purposes, hose lines and monitors may be provided, where required, to supplement portable fire extinguishers. The water supply may be from any piped water system (refer to 7.5). The supply and pumping system shall be able to provide sufficient flow and pressure for the anticipated emergency. Hose lines and monitors should be used only by trained and qualified personnel.

7.6 FIRE EMERGENCY PLAN

Each facility shall develop a written fire emergency plan that specifically addresses actions to be taken in the event of a fire in the facility. This plan may be developed as a separate plan or may be incorporated as a portion of other written emergency or fire plans for the facility (see 6.5). The written



fire emergency plan shall address, where appropriate, each of the following elements:

- a. Actions and responsibilities of employees in reporting a fire (see 6.7).
- b. Responsibilities and action to be taken to control vapors (see 7.2.1) and prevent ignition (see 7.2.2) of vapors resulting from spills, releases, etc.
- c. Actions and procedures (see 6.3) to be taken in fighting fires both manually and by activation and deactivation of fixed fire protection systems.
- d. Desired method of extinguishment, such as through a controlled burn-out (see 7.4.1) or by application of an extinguishing agent.
- e. Notification of appropriate authorities.
- f. Investigation of the fire and recommended corrective action, if needed.
- g. Contact names and numbers to obtain additional foam.

Fire emergency plans should be reviewed regularly and updated as products, equipment, and operating conditions change. Updating and filing of emergency plans shall be in accordance with the applicable federal, state, or local requirements.

Where the plan includes assistance from an outside organization, such as a public fire department or mutual aid group, the plan shall be coordinated with those organizations prior to initial implementation and following any significant changes. Once the plan has been developed, employees shall be trained on the duties and actions they are expected to perform. A training session and practice drill shall be conducted periodically or as per local/state regulatory requirements. Refer to NFPA 600 and OSHA 29 CFR 1910, Subpart L, for employee incipient fire fighting and fire brigade requirements.

If outside agencies, mutual aid groups, or other organizations will be expected to respond to and assist in an emergency situation (see 6.5), drills should include their participation. Written records of training sessions (see 6.7) and drills shall be maintained as directed by the applicable regulatory requirements. Records should include the name and title of the employees and outside assistance personnel attending, the date of the drill or training session, the purpose of the drill, a description of the skills performed, and equipment failures or deficiencies.

7.7 EXPOSURE PROTECTION

Exposure protection for terminal and tank facilities is generally accomplished in the original design and construction by providing (a) adequate spacing between equipment (see Sections 2 and 8) and structures (see 13.1), (b) adequate drainage or impoundment (see Section 9) of spills or releases, and (c) separation from adjacent properties (see 2.3). Refer to NFPA 30 or other local recognized codes, such as the ICBO

Uniform Fire Code for spacing requirements and for the requirements for dikes, berms, and drainage (refer also to Section 9). Burying and mounding of storage tanks is not recommended.

Fireproofing has limited application in these types of facilities. However, fireproofing should be considered for protection of exposed structures, such as steel supports for piping or supports for elevated tanks, whose failure could contribute to a fire.

Additionally, critical wiring, emergency shutdown devices, isolation valves, or de-inventory capabilities (the ability to pump down a tank under fire conditions) should be protected from fire exposure.

7.8 SPECIAL PRODUCT CONSIDERATIONS

7.8.1 Oxygenated Products

Polar solvents and other water soluble liquids are a particular fire protection concern because they may be destructive to many of the standard fire fighting foams and may make extinguishment of fires involving these liquids more difficult.

With the recent requirements for oxygenated and reformulated fuels, larger quantities of polar solvents are being routinely handled in tank storage facilities and terminals. Fire protection plans should address the storage of oxygenated products, and the appropriate fire protection requirements, where applicable.

The most common polar solvent liquids found in tank and terminal facilities include alcohols, ethers, glycols, and amines. Oxygenates include methanol, ethanol, ethyl-tertiary-butyl-ether (ETBE), methyl-tertiary-butyl-ether (MTBE), and tertiary-amyl-methyl-ether (TAME). All of these may be handled in pure form or as a blend with gasoline. Generally, blends that have 10% – 15% polar solvent in gasoline may be treated as gasoline for fire fighting purposes. However, depending on the particular oxygenate or polar solvent, higher proportioning ratios (percentage of concentrate in water) and higher applications rates may be necessary.

Fire protection for polar solvent liquids may require the use of special foams. These foams, sometimes referred to as “alcohol resistant,” are specifically formulated for use on polar solvents.

7.8.2 Asphalt, Crude Oil, and Residual Fuel

Light hydrocarbons may migrate out of crude oils and residual fuels and form a flammable mixture in the vapor space within the storage tank. Unless known to be otherwise, crude oil and residual fuels in storage should be considered to be a flammable liquid for fire fighting purposes.

Asphaltic crude, crude oils, and residual fuels may have characteristics that promote “boil-over” and “frothing.” Unless known to be otherwise, asphaltic crude, crude oil, and residual fuels in storage should be considered to have this

potential. This is also particularly true of oils that contain a mixture of hydrocarbons with a wide range of boiling points.

7.8.3 Gasoline and Distillates

Gasoline and distillates are considered to be stable and water insoluble. Normal fire fighting foams are suitable for extinguishing fires involving gasoline whereas water, properly applied, may be used to cool and extinguish distillate fires.

7.8.4 Reactive or Unstable Chemicals

Some chemical materials require special fire protection considerations due to the nature of their reactivity. This includes, but is not limited to, liquids and materials that react or decompose when heated or that react spontaneously with air or water. In general, materials that react or decompose when heated will require a high application rate of water for cooling if exposed to a fire. If such products are stored on site, the adequacy of the fire fighting equipment (see 7.3), emergency action plan (see 6.5 and 7.6), and employee training (see 6.7) should be evaluated to determine the suitability of each to extinguish a fire involving these products.

The Material Safety Data Sheet (MSDS) for the material will provide specific information on its reactivity as well as recommendations on specific fire fighting and extinguishing techniques.

8 Tanks

8.1 ABOVEGROUND PETROLEUM STORAGE TANKS

8.1.1 General

Design, construction, maintenance, inspection, testing and repair of aboveground storage tanks are covered in API Std 620, API Std 650, API RP 651, API RP 652, API Std 653, API 12F and UL-142. The applicable mandatory provisions stipulated in these standards shall be followed. Where applicable codes or regulations are more stringent, such codes shall apply.

8.1.2 Tank Selection Criteria

Typical types of aboveground storage tanks found in petroleum terminals include fixed-roof tanks or aluminum domed fixed-roof tank, tanks with internal floating roofs covered with fixed or aluminum domed roofs and fixed-roof tanks with vapor-recovery systems, and external floating roofs.

Selection of tank types and required emission controls for storing volatile organic liquids (including petroleum liquids) in new or modified tanks shall conform to the EPA's New Source Performance Standards, 40 CFR 60, Subpart Kb, state regulations and other applicable air regulations where required and meet the objectives of 5.3.1 (see 8.1.3.3).

Factors that influence the type of aboveground tank appurtenances used for storage of a specific liquid include, but are not limited to the following:

- a. Vapor pressure, operating pressure, flash point, stream composition, reactivity and temperature of stored product.
- b. Tank capacity, frequency of turnover, and consequent value of vapor losses from filling and breathing.
- c. Vapor-control requirements, regulations, dates of construction, and new source issues. (See API MPMS Ch. 19.1 and API MPMS Ch. 19.2, which describe the evaporation losses from different types of aboveground storage tank designs.)
- d. Fire hazards, both to the tank and adjacent property (see Sections 2, 5 and 7).
- e. Corrosiveness of stored product or its vapor to carbon steel (susceptibility of stored product to degradation, decomposition, or contamination due to the surrounding atmosphere that would lead to a corrosion problem) (see Section 10).
- f. Static charge hazards (see 7.2.2).
- g. Gas blanketing requirements.
- h. Temperature and liquid level standards (see 11.12).
- i. Product quality issues (minimize contamination by selection of design premises).
- j. Provision for future flexibility for product changeovers that may have different specific gravities or other physical properties.
- k. If used, tank seal and tank lining material compatibility with the stored product.

8.1.3 Release Prevention, Leak Detection, and Air Emissions

8.1.3.1 Release Prevention Systems

The protection of the subgrade and ground water under new aboveground tanks is achieved through the use of a release prevention barrier (or other release prevention systems) (refer to API Std 650, Appendix I and API Publ 340). For existing facilities, the inspection and maintenance practices described in API Std 653 serve to supplement the protection of the subgrade and groundwater. High-level alarm systems provide additional overfill protection (see 8.1.9 and API RP 2350).

A leak detection program and operating practices that allow for inventories to be balanced and reconciled should be used for all Class I liquid storage tanks (see NFPA 30) and should be used on other steel tanks to provide an additional method of detection of significant product leaks. All tanks in service shall be maintained liquid tight. In service tanks that have been structurally damaged, repaired or reconstructed, shall be tested. For smaller leaks, there are a variety of additional practices that may also be applicable for subgrade and groundwater protection and detection of product release. The effectiveness and applicability of each of the following prac-

tices depend upon the tank site conditions, tank history, stored fluids, and potential for a release to migrate beyond the facility boundaries:

- a. Cathodic protection of the tank bottoms (see 12.4).
- b. Use of planned and documented inspections (see 8.2).
- c. Use of a release prevention barrier (see 1.4.11) (e.g., double steel bottom systems, plastic geomembranes and clays) under the tank with site appropriate CP and leak detection.
- d. Installation of a leak detection system that may include a double steel bottom (see 8.1.3.2), corrosion protection/cathodic protection (see Section 10), and various structural support systems (see API Std 650 Appendix I).
- e. Use of an internal liner per API RP 652 (compatible with the products stored) installed over a sound steel tank bottom (per API RP 652).
- f. Use of a plan to manage product removal (see 6.5).

8.1.3.2 Leak Detection

Many different types of leak detection systems currently exist. Some systems are designed to take continuous readings, and other systems use periodic readings (including visual monitoring) to determine tank integrity. Current API references on leak detection include API Publ 306, API Publ 307, API Publ 334, API RP 575, and API Std 650. Additionally, there are a number of different technologies being used, as well as new technologies being developed, for use in above-ground storage tanks to check integrity. Examples of systems include acoustic emissions, tracer methods, volumetric (including mass deviation) monitoring, and vapor sensing. Each system requires trained and skilled personnel to interpret the results. The most common means of AST leak detection include, but are not limited to the following:

- a. Use of monitoring wells in the tank farm area.
- b. Use of a leak detection system (see API Std 650, Appendix I).
- c. Placement of smaller tanks on a steel reinforced concrete slab underlying the entire tank bottom (an RPB).
- d. Tightness testing.
- e. Inventory reconciliation.

8.1.3.3 Aboveground Storage Tank Vapor Emissions

Emissions from aboveground atmospheric tanks storing petroleum and petroleum products are generated during product movements and normal tank breathing (collectively known as “working losses”). Where required by regulation or facility policy, one or more of the following methods can be used to reduce emissions:

- a. Installation of an IFR inside a fixed-roof tank in petroleum product service, if the product vapor pressure is greater than 1.5 psia (10.3 kPa) TVP in compliance with EPA 40 CFR 60.

Federal, state or local air regulations may require floating roofs for products with a true vapor pressure as low as 0.1 psia (0.689 kPa). Provisions should be made to avoid drawing the product height below the low legs of the IFR on a routine basis (see API Std 650 Appendix H for rules covering IFRs).

- b. Installation of a secondary seal (double seal) system on a floating-roof, particularly for an external floating-roof tank.
- c. Installation of a vapor-control system for a fixed-roof tank in petroleum product service.
- d. Vapor-balance system.
- e. Coating storage tanks white (or a light reflective color) for gasoline and distillates to reduce product temperature thus minimizing losses and emissions. Refer to state and local agencies that may have differing requirements. Refer to 12.2 for coating requirements.
- f. Adding a fixed roof to an external roof tank (refer to 5.4.1.1).

In addition, if a facility meets the CAA definition of a “Major Source,” other emission requirements will apply (see EPA regulations) (see 5.3.1).

8.1.4 Tank Calibration

Refer to API MPMS Ch. 2 for calibration of new or recalibration of existing tanks.

8.1.5 Coating and Protection from Corrosion

See Section 10 for information coatings and corrosion protection.

8.1.6 Tank Appurtenances

8.1.6.1 Vents

Normal tank venting should be provided in conformance with NFPA 30, API Std 650 and API Std 2000. Emergency venting shall be provided for all tanks. Emergency venting may include a weak or frangible roof to shell connection (typically, tanks greater than 50 ft [15.24 m] in diameter). Additional emergency venting may be required by local code or ordinance. A regular program for inspection and maintenance of vents should be conducted.

8.1.6.2 Gauge Hatches and Gauges

Tank gauging is a fundamental operation in accurately monitoring and controlling aboveground storage tank inventories. A tank gauging program should be implemented as a basic facility inventory control system and to analyze the inventory variations of each tank and product. There are a variety of systems available ranging from basic manual gauging to automatic remote reading systems. Available gauging systems are discussed in 8.1.6.2.1 through 8.1.6.2.3. Inspection and testing of gauging systems shall be performed at intervals acceptable to the authority having jurisdiction.

8.1.6.2.1 Manual Tank Gauging System

Each tank should be equipped with a roof mounted manual gauge hatch. The hatch should be designed to be vapor tight against at least one ounce force (0.28 Newton) internal force except for products that are permitted by the regulatory agency having jurisdiction to be open vented. The manual gauge readings are taken using tape and plumb bob to measure the liquid level in the tank. A gauge tube is often used in conjunction with a gauge hatch. The gauge tube used in conjunction with the gauging system may be designed as an open or closed pipe. The open pipe or slotted gauge tube provides access for obtaining a representative sample in any level of the tank. The slotted tube is also a potential conduit for the transmission of vapors. Internal floats or other sealing devices may be required to contain these vapors. The non-slotted tube does not act as a conduit for vapors; however, it may not provide a representative sample of all tank levels.

Safe gauging practices should be established to prevent employee exposure and injury (refer to API Publ 2026).

8.1.6.2.2 Ground-reading Gauges

Each new tank should be equipped with a gauge capable of being read at ground level. Gauge accuracy should be verified by periodic manual gauging.

8.1.6.2.3 Remote Gauging

Remote gauging systems are available using various types of technologies. The remote gauging system accuracy should be verified using manual gauges on a periodic basis. (See API MPMS Ch. 3.1B.)

8.1.6.3 Overflow Slots

Cone roof tanks with internal floating roofs may be equipped with overflow slots to prevent damage to the fixed roof and IFR in the event of an overfill condition. Overflow slots also serve as air circulation vents that prevent a flammable atmosphere from developing between the fixed-roof and the floating roof.

8.1.6.4 Manholes

Manholes at least 24 in. (0.6 m) in diameter (for new tanks) shall be provided in the tank shell and in the cone roof of covered floating-roof tanks to provide access for inspection, repair and ventilation in accordance with API Std 2015. Entry into such areas shall be in accordance with the facility's confined space entry procedure (refer to 6.4 and OSHA 29 CFR 1910.146).

8.1.6.5 Ladders

Internal ladders may be provided in internal floating-roof tanks extending from the manhole in the fixed cone roof to

the floor. Where provided, the ladder shall be designed for full travel of the floating roof regardless of any settling of the roof supports. The use of interior tank ladders on external floating-roof tanks or internal floating-roof tanks is an option that should be reviewed from a safety standpoint. Some tanks are not equipped with a permanent ladder to ensure that the tank entry process is controlled. Safety procedures must be established and followed when using these systems (see 6.4). Refer to API Std 650, Appendix H. Entry into such areas shall be in accordance with the facility's confined space entry procedure (refer to 6.4 and OSHA 29 CFR 1910.146).

8.1.6.6 Anti-rotation Devices

Anti-rotation devices are required in internal and external floating-roof tanks to prevent rotation of floating roofs.

8.1.6.7 Bonding

Requirements for bonding an internal or external floating roof to the tank shell are described in API Std 650 and API RP 2003.

8.1.6.8 Grounding

Aboveground storage tanks shall be capable of dissipating electrical charges to ground (refer to NFPA 30, NFPA 77, and NFPA 780, and API RP 2003).

8.1.6.9 Thermometers

Accurate measurement of product temperature is another factor in maintaining accurate inventories. There are a number of ways to install thermowells and thermometers in a tank. Examples include thermometers installed in the tank shell, on an internal floating suction, or submerged in the tank gauge tube. Portable thermometers may also be used to measure product temperatures at various levels. A representative temperature is required to accurately determine the net quantity of stored product. Safe work practices should be established for use of thermometers to prevent release of a static electric spark or employee exposure.

8.1.6.10 Stairs and Platforms

Stairs, ladders, toe boards, and platforms are provided for safe access to the top of storage tanks. The design requirements for these appurtenances are covered in API Std 650 and OSHA 29 CFR 1910 Subpart D. These items are typically supplied by the tank fabricator. Design options include the use of different types of non-skid surfaces, stairways or ladders, and platforms for gauging, temperature measurement, and sampling. Railings and toe boards are also part of the design requirements.

8.1.7 Water Draw-off

A water draw-off system to remove and properly dispose of water (and off specification product) that accumulates inside the bottom of the tank shall be provided. The typical system includes a drain line near the bottom of the tank shell that is equipped with a freeze resistant (where weather conditions warrant) steel valve. A tank water bottom collection system may be provided that uses hard piped connections, portable tank trucks, or other alternatives depending upon site logistics, product characteristics, permit requirements, and exposures (e.g., freezing temperatures). Tank water draw off systems are not normally used for hot oils (e.g., asphalt and greases). Safety procedures and safe work practices should be established to minimize exposures and to control the draw off of product during water draw off operations. Provisions should be in place to ensure that water draw off valves are kept closed and secured when not in use to prevent product release.

8.1.8 Roof Drains

External floating-roof tanks shall be equipped with roof drains. The drains are used to remove the accumulation of water from the roof. The drains are typically located at the center of the external floating roof and routed through the contained liquid in the tank by hose or flexible pipe connection. Discharge from external floating roof drain systems should be carefully managed to prevent product releases. Note that internal floating-roof tanks may not require roof drains for rainwater.

8.1.9 Tank Alarms

8.1.9.1 General

High level-alarms provide additional overfill protection for receiving tanks by alerting the operator to a potential overfill. Local regulations may require the installation of high-level alarm systems (see 7.2.3). API RP 2350 details the use and types of high-level alarm systems. NFPA 30 defines the requirements for tank overfill protection including the requirements for high level alarms. Liquid level alarm systems may also be used to alert the operator of potential for damage to a fixed roof or an internal floating roof from an overfill condition and to provide low level protection for pumps and other equipment. Procedures and practices for regular testing of alarm systems, including the primary sensor, shall be established in accordance with API RP 2350.

8.1.9.2 System Requirements

The following features represent the requirements for a typical two stage high level alarm system:

a. Alarms should be independent of any tank-gauging device. See 8.1.9.3 for required alarm stages.

b. The alarm should be tied to an annunciator and located where personnel may promptly arrange for flow stoppage or diversion.

c. The alarm system shall be designed such that an electrical fault in the alarm system will be automatically annunciated.

8.1.9.3 Alarm Stages

Tank level alarms may have two stages. The first stage, high, is set to give a warning at a specified number of minutes before liquid reaches the high level target for the tank. The second stage, high/high, alarm should be set to give a warning at a specified number of minutes before maximum fill height occurs or provide an automatic shutdown and/or diversion of the tank receipt. Both visual and audible alarms, should be designed to notify the appropriate facility personnel or product transfer (such as pipeline) personnel.

The safe distance between the alarms and the high fill level target varies in each tank because of different tank sizes, seal arrangements, maximum product flow rates into the tank, and the time necessary for personnel to perform an orderly shutdown. The safe distances between alarm stages and high fill level should be established at each facility on a tank-by-tank basis taking into account the above conditions (refer to API RP 2350). In computing the safe distances, the maximum expected flow rates shall be used.

8.2 OPERATIONS, INSPECTIONS, MAINTENANCE, AND REPAIR FOR ABOVEGROUND TANKS

8.2.1 General

Safe and environmentally sound management of aboveground tanks include inspections made in accordance with API Std 653, development and use of formal operating procedures (see 6.3), and training of operators (see 6.7) to execute these responsibilities. Facilities should establish and implement an aboveground storage tank operations plan that includes, but is not limited to the following:

- a. Physical inventory procedures including reconciliation.
- b. Inspections and checks of the following:
 1. Rectifier readings for cathodic protection (see 12.4.4).
 2. Calibration of thermometers and automatic tank gauges.
 3. Fire protection equipment and systems (see 7.3).
 4. Overall tank farm operations and conditions.
 5. External and internal condition of the tanks per API Std 653 and regulatory/permit requirements.
 6. High-level alarm system.
 7. Dikes, drainage valves, berms, and walkways.
 8. Roof drains on external (and some internal) floating-roof tanks and water drawoffs on all tanks.
 9. Vapor holder tank above the bladder for vapors in tanks so equipped.

10. Tank vents and flame arresters.
11. Internal and external floating roofs and seals, including the straps bonding the roof to the shell and the straps bonding the ladder to the roof.
12. Periodic settlement monitoring (refer to API Std 653).
13. Differential pressures on any strainers or filters to establish need for cleaning.
14. Operation of the floating suction in each tank.
15. Railings, stairs, platforms, and gauging stations and positions for compliance with OSHA and related safety considerations.
16. External corrosion (see 12.2 and 12.4).
17. Dike area for drainage adequacy, erosion, and weed control (see 7.2.3 and 7.2.11).
18. Tank mixers.
- c. Review of the spill contingency plan for the tank farm and update/revalidation as required by regulation (see 6.5).
- d. Monitoring the observation wells and record data, where applicable.
- e. Identifying tanks and other equipment for inspection, testing, and maintenance.
- f. Emergency planning, operations, and records.
- g. Incorporating the inspection requirements of applicable air regulations.

The operations plan should describe acceptable conditions and actions appropriate for the site specific facilities. In addition to the items listed above, the plan should have other safety considerations, including but not limited to the following: hot work permits, tank watch procedures, and other appropriate hazard control and prevention measures (see Sections 4 and 5). Records should be kept of these activities.

8.2.2 Requirements

All aboveground tanks shall be inspected, maintained, repaired, and tested in accordance with the mandatory provisions of API Std 653. Tank inspectors shall be certified in accordance with API Std 653. Tank entry and cleaning shall be conducted in accordance with API Std 2015.

8.3 FIBERGLASS ABOVEGROUND STORAGE TANKS

Refer to API Spec 12P for minimum requirements for aboveground fiberglass storage tanks. The use of fiberglass aboveground storage tanks is normally limited, due to many considerations, including lack of fire resistance. Class I, II, or IIIA liquids may not be stored in aboveground storage tanks made of combustible materials. Refer to NFPA 30 for more information. Products, such as water, water treatment, fire fighting foam, wastes, bulk lubricants, and specific types of chemicals including nonflammable corrosives are typically stored in fiberglass tanks. Fiberglass tanks may be used in UST applications; refer to EPA 40 CFR 280 for additional

requirements. A hazard analysis should be conducted on sites that use fiberglass tanks to consider the consequences of a large spreading fire on the tank and its contents.

8.4 UNDERGROUND TANKS AND PIPING

The following API documents cover the recommended practices and design considerations for underground tanks and should be consulted for detailed requirements:

- a. API RP 1604.
- b. API RP 1615.
- c. API RP 1621.
- d. API RP 1631.
- e. API RP 1632.

The use of underground tanks for petroleum product storage must consider the federal underground storage tank regulatory requirements described in the EPA 40 CFR 280 as well as state and local requirements. Underground tanks may also be used for non-hazardous product storage, loading rack spill-containment and drainage systems.

8.5 UNDERGROUND STORAGE TANK VAPOR EMISSIONS

Emissions from underground tanks storing gasoline are generated during the filling of the tanks and vapor recovery is used to reduce these emissions. Refer to API RP 1615, API RP 1639 and NFPA 30 for further information on Stage I vapor-recovery controls. In addition, to prevent normal breathing losses, some state and local jurisdictions require the installation of a pressure-vacuum (P-V) valve on the vapor-vent line.

For further information concerning Stage I vapor controls, refer to API RP 1615 and NFPA 30 and 30A.

9 Dikes and Berms

9.1 OVERVIEW

This section covers the design and construction of dikes and berms for tank containment areas. Operating features associated with dikes and berms are addressed in 9.2.10, 9.2.11, 9.3.4, and 9.3.5.

9.2 DIKES

9.2.1 General

When used for secondary containment of tank contents, dikes and intermediate dikes shall be constructed in accordance with NFPA 30. Consideration shall also be given to the requirements in 29 CFR 1910 and 40 CFR 112 and applicable state and local regulations or permits. These documents contain information on siting, spacing, design, and other aspects of tanks and secondary containment and should be consulted

for special considerations in the construction of containment dikes.

9.2.2 Capacity

Dikes shall be sized so as to contain the greatest amount of liquid that may be released from the largest tank within the diked area, assuming a full tank and providing sufficient allowance for precipitation after taking into account protection provided by remote impoundment (see NFPA 30). The requirement for freeboard is often set by state or local jurisdictions. The SPCC rule has some guidance.

9.2.3 Drainage of Rainwater

Unless other provisions are made for drainage, the floor of the diked area shall be graded to at least 1% for 50 ft (15 m) away from the tank(s) or to the dike base, whichever is less.

9.2.3.1 The sloped area shall be directed toward one or more drain openings or retention areas. Major paths of drainage should be routed, or internal intermediate diking shall be provided, so that piping, equipment, tanks, or vessels will not be seriously exposed should flammable or combustible liquid in the drainage ditch ignite. Piping should be protected where it crosses over drainage routes or ditches.

9.2.3.2 Unless other provisions are made in the site's SPCC plan, drainage that would bypass the in-plant treatment system shall be accomplished through block valves that are located or that may be safely operated from outside the diked area. These valves shall be normally closed and secured. Drainage system designs should consider the fire water loading.

9.2.3.3 Dike drainage shall be documented where required by the SPCC regulation (40 CFR 112).

9.2.4 Height

Dike height shall be limited to an average of not more than 6 ft (2 m) above the interior grade, unless special provisions are made for normal access and necessary emergency access to tanks, valves, and other equipment with safe egress from the diked area provided. Provisions made for vehicular and foot traffic shall not compromise the integrity of the secondary containment.

9.2.5 Walkways

On earthen dikes 3 ft (1 m) or more in height, a flat section at the top not less than 2 ft (0.6 m) wide shall be provided.

9.2.6 Slope

The slope of the side walls of earthen dikes shall be consistent with the angle of repose of the dike material with consideration given to safe maintenance operations.

9.2.7 Liners

Consideration shall be given to the permeability of the dike material (see API Publ 351). In those areas where the material may lack sufficient impermeability, a risk-based analysis including the impact on receptors, the facility prevention systems in place, and other site specific factors should be considered to determine the need for a liner. The analysis should consider factors associated with dike liner long term integrity discussed in API Publ 341. (Also see API Publ 315.)

9.2.8 Operating Equipment

Where provided, hose connections, controls and control valves used for fire fighting shall be located outside of the diked area to protect and provide for access to during a fire or a spill. While location of pumps outside the diked area is desirable from a fire safety standpoint, location of pumps inside a diked area provides for protection of the environment. Both safety and environmental factors should be weighed when planning the location of pumps, of operating valves, and of valves used for fire fighting. Refer to 10.3 through 10.5 for pipe and pump requirements.

9.2.9 Piping

Piping or conduit passing through dike walls shall be designed to prevent build-up of excessive stresses on pipe or conduit as a result of settlement. Penetration of dikes (except drains) shall be kept to a minimum to eliminate leakage paths through the dike. The area surrounding the penetration shall be sealed with a high-temperature fire resistant material to prevent migration of liquids through the dike. Piping that penetrates the dike shall be protected from corrosion by use of coatings, pipe wraps, or secondary containment (refer to 8.3, 8.4, 12.2, and 12.4). Conduit passing through the dike shall be sealed liquid tight as it leaves the dike wall.

9.2.10 Restoration

If the integrity of a dike used for secondary containment around an in-service tank is compromised, such as by cutting the dike to gain access with heavy equipment, the dike shall be restored to a height or width necessary to maintain the integrity of the containment system before the area is left unattended, unless other provisions are made to provide for the necessary containment (refer to 6.4 and 6.10).

9.2.11 Weed Control

Measures shall be taken to ensure that any vegetation adjacent to or within the diked area is kept to a level that does not pose a threat to successful fire control (see 7.2.2, 7.2.4, and 7.2.5).

9.3 BERMS

9.3.1 General

For the purpose of this standard, a berm is defined as the annular area around the tank, inside the dike, normally used for access to the tank and the equipment surrounding it.

9.3.2 Construction

Berms shall consist of a walking area, sloped gently away from the tank, of sufficient width and extending sufficiently around the circumference of the tank so as to permit access to hatches, equipment, and appurtenances on or near the tank, such as mixers and valves.

Where dikes exceed 6 ft (2 m) in height above the interior grade, NFPA 30 requires a minimum distance of 5 ft (1.5 m) between the tank and the toe of the dike, in addition to other requirements (see NFPA 30).

9.3.3 Grading

Grading between the berm and the toe of the dike shall allow drainage as covered in 9.2.3.

9.3.4 Restoration

If the berm is disturbed for any reason, it should be restored to original condition as soon as practical.

9.3.5 Erosion Control

Where necessary, erosion control measures should be considered for application around the tank perimeter.

10 Pipe, Valves, Pumps & Piping Systems

10.1 GENERAL

Pressure piping and related components at facilities covered under this section shall conform to the provisions of ASME B31.4 or ASME B31.3, as appropriate, or other codes referenced in this standard. Marine systems may have additional codes to conform to, such as AWS D-1.1 *Structural Welding Code—Steel* or ABS *Rules for Building and Classing Steel Vessels* for load conditions.

The guidelines in this section are applicable for liquid hydrocarbons that have low corrosivity and that are at temperatures between –20°F (–29°C) and +190°F (88°C). Special design and operating considerations must be made for liquid hydrocarbons that are highly corrosive or that operate outside of this temperature range. Water, air, and other utility piping systems that are not designed for hydrocarbon usage are covered in 13.2.

Guidance for inspection and maintenance of in-service piping is provided in API 570.

10.2 MATERIAL COMPATIBILITY

With the advent of new products, including use of various oxygenated fuels, special consideration shall be given to the compatibility of the piping system, especially seal materials, gaskets, and other elastomers with additives and oxygenates, such as TAME, ETBE, MTBE, ethanol, and methanol.

10.3 PIPING SYSTEMS

10.3.1 General

A piping system consists of the pipe, fittings, valves, pumps, and other types of equipment that are connected together to provide a means of conveyance to handle product. While each component of the system may have its own specifications and design parameters, care must be taken to consider the interaction of the components in the overall piping system design.

The design of the piping system should be as uncomplicated as possible minimizing connections, fittings, and valves. Operating errors, maintenance costs, and risks of an environmental release will increase as a piping system becomes more complex. The designer shall consider provisions for the integrity assurance of the piping system (refer to 10.6).

10.3.2 Aboveground versus Buried Piping Systems

There are advantages and disadvantages to both aboveground and buried piping systems. Factors to be considered in placement of piping include the following:

- a. Local regulations may favor either aboveground or buried piping and should always be consulted.
- b. Aboveground piping is accessible for visual inspection, maintenance, and repair, thus enhancing leak detection and prevention.
- c. Access to areas of the facility during emergencies may be inhibited with aboveground piping.
- d. Piping modifications are usually easier to complete on aboveground piping due to the absence of excavation requirements.
- e. Aboveground piping will be more affected by radiant heat. Therefore, consideration should be made for expansion and pressure relief on closed sections.
- f. Aboveground piping provides more flexibility for movement in all planes. Flexibility may be necessary to accommodate uneven settlement, shifting foundations, soil movement, earthquakes, movements from line shocks or water hammer, and movements from thermal expansion and contraction.
- g. Buried piping may be necessary to completely drain tanks, such as storage tanks, sumps, drop-out tanks, and other vessels.

- h. Buried steel piping may require protection from external corrosion (e.g., effective coating and cathodic protection).
- i. Buried piping is less susceptible to damage by vandalism, vehicular traffic, and fire. However, buried piping should be marked or mapped to avoid damage during excavation work.

10.3.3 Anchoring Structures and Pipe Supports

Anchor structures and pipe supports shall be designed and installed to support or control pipe movement where appropriate, and thus protect equipment, such as pumps, tanks, and valves from excess mechanical loading. Anchor structures and pipe supports shall be constructed to prevent wear and corrosion of the piping and should be designed to allow adjustment of the support. Refer to ASME B31.3 and ASME B31.4 for technical aspects of anchoring and supporting piping. Fire protection provisions should be considered, and are covered in NFPA 30 and other locally recognized codes, such as the ICBO *Uniform Fire Code* and the *International Fire Code* or other locally adopted and applicable building and fire codes.

10.3.4 Pipe Insulation and Heat Tracing

High pour point hydrocarbons may require heat tracing or insulation. Design considerations should include these factors: temperature requirements, thermal expansion, clearance for insulation at pipe supports, insulation type, and insulation protection (weather and mechanical). The designer should review the potential for corrosion (see 12.2.3, 12.2.4 and 12.4.3 for design considerations) and the risks of corrosion under the insulation as noted in API 570 and NFPA 30.

10.3.5 Dead Legs

Industry experience has shown that dead legs (idled sections of pipe that do not experience flow under normal conditions) may be subject to internal corrosion and freezing or rupture problems. For these reasons, the construction of dead legs shall be avoided and reduction or elimination of idle piping sections should be considered during design and construction.

10.3.6 Vapor-control Piping Systems

Pipe for vapor-control systems may include spiral weld pipe that conforms to API Spec 5L or pipe listed in 10.4. The design of a vapor-control piping system should include providing proper slope towards condensation collection points to prevent trapping liquids. Refer to API Publ 2557 for technical considerations for storage and transfer operations. For marine installations, refer to USCG 33 CFR 155.

10.3.7 Drainage Systems

Design of drainage systems should include consideration of material compatibility and pressure limitations for the

worst case situation as well as the possibility of uncontrolled flow of flammable hydrocarbons through a drainage system. See 13.2.3.2 and 13.2.3.3 for additional comments. Consideration should be given to upgrading drainage systems, unless they can be pressure tested.

10.3.8 Packaged Piping Systems

Piping that interconnects individual pieces or stages of equipment within a packaged equipment assembly shall be in accordance with ASME B31.4 or ASME B31.3, as appropriate. In addition, packaged refrigeration equipment may conform to the requirements of ASME B31.5.

10.3.9 Flow Diagrams

Flow diagrams which indicate all major valves and flow directions for normal conditions as well as for upset conditions should be available at each facility. Valves should be numbered or otherwise identified to match the flow diagram.

10.4 PIPING COMPONENTS

10.4.1 Pipe

The recommended types of pipe are listed in ASME B31.4 and ASME B31.3 and include seamless, electric-resistance-welded (ERW), and electric-fusion-welded pipe (EFW). Manufacturing specifications are also included in the specifications listed in ASME B31.4 and ASME B31.3.

Calculations for the diameter of the pipe are normally based on desired liquid flow velocity and pressure drop in the pipe. Typical recommended design rates are between 5 ft/s and 20 ft/s (1.5 m/s – 6 m/s). Higher velocity flows may result in static electric build-up, hydraulic surges, or internal pipe erosion, requiring additional design evaluation. Refer to API RP 2003 for additional information.

Steel pipe that is subject to external corrosion shall be protected (see 12.2 and 12.4). The wall thickness of the pipe should be selected based upon pipe diameter, pipe grade, allowable stress, operating pressure and temperature, corrosion effects, dynamic effects (vibration, hydraulic shock), weight effects (pipe, pipe contents, snow, insulation), and movement of connected components. Formulas for wall thickness calculations are included in ASME B31.4 and ASME B31.3, as applicable.

Typical piping joints are welded, flanged, or threaded. While piping joints are necessary, piping systems should be designed to minimize the number of joints, and joints should be welded wherever practicable. As a general guideline, joints on piping 2 in. (5 cm) and larger should be welded, or flanged joints. Piping 2 in. (5 cm) and smaller may be threaded. Requirements for nondestructive testing of welded joints are listed in ASME B31.4 and ASME B31.3, as applicable.

10.4.2 Fittings and Flanges

Fittings shall be constructed of forged steel and shall have a minimum pressure rating of 2,000 psi (13,790 kPa) for threaded fittings and 3,000 psi (20,684 kPa) for socket-weld fittings. Cast iron and brass fittings shall not be used in new construction or as replacement components for liquid hydrocarbon service. Aluminum fittings are commonly used on truck loading racks for dry-break couplers and break-away fittings, but if used, they should be used downstream of shut-off valves. In addition, the possibility of structural failure of aluminum fittings during a fire should be considered when such fittings are used at the truck loading racks.

Miter welds should be avoided, except for certain applications. Refer to ASME B31.4 and ASME B31.3, as appropriate, for miter weld use information.

Threaded fittings and socket-weld fittings shall conform to ASME B16.11, and flanged fittings shall conform to ASME B16.5 and ASME B16.47. Welded fittings shall conform with ASME B16.9, ASME B16.28, and MSS SP-75. Threaded fittings should not be buried unless mitigation strategies are used to prevent leaks, including seal welding, leak detection, or other means. The use of buried flanges should be avoided unless they are installed in a vault or pit, or include some means of detecting leaks.

The use of solid steel plugs is recommended over hollow core plugs, and the plugs should conform to ASME B16.11.

Pipe joints dependent upon the friction characteristics and integrity of combustible materials for mechanical integrity or liquid tightness of piping shall not be used for transporting petroleum liquids.

Union fittings with machine finished metal to metal seats or with spiral wound gaskets are recommended. Insulating unions with cathodic protection gaskets may be used, as appropriate. Union fittings shall conform to MSS SP-83 and ASME B16.11.

10.4.3 Gaskets & Bolts

Gasket material should be compatible with the contained fluid. Gaskets shall meet the fire resistant properties as specified in NFPA 30 and shall conform to ASME B16.20 or ASME B16.21.

Studs used with flange joints should extend completely through the nuts. Any that fail to do so are considered acceptably engaged if the lack of complete engagement is not more than one thread. Studs shall conform to ASME B16.5 and nuts shall conform to ASTM A 193, ASTM A 194, or ASTM A 325.

10.4.4 Valves

A piping system designer has a wide assortment of valves from which to choose. The type of valve to be used will vary for each specific situation. Lists of applicable standards for the various valves are included in ASME B31.4 and ASME

B31.3, as appropriate. Information labels on valves should be protected and not removed, not painted over, or otherwise damaged. Consideration should be given during valve selection to minimizing hydrocarbon vapors emitted from the valve. See 5.3.1.4 regarding fugitive emissions. Thermal pressure-relief valves should be considered to prevent excessive pressure build-up in a closed piping system, such as around closed valves, check valves, or pumps. When designing thermal pressure-relief systems, the design should account for the additive nature of relief pressures in the system.

Inherently fire safe all metal gate valves or fire-tested valves for soft-seated valves should be considered for use in certain locations, such as the first valve from the tank and the isolation valves in the loading areas. Fire-test specifications include API Spec 6FA and API Std 607. Ductile or cast iron should not be used for critical isolation valves as they may fail if suddenly quenched with cold fire water streams during a fire incident. Rather cast steel or fire-rated valves should be used. Valve size may be a consideration in determining the need for a fire-tested valve.

Valves made of non-ductile cast and low-melting temperature metals, such as brass and aluminum (see 10.4.2) shall not be used in new construction or as a replacement for valves in hydrocarbon service. Bolted bonnet valves are preferred over union or screwed bonnet valves.

Where product separation or bubble-tight closure is critical for a particular situation, double block-and-bleed valves should be used. These valves should also be used when performing a pressure tightness test.

Valves used in isolation or shut-off service should be able to maintain a positive seal of liquid when the piping system is disconnected on the discharge end of the valve. Wafer valves or valves with bolts extending from flange to flange outside of the valve body should not be used for isolation service without a special means of fire protection. This precaution is due to the possibility of bolt deformation during a fire. See 7.7 for additional information on exposure protection.

Check valves are used to control the direction of flow and may not be relied upon for positive shutoff in the reverse direction. Use of check valves should be considered at the discharge of each pump on a multi-pump piping system and on the pump bypass piping at centrifugal pumps.

Pressure-relief valves should be considered to prevent excessive pressure build-up in a closed piping system, such as around closed valves, check valves, or pumps such as positive displacement (PD). When designing pressure-relief systems, the design should account for the additive nature of pressure relief in the system. If pressure-relief valves are used, a regular documented testing program shall be instituted for each pressure-relief valve. Refer to API RP 520 for sizing and selection of pressure-relief devices.

Discharge from a pressure-relief valve should be directed to a lower-pressure receptacle where the relieved liquid will not interfere with downstream conditions. Block valves on a

pressure-relief system should be secured open to ensure a properly functioning system.

Remote operation of valves may be utilized for convenience as well as for emergency operation. Consideration should be given to the final valve position in a failure mode (e.g., fail-open, fail-close, or fail-unchanged).

10.5 PUMPS

10.5.1 General Information

Centrifugal and PD pumps are typically used in facility applications. Centrifugal pumps typically conform to ANSI/ASME B73.1M or API Std 610. PD pumps typically conform to API Std 674, API Std 675, and API Std 676. Pumps conforming to specific trade group standards may be considered for use. For non-asphalt hydrocarbon service, the pressure-containing components of a pump installed during new construction or for replacement shall not be constructed of cast iron.

Pumps should be selected on performance specifications, compatibility with the service application, durability, and anticipated maintenance requirements. The pump and motor selected should be reviewed to ensure that motor horsepower is adequate for all performance points over the entire range of operation, not just one design point. Pump and motor nameplates and instrumentation should be protected and should not be removed, painted over, or otherwise damaged.

10.5.2 Pump Installation

Piping systems at pump locations should be designed to allow for pump removal and maintenance. At locations with multiple pumps, each pump should have isolation valves and check valves. When check valves are used, the check valve should be designed so as not to slam during alternating pump cycling (see 10.4.4).

PD pumps should utilize a pressure-relief system and may require pulsation dampeners. The piping system should be designed to prevent binding, misalignment, and seal wear on the pump as well as to avoid exceeding structural limitations of the pump casing. Proper piping design techniques, anchoring of pipes and pumps, and stress analysis are preferred over flexible connections to the pump.

If a pump is installed within a contained area, the motor shall be of a class compatible with that environment (see 13.2.2). Drip and spill containment around the pump should be considered. The pump should be located outside the secondary containment or protected from fire exposure.

10.5.3 Pump Operation & Maintenance

The operator should maintain a data file for each pump that should include pump make and model, serial number, motor make and model, flow rate, pressure rating, pump curves,

dimensional data (pump, motor, shaft, stages) seal, and wearing material data. The design information should be readily accessible and should be updated to include any changes in service, use, or pump specifications. Changes in service should initiate a review of the pump data to ensure the existing design is suitable for the new service. Requirements for equipment data and management of change can be found in OSHA 29 CFR 1910.119.

10.6 PIPELINE INTEGRITY ASSURANCE OF EXISTING PIPING SYSTEMS

10.6.1 General

All facilities shall periodically assure the integrity of system piping. The integrity of buried piping systems shall be assured by a comprehensive program utilizing a combination of the methods in 10.6.3. The integrity of aboveground piping systems shall be assessed by one of the methods in 10.6.2. Further details are provided in ASME B31.4 and API 570. Requirements for marine facilities are included in USCG 33 CFR 156.

10.6.2 Aboveground Piping Systems

The most reliable means of both leak testing and inspection of non-insulated aboveground ambient-temperature hydrocarbon piping is visual inspection using the principles of API 570. Other supplementary methods which may be needed based on unique and site specific conditions include, but are not limited to, vapor detection, ultrasonic, wall thickness measurement and pressure testing. See 10.6.4.

10.6.3 Buried Piping Systems

Methods of integrity assurance for buried piping (both gravity and pressure) include the following: pressure testing, volumetric testing, acoustic testing, selective excavation and inspection, visual inspection of pipe whenever exposed, ground penetrating radar, tracer testing, monitoring of the cathodic protection system (see 12.4), instrumented internal inspection device, visual inspection of the area surrounding the buried piping, and monitoring wells.

10.6.4 Pressure Testing

Although pressure testing of new piping systems may be performed at or above 100% of maximum design pressure during an initial system pressure test (see 10.7), repeated tests at high pressures are not recommended for periodic integrity assurance of existing piping. Such repeated pressure testing at high pressures may increase the likelihood of piping leaks. If periodic pressure testing is used to check piping integrity, it is recommended that these tests be conducted at less than or equal to 100% of the normal or day-to-day maximum operating pressure, and giving consideration to individual system

factors such as pressure-relief valve settings, maximum head pressure of pump, etc.

However, for those facilities that operate where the jurisdictional authority mandates pressure testing to higher pressure, such as those facilities that fall under US DOT jurisdiction, pressure testing shall be in accordance with the appropriate regulatory requirements (see 10.6.5). The recommendations provided in this section do not meet the requirements of OPS RSPA 49 CFR Part 195.304 or Part 195.306.

10.6.5 Pressure Testing Medium

10.6.5.1 Pressure testing may be performed with the contained fluids only if the test pressure does not exceed the normal operating pressure, or if the requirements of 10.6.5.2 are met.

10.6.5.2 Pressure testing above the normal operating pressure with the contained fluid has potential to leak or spill the contained fluid. The facility owner/operator shall consider and evaluate the risks associated with a leak or rupture prior to conducting this kind of test under the following conditions:

- a. The test medium shall be water when the test pressure is above the maximum normal operating pressure, but below the original design pressure (when original pipe test data is not available and the test pressure will produce a hoop stress in excess of 35% of the specified minimum yield strength of the piping system), the test medium shall be water.
- b. The test medium may be hydrocarbons when the test pressure is higher than the maximum normal operating pressure, but not exceeding the design pressure; and if original test data is available and the remaining wall thickness is sufficient to sustain the pressure, providing the flashpoint is above 120°F (49°C) and a risk assessment has been documented and proved by the facility management.
- c. When testing to a pressure that will produce a hoop stress of less than 35% of the specified minimum yield strength of a piping system for which original pipe test data is not available.

The temperature of the pipe and the test medium shall be in accordance with the recommendations of ASME B31.3 and B31.4, as appropriate. Water should not be used to pressure test hot oil or asphalt piping. See USCG 33 CFR 156 for facilities under Coast Guard jurisdiction.

Satisfying the requirements for pressure testing above may be done on damaged piping provided that the principles for fitness-for-service have shown that the risk of failure due to pitting, cracking, or other damage mechanisms is low. Refer to API Std 579.

10.7 TESTING FOLLOWING CONSTRUCTION

Testing of piping systems following new construction or major modification to piping system components shall conform to API RP 1110, ASME B31.4, or B31.3, as appropriate.

See USCG 33 CFR 156 for facilities under Coast Guard jurisdiction. For piping conforming to ASME B31.3, refer to API 570 for piping system testing.

11 Loading, Unloading and Product Transfer Facilities

11.1 SCOPE

This section covers facilities that transfer all classifications of liquid petroleum to or from tank trucks (excluding oil production facilities), rail tank cars, marine vessels, and stationary storage tanks. See 1.4.3, 1.4.5, and 7.8 for classifications of petroleum liquids.

11.2 GENERAL DESIGN

All transfer facilities shall be designed in conformance with NFPA 30, applicable local and national codes, and good engineering practices. In the design process, particular attention should be given to the specific hazards associated with tank trucks, rail tank cars, and marine vessels entering transfer facilities. Design and maintenance practices should consider impact loads and potential damage from docking operations at marine facilities. For additional guidance, see the ICOS/OCIMF/IAPH *International Safety Guide for Oil Tankers and Terminals*. Consideration should be given to the need for protective barriers or other means of hazard identification (see 6.2) to minimize potential for vehicular accident damage to facilities.

Loading, unloading, and product transfer areas should be located in relationship to other facilities to provide room for safe ingress/egress. An ingress and egress plan should be developed that will provide safe movement of truck or rail tank car traffic, while providing for adequate staging areas. Care should be taken to not block normal traffic flow. Safe driving speeds should be established, posted, and enforced. Refer to 2.3 for additional information on spacing of facilities.

Due to the nature of the materials being handled, transfer facilities shall incorporate adequate fire prevention design criteria and environmental protection systems. Refer to Section 5 for more guidance on fire protection systems, to Sections 3 and 7 for information on environmental issues, and to Section 6 for tanks.

Only noncombustible materials shall be used for the construction of loading racks. Piping, valves, and fittings shall be designed and fabricated from materials compatible with the product being handled and having adequate strength and durability to withstand the pressures, stress, and exposures to which they may be subjected. Refer to Section 8 for additional guidance.

Loading arms and components should be designed to maintain sound mechanical and structural integrity. Heat traced and jacketed loading arms and hoses should incorporate handling accessories to prevent personnel from contact-

ing high-temperature surfaces. Hoses used for loading should be supported in such a manner as to prevent personnel injury and prevent damages or excessive wear.

Special consideration shall be given to the design and location of loading arms and hoses to assure that adequate safety clearance is maintained when in the stored position. Rail clearance guidance should be obtained from the carrier servicing the facility or from the Association of American Railroads (AAR).

Pumps and loading devices shall be sized to provide rates of flow appropriate to the design capacity of the facility and its safe operation. Refer to API RP 2003 and NFPA 77 for guidelines on filling rates. Care shall be taken during design to ensure that an operator, when present, may follow the prescribed appropriate method of loading and unloading at all times and have adequate time to shutdown the transfer. Control systems, including automatic set-stop valves, shall have adequate time to shutdown the transfer before tanks are filled beyond maximum safe fill levels (see 8.1.9). Where flow control valves or emergency shutdown valves are employed that operate using line pressure, the system hydraulics shall be designed so that the required pressures are available under all operating conditions to allow for a safe and reliable shutdown (see 6.5). In general, fail-safe control valves are recommended for use in the control system. Where automated systems are employed that require electrical power, the primary flow control systems shall be designed to safely shutdown operations in the event of a power failure.

Design considerations should include development of an area lighting plan (see 13.2.2, 13.2.5, and the *IES Lighting Handbook*). Lighting levels should be provided consistent with the safe operational needs of each specific area of the facility to facilitate loading, unloading, and product transfer.

11.3 TRUCK LOADING/UNLOADING

Further reference for truck loading may be found in 4.3.3, 5.3.1.1, and 13.3.3 (see NFPA 30 for additional information). Additional information on safe truck loading may be found in API RP 1007.

11.3.1 Spill-containment Paving

Adequate spill containment shall be incorporated into the drainage design to contain and control a spill resulting from accidental overfill, equipment failure, or malfunction.

Truck loading rack areas should include concrete pavement with a raised edge (curbing) or other spill-containment method provided around the loading rack perimeter. The raised edge should be sloped or rounded to facilitate truck access. Concrete joints should be sealed with petroleum resistant sealant to prevent leaks to subgrade. Pavement should be sloped toward catch basins and drains to prevent accumulation of liquid product on the surface. Catch basins and drains should be connected to containment or treatment facilities.

Catch basins should be located so that the liquid will flow away from the tank truck, loading rack equipment, and personnel. Catch basins should be accessible under fire conditions and away from the actual loading operation. Drainage systems should be designed to prevent the spread of fire from one loading lane to another and to areas outside of the loading rack. Manholes with fire seals should be incorporated to safely flush and drain away any spills.

Maintenance of drainage systems shall include necessary measures to prevent snow, ice, dirt, or other solids from clogging the system. For further reference, see 13.2.3 and 13.3.

11.3.2 Loading Rack Canopy (Weather Covers)

Where loading operations are conducted in areas that are exposed to the elements, measures to minimize the introduction of surface water and precipitation into the loading rack containment system will reduce the quantity of liquid that must be environmentally treated if storm water segregation is provided (see 5.3.2). Installation of canopies over the entire loading area is an effective means of reducing the volume of precipitation entering the loading area containment system.

Canopies should be constructed of noncombustible materials in accordance with all local, state, and federal standards (see 13.1). Special care must be taken to assure safe personnel egress in case of emergencies.

Proper external weather cover lighting should be provided to allow safe operation and to reduce the likelihood of accidents causing spills or product mixing. Lighting under the external weather cover should provide adequate illumination to read meters, conduct required operations, and perform general maintenance of the loading rack equipment. Refer to the *IES Lighting Handbook* or applicable state or local codes for lighting requirements. The electrical classification of the external weather cover lighting system shall adhere to the requirements stipulated in 13.2.2.

11.3.3 Loading Arms, Hoses, and Meters

When possible, the loading arms and hoses should be arranged to enable the filling of all tank compartments without having to move the vehicle, thus reducing the potential for accidents.

Loading arms and components must have high mechanical integrity to prevent emissions of VOCs under normal operating conditions. The use of aluminum pipe, fittings, or components should be limited to quick connect couplings, breakaway couplers, and drop tubes. Loading arms and hoses should be inspected and maintained, as necessary, to ensure integrity of the system (see 10.4).

Pumps capable of pressures in excess of the safe working pressure of the hose or loading arm shall be provided with bypasses, relief valves, or other arrangements to protect against excessive pressure. Pressure-relief systems shall be employed when necessary to prevent or control over-pressur-

ization resulting from thermal expansion or line shock. Relief devices shall be tested periodically to verify their set pressure (see 10.4.4). Records of this testing should be maintained at the facility.

11.3.3.1 Top Loading

Top loading is most applicable for Class III liquids, distillate products, asphalt, or liquid sulfur. However, top loading is discouraged, particularly for flammable liquids, due to the potential to generate a higher rate of vapors, as well as the potential hazard of falling from the top of the truck or tank car.

Appropriate measures shall be taken to protect personnel from falls during top-loading operations. Where platforms are provided, stairways and handrails serving the loading rack shall be maintained in good condition and shall comply with applicable OSHA regulations. Refer to 6.4 for additional safety requirements.

Drop tubes of adequate length and proper design should be used to reduce splashing, static discharge, and vapor generation (see 5.3.1.1 and 7.2).

Loading procedures should be established that incorporate safe loading practices (see 6.3). Signs displaying the required loading procedures should be mounted so as to be visible from each loading position.

11.3.3.2 Bottom Loading

The use of the bottom-loading method is preferred for Class I liquids and strongly encouraged for other light Class II liquids. In addition to the reduction of air emissions, bottom loading provides for improved safety because all work is conducted at grade level, and splash generated static electricity build-up is reduced with less likelihood of an incendive spark.

Refer to API RP 1004 and NFPA 30 for recommendations concerning selection of standardized equipment, such as couplers, adapters, layout of connections, secondary shutoff controls systems, and vapor-recovery systems.

Loading procedures should be established that incorporate safe loading practices. Signs displaying the required loading procedures should be mounted so as to be visible from each loading position.

A system to prevent exit from a loading rack while a loading arm or vapor hose is connected, such as an air brake interlock system, should be considered.

11.3.3.3 Heavy Products Applications

High-viscosity/heavy products may impose additional system requirements for loading/unloading. Purging, heating, or pigging systems may be necessary for specific products or facility requirements. Many times these products are sold by weight, and truck scales are used for measurement and loading control. Heavy product applications apply for both top

and bottom-loading systems. Individual product specifications should guide the loading system configuration.

11.3.4 Control Systems

Control systems incorporated in the design of truck loading facilities range from complex computer controlled systems to manual operation. As a minimum, the following controls should be incorporated into the design:

11.3.4.1 Grounding/Bonding

Static electricity may be generated during the loading/unloading operation through non-closed connections from splash loading or from designs that promote static generation, such as high-flow rates, filters, and water entrainment or do not allow proper relaxation time for static dissipation. Under these conditions, or when required by API RP 2003 or NFPA 30, the truck shall be bonded to the loading rack by a continuous monitored bond connection before connecting loading hoses and initiation of the loading process. In addition, the absence of a bond connection to the truck should prevent loading by a control system interlock. Bonding allows for the equalization of electrical charge between the truck and the rack, thus reducing the chance of a spark when the loading arm is moved away from the truck.

The loading rack should be grounded to earth either through piping or ground rods. Additional information and requirements on grounding and bonding for product transfers is contained in API RP 2003 and NFPA 30.

All electrical equipment and systems shall be grounded in accordance with the latest version of the *National Electrical Code* (NFPA 70) (see 13.2.2).

Metal structures, such as canopies and supports over loading/unloading areas shall be bonded to the rack and grounded to minimize damage that might occur from direct-strike lightning (see 13.1). Additional information on lightning protection may be found in API RP 2003.

11.3.4.2 Overfill Protection

When top loading a tank truck, valves shall be of the self-closing type and manually held open, except when automatic means are provided for shutting off flow when the vehicle or compartment is full. Automatic shutoff systems shall have a manual means of shutoff if the automatic system fails.

When bottom loading a tank truck, a positive means shall be provided for loading a predetermined quantity of product together with a secondary automatic shutoff control to prevent overfill. Primary protection should be provided by meter-controlled automatic valves. The secondary automatic shutdown devices should include devices such as thermistor or optical level probes. These devices should be of self-checking design. The components of safety systems on the vehicle and the loading rack shall be compatible. The primary

connection between the loading rack fill pipe and the tank piping shall be a dry disconnect coupling. Precautions that prevent overfilling, product contamination, and unsafe conditions shall be established and followed. See Section 4 for additional safe operation requirements. Refer also to Section 8 and API RP 1004 for equipment standardization and additional recommendations.

11.3.4.3 Fire Prevention and Protection

Fire prevention measures, such as emergency shutdown, positive drainage, overfill protection, and reduction of the potential for static build-up should be considered and evaluated during the design of loading and unloading systems (see 7.2).

When fixed fire suppression systems are provided, an automatic and manual activation system should be considered and in some cases may be required by code or regulation. Automatic fire detection systems should also shutdown product flow, in addition to activating the fire suppression system. Refer to 7.4.4 for additional information concerning fire protection in loading/unloading areas.

11.3.4.4 Metering and Flow Control

Product metering for truck loading/unloading operations may be accomplished using various types of metering equipment. Most often, either a positive displacement meter or a turbine meter is used. The selection should be based on product characteristics and facility operating design. For high-viscosity products, mass flow meters or vehicle scales are generally used, and the product is loaded by mass in lieu of volume. Measurement equipment must be calibrated to maintain accuracy and in many cases is required by law.

Starting and stopping of the loading operation may be done manually; however, the use of automatic set-stop controls is preferred.

11.3.5 Additive Injection Facilities

When additive injection is required, measures should be taken to ensure that the proper amount is injected. Calibration of additive injection systems should be conducted in accordance with equipment manufacturers' and the company's recommendations. Additional verification may be warranted either through metering or positive indication of the piston stroke (if the injection system utilizes a calibrated cylinder). The additive system shall be designed to be compatible with the chemical being injected.

Operating practices to ensure that additive inventories are properly monitored and controlled shall be used.

11.3.5.1 Additive Storage

Dikes/berms, secondary containment, gauging, and other methods of spill prevention and control shall be considered

for additive storage. See Sections 3, 6, and 7 for additional information.

11.3.5.2 Additive Transfer

Additive transfer is the same as described in 11.3.1 through 11.3.4. Spill containment within the immediate area of the hose coupling activities should be considered. Provisions for lighting, grounding, personal protection, emergency response, and other applicable safety precautions should be implemented as required by the MSDSs covering the additives being used.

11.4 RAIL TANK CAR LOADING AND UNLOADING

Rail tank cars are loaded and unloaded in a similar manner to truck loading. There are two types of loading: (a) loading an individual rail tank car, and (b) loading a unit-train that has numerous interconnected tank cars that act as one large tank.

When rail tank cars are top loaded, measures shall be taken to protect personnel from falls since work is above grade level. Where platforms are provided, stairways and handrails serving the loading rack shall be maintained in good condition and shall comply with applicable OSHA regulations. When top loading, drop tubes shall be of sufficient length to reach the bottom of the tanks being loaded and designed to minimize splash (see 11.3.4.4).

Where required, when loading or unloading rail tank cars, vapors should be handled in accordance with 11.7.

Where required, pressure-relief facilities should be provided for the pumping system as well as the rail tank car.

11.4.1 Spill Containment

Where required, spill containment for loading/unloading of rail tank cars should be provided. Spill-containment material shall be capable of retaining the spilled product. Spills should be diverted to a product collection system (see 13.2.3). Spill-containment systems are similar to those used with truck loading racks (see 11.3.1).

11.4.2 Rail Tank Car Loading and Unloading External Weather Cover

The installation of an external weather cover at the rail tank car loading and unloading area depends upon facility specific operational requirements and weather conditions. If it is determined that a rail tank car loading/unloading external weather cover is required, refer to 11.3.2 and 13.1 for guidance.

11.4.3 Loading Arms, Hoses, and Couplers

Loading arms, hoses, and couplers used for top loading rail tank cars are similar to those used in the tank truck loading. Bottom loading will generally require use of hoses and cou-

plers to match specific rail tank car connections. Refer to 11.3.3 for general guidance and AAR *Mechanical Division Standards*.

11.4.4 Control and Safety Systems

Control systems incorporated in rail tank car loading facilities are similar to those for truck loading; 11.3 should be reviewed before design.

11.4.4.1 Grounding and Bonding

It is recommended that a means of preventing the build-up of an electrostatic charge and dissipating any charge generated on the rail tank car be incorporated in the design of rail tank car loading facilities. See API RP 2003 and NFPA 30 for guidance. Bonding shall be provided between the rail tank car and loading rack to equalize the electrical potential. The fill pipe should be permanently bonded to at least one rail and the loading structure to protect against stray electrical currents. Rail tank cars are usually grounded by contact of the wheels to the rails.

11.4.4.2 Overfill Protection

Overfill protection should be included in the design of rail tank car loading systems. Systems similar to those discussed in 11.3 should be considered.

11.4.4.3 Fire Protection

Automatic fire protection systems shall be installed as required by regulation or facility policy, refer to 7.4.4 for guidance on fixed and portable fire protection systems, extinguishers, and equipment.

11.4.4.4 Metering and Flow Control

Except for the unit-train configuration of rail tank car loading, the metering and flow control systems used are similar to those used in truck loading. Facilities loading unit trains shall develop and implement appropriate procedures for flow control. Refer to 11.3 for further guidance.

11.5 MARINE LOADING/UNLOADING

Additional information on marine loading/unloading operation and safety may be found in the ICOS/OCIMF/IAPH *International Safety Guide for Oil Tankers and Terminals*.

11.5.1 Spill Prevention and Containment

Loading of barges and marine vessels (tanker ships) shall not commence until the shore supervisor and the person in charge of the vessel agree that the barge or marine vessel is properly moored and all connections are secure. Communications shall be maintained between the barge/marine vessel and shore during the loading/unloading operation (see USCG

33 CFR 26). See API RP 1125 for guidelines for overfill control systems for barges and marine vessels.

Where barges or marine vessels are loaded or unloaded through articulated arms or hose connections, spill containment shall be incorporated to contain and control a spill resulting from leakage or accidental equipment malfunction depending upon the vapor pressure of the material being handled. The terminal should incorporate storage for containment booms and keep deployment equipment ready to contain a spill on the water.

11.5.2 Loading Arms and Hoses

Marine swivel joints, when used, shall be designed so that if the packing materials fail, the mechanical strength of the joint will not be impaired.

Marine hoses or loading arms shall be capable of accommodating the combined effects of change in draft and tidal change. Mooring lines shall be kept adjusted to prevent sway and surge movements of the vessel from placing stress on the cargo transfer system.

Shut-off valves shall be provided for each flexible product line at the base of the cargo transfer equipment or near the approach to the pier or dock to stop the flow in the event of rupture. These may include pressure-actuated valves that close automatically in the event of a leak.

Loading arms and hoses shall be designed and tested periodically in accordance with OCIMF *Design and Construction Specification for Marine Loading Areas* and U.S. Coast Guard (USCG) requirements (33 CFR 156). Test pressure is typically 125% of the maximum operating system pressure. Records of the tests shall be maintained.

11.5.3 Control Systems

The control systems that are used in the design of marine loading and unloading facilities are similar to those used in truck loading and unloading systems. See 11.3 for reference.

Emergency shutdown procedures and notifications shall be in accordance with the applicable U.S. Coast Guard Regulations. Adequate lighting shall be provided for both low-level area lighting and work level lighting in equipment and loading areas (see 13.2.2).

11.5.3.1 Grounding and Bonding

Barges and marine vessels are inherently grounded as they sit in water. For additional information on grounding and bonding of tank ships and barges, refer to API RP 2003. The use of insulated flanges on pipe connections for loading/unloading hoses should be considered to reduce the chance of an arc when hoses are disconnected. Insulated flanges should be installed if excessive stray currents are present or if shore based piping is cathodically protected. Bonding and grounding connections of all pipelines shall be on the wharf side of insulating flanges.

11.5.3.2 Overfill Protection

For overfill protection of marine vessels and barges, refer to API RP 1125.

11.5.3.3 Fire Prevention and Protection

Refer to NFPA 30 for fire protection of marine vessel and barge facilities.

11.5.3.4 Metering and Flow Control

Metering and flow control for tank ship and barge loading and unloading is similar to truck loading and unloading (see 11.3.4.4, API RP 2003, and API RP 1125).

11.5.4 Additive Injection Facilities

Additive injection during marine transfers will incorporate equipment for injection and storage. Many of the same procedures and practices applicable to truck loading rack additive injection are valid in marine transfers. See 11.3.5 for further information.

11.5.5 Dredging

Periodic soundings should be conducted to verify adequate water depth for the vessels that use or could use the dock. Dredging shall be conducted as required. All dredging and disposal shall comply with the applicable requirements of the authority having jurisdiction, such as the Army Corps of Engineers (Section 404 dredging permitting), state port authority, or EPA.

11.6 AVIATION LOADING/UNLOADING

11.6.1 Spill Containment

Adequate spill containment shall be incorporated into the drainage design to contain and control a spill from accidental overfill, equipment failure, or malfunction. Refer to truck loading spill containment (see 11.3.1) and NFPA 415.

11.6.2 Loading External Weather Cover

Refer to truck loading rack external weather cover (see 11.3.2).

11.6.3 Loading Arms, Hoses, and Meters

Refer to truck loading arm, hoses, and meters (see 11.3.3 and API Std 1529). Filters/separators information can be found in API Publ 1581.

11.6.4 Control and Safety Systems

Refer to the truck loading rack control and safety system (see 11.3.4).

11.6.5 Fire Prevention and Protection

Refer to Section 5 of this standard, NFPA 30, NFPA 403 and NFPA 407.

11.6.6 Additive Injection Facilities

See 11.3.5 if additives are required to be injected into the fuel.

11.7 VAPOR CONTROL

Vapor-control requirements are governed by EPA, state, and local air quality agencies. Requirements vary greatly from one region to another within the United States. Consultation with applicable agencies is advisable before design, construction, and operation of new vapor-control systems, vapor combustion units, or modifications to existing systems (see 5.3.1).

VOC and HAP emissions may be generated when tanks, tank trucks, rail tank cars, and marine vessels are filled with petroleum and petroleum products. Existing vapors that may be in the containment space at the time of loading are displaced as well as any vapors created by the material being loaded. Technologies for recovering or incinerating these emissions during loading operations are reviewed in 11.7.1.4. Extensive guidance is available in API RP 1124 and API Publ 2557 and in API Std 2015 and API RP 2016 for vapor control during tank cleaning.

11.7.1 Tank Truck Vapor Control

Where required by regulation during tank truck loading, displaced gasoline vapors should be collected and absorbed, condensed or thermally oxidized, as appropriate (see 11.7.1.4). If the facility tankage is equipped with vapor control, returning vapors to tankage should be considered. If switch loading (see 11.3.4.4) has occurred, trucks loading fuel oil may also emit gasoline vapors that should be processed where required. In the event the vapor-control unit shuts down or is not operating properly, procedures should be provided to shut down the loading facilities unless authorization to continue operations has been given by the regulatory authority having jurisdiction. Connections to the vapor-recovery system shall be designed to prevent the escape of vapor to the atmosphere when not connected to a vehicle. A pressure test may be used to determine whether tank trucks are leak tight.

Tank truck unloading operations discussed in this standard apply to product deliveries from trucks into aboveground storage tanks. Tank truck unloading operations for deliveries to underground storage tanks is covered in API RP 1615 and NFPA 30.

11.7.1.1 Submerged Filling

All loading operations should be performed using submerged filling. Submerged filling is the introduction of liquid into the tank truck below the liquid level. Submerged filling minimizes droplet entrainment, evaporation, turbulence, and static electricity generation.

Submerged filling is accomplished when top loading, by lowering the fill tube until it is just off of the bottom of the tank and filling slowly until the fill tube is submerged. In bottom loading, the fill is started slowly until the product covers the area where a fixed fill pipe enters the tank truck from the bottom. Bottom loading is the preferred method. The automatic loading rates should be slow until the filling nozzles are submerged. When bottom loading, the coupler between the liquid loading hose and the truck shall be a dry break disconnect.

Flammable atmospheres in tank compartments may result from the vapor pressure of the material being handled. As the tank atmosphere passes through the flammable range, the vapor is vulnerable to a static related ignition unless the loading is performed at a flow rate that will minimize the generation of a static charge and sufficient relaxation time has been provided downstream of any static generators such as filters (see API 2003 for more information). When top loading Class I and II liquids, the loading tube shall be close to the bottom of the tank compartment and product shall be loaded at a slow rate until the outlet is submerged. When bottom loading Class I and Class II liquids, automatic set-stop controls with low flow start capabilities and splash deflectors should be provided to prevent splashing, minimize turbulence, and reduce the potential for static build-up. Switch loading operations occur when a low-vapor pressure product is loaded into a compartment that contains a flammable vapor atmosphere that may be at or above the lower flammable limit (from previous use of the tank). Procedures and precautions that should be followed when switch loading are described in API RP 2003 and NFPA 30.

11.7.1.2 Rail Tank Car Vapor Control

Collection of vapors during rail tank car transfer is similar to truck tank transfers (see 11.7.1).

11.7.1.3 Marine Vapor Control

Emissions from loading/unloading operations are controlled at the vapor outlet of the vessel compartment or tank being filled.

The use of marine vapor-control systems during loading or ballasting of bulk liquid cargo tanks introduces potentially significant hazards different from those at tank truck and rail tank car loading facilities. Regulations governing the safe

design, installation, and operation of marine vapor-control systems include USCG 33 CFR 154 and USCG 46 CFR 39.

The primary hazards associated with the use of marine vapor-control equipment are cargo tank over- or under-pressurization, overfill and spillage, fire, explosion, or detonation.

See API RP 1124 for guidance on vapor collection manifolds.

11.7.1.4 Vapor-processing System

The major types of vapor processing (or degassing) include, but are not limited to, the following: carbon adsorption, refrigeration, thermal oxidation, lean oil absorption, or a combination of such systems.

A vapor-processing system consists of the following basic components:

- A vapor processor (recovery unit or combuster).
- Gasoline supply or return systems for the processor (not applicable to thermal oxidation).
- Vapor-handling lines.
- Vapor-tight tank trucks (rail tank cars or marine vessels/barges) constructed or modified for bottom loading and vapor recovery or top loading and vapor recovery.

It is recommended that the accumulation of vapors within the explosive range be minimized.

11.7.1.5 Vapor-handling Systems

Vapor-handling systems may be regulated at some terminals and bulk plants under SIPs. Refer to appropriate federal, state, and local regulations. A tank truck rack vapor-handling system includes the following components:

- A closed system with no operating vents open to the atmosphere during tank truck loading or unloading, except as necessary to prevent over pressurization of equipment.
- Vapor-tight gasoline tank trucks properly equipped for bottom loading and vapor recovery (or for top loading and vapor recovery).
- Vapor-recovery arms or hoses at each gasoline truck loading station.
- A vapor-collection system from the loading rack and truck unloading station to the gasoline storage tanks or vapor process unit. Check valves shall be installed in truck vapor connection branches at loading racks.
- Vapor-balance connections at the gasoline storage tanks should typically be located at an existing roof nozzle or modified roof manhole cover.

f. A vapor tank may be used as a means to reduce unit cycling and reduce energy consumption of the vapor-control unit(s).

g. Flame arresters or detonation devices should be considered for installation between loading facilities and vapor-control unit(s). For marine vapor recovery, see 11.7.1.3.

11.7.1.6 Inspection and Maintenance

All vapor-control processing equipment shall be subject to periodic maintenance, testing, and inspections. Records of inspections and maintenance should be kept on file at the facility. Periodic testing of vapor return lines should be conducted to verify the tightness of connections.

When flame arresters or detonation arresters are installed in vapor lines, they should be periodically inspected and cleaned if needed to ensure that clogging that could cause elevated pressures and malfunction of the device in an emergency has not occurred.

Pressure/vacuum vents should be inspected periodically and serviced if necessary to ensure the absence of clogging and proper operation.

Other required testing of vapor-control systems, including the VRU or vapor oxidizer, should be conducted in accordance with the manufacturers' recommendations, facility procedures, and the applicable regulatory requirements.

11.8 OXYGENATE BLENDING

Ethanol, methanol, MTBE, ETBE, and TAME are oxygenates commonly in use today. MSDSs shall be consulted for hazards involved in handling alcohol and other oxygenates. Refer to API RP 1626 and API RP 1627 for guidelines on the storage and handling of ethanol/methanol and other cosolvent products. Refer also to 7.8 for fire protection guidelines.

Alcohols and other oxygenates may be blended into gasoline at truck loading racks sequentially (one component loaded into the truck after the other) or by the inline or ratio methods (all component streams loaded in the proper ratio simultaneously into the truck). With the sequential method, one meter is typically used for all components. A separate meter is used for each component when inline blending.

When oxygenates are blended with gasoline, procedures should be in place to assure that the proper Volume Correction Factors (VCF) for the components or the blend being measured are used.

When blending by the sequential method with one meter, procedures should be in place establishing meter factors for all components if product characteristics or differing flow profiles cause meter factors to vary.

Care should be taken in the design of oxygenate blending systems to ensure equipment compatibility with the oxygenate being handled. Valves, hoses, gaskets, meters, and pumps should be specified to be compatible with the oxygenate to minimize maintenance problems (see 10.2).

11.9 EMERGENCY SHUTDOWN SYSTEMS AND PROCEDURES

Emergency shutdown systems and procedures should be provided at all product transfer facilities. Emergency shutdown systems should be designed, operated, and maintained using good engineering practices and standards for safety instrumented systems such ISA 84.00.01 or other equivalent. Emergency shutdown systems should include clearly marked manual de-activation switches at loading/unloading areas and at remote areas that are accessible during an emergency. When fire protection or vapor-detection systems are activated, they should automatically activate the emergency shutdown system. Periodic inspection and maintenance of alarm and shutdown systems should be conducted by trained personnel in accordance with manufacturer's recommendations or facility policy.

The emergency shutdown system should shutdown all flow and provide a visual or audible indication to personnel in the area as well as supervisory personnel, as appropriate. If the emergency shutdown system automatically deactivates the main circuit breaker for the facility incoming power, consideration should be given to providing emergency backup power for fire protection, gate operation, and lighting for safe evacuation of the area at night (see 13.2.2).

Consideration shall also be given to the orderly shutdown of all systems upon the activation of the emergency shutdown system (see 6.5 and 7.6).

Design of emergency shutdown systems for marine facilities shall be in accordance with USCG 33 CFR 154.

11.10 PRODUCT TESTING

Testing to verify product quality should be conducted in compliance with regulatory, operational, and contractual requirements and may be conducted at the beginning, during, or after a receipt and during or after any product blending operation. For marine transfers, quality testing should be completed before the start of transfer, conducted periodically during transfer, and conducted upon completion of transfer.

11.11 COMMUNICATION

A reliable means of communication or notification shall be provided, such as voice intercoms, alarms, signals, telephones, or approved radios between the truck loading rack, rail tank car, loading facility, or marine vessel dock and with personnel who may respond in the event of an emergency when product transfers are in progress (see 13.2.5). USCG 33 CFR 154 shall be followed in marine terminals.

11.12 MEASUREMENTS

When the transfer involves custody transfer or if the quantity loaded must be known with a high degree of accuracy, measurement of the transfer should be accomplished accord-

ing to all appropriate chapters of the *API Manual of Petroleum Measurements Standards* and applicable weights and measures requirements.

When the metering systems are used for custody transfer, procedures should be established designating the method and any necessary additional facilities or services to prove each custody transfer meter.

11.13 VALVES, LINES, LOADING ARMS, AND HOSE PRODUCT IDENTIFICATION

When more than one product is handled within the facility, the transfer equipment should be adequately marked with product type or so designated that the operator is able to identify the various loading arms, hoses, lines, or valves without having to trace them back to their source or destination (refer to 10.2.11).

11.14 RELEASE PREVENTION SYSTEM IN LOADING/UNLOADING AREAS

In all new construction or major modifications, consideration should be given to the installation of release containment and drainage systems where truck, marine, or rail transfers take place.

11.15 MAINTENANCE/TESTING

Typical maintenance and testing requirements at a facility include, but are not limited to, the following:

- a. Periodic inspection and preventive maintenance should be conducted on all transfer systems to control leaks.
- b. Accurate inventory records may be maintained and periodically reconciled for indication of possible leakage from tanks and piping systems.
- c. Other maintenance to be considered includes, but is not limited to, the inspection and cleaning of strainers and filters, proper adjustment of flow control and shutdown devices, and the maintenance of any other systems required to safely operate the facility.
- d. Marine, rail tank car, and truck loading facilities should be maintained in a neat and orderly manner, and no accumulation of trash or other combustible material shall be permitted except in approved containers.
- e. Hotwork, such as welding, cutting, or use of non-approved tools, in areas where vapors may be present, shall be permitted only under adherence to the facility established hotwork program designed to prevent accidental ignition of petroleum vapors (see 6.4).
- f. Complete maintenance records should be maintained by the operator for all equipment within a terminal.

Note: Non-motorized hand tools under normal use do not produce incendive sparks.

11.16 AUXILIARY SYSTEMS

For pump back and own use fuel systems that are located separate from truck loading racks, similar spill containment, electrical, lighting, and grounding/bonding requirements should be considered (see 11.3). Own use dispenser facilities shall comply with the requirements of NFPA 30 or other applicable regulatory agencies.

12 Corrosion Control

12.1 SCOPE

This section covers the information, procedures, and practices for achieving effective corrosion control for terminal and tank facilities in hydrocarbon service. This section contains provisions for the application of cathodic protection, coatings, and linings to existing and new storage tanks and other terminal facilities and structures. Detailed designs and specifications are not provided. Persons knowledgeable in corrosion control practices and in accordance with applicable codes and regulations should develop such designs. This section does not designate specific practices for specific situations, as varied conditions preclude standardization of such practices.

This section addresses three separate areas of corrosion: protective coatings (see 12.2), interior tank lining (see 12.3), and cathodic protection (12.4). Other corrosion control requirements, including, but not limited to, the use of nonmetallic materials and the problems of bi-metallic corrosion are not addressed. A thorough discussion of corrosion mechanisms may be found in various publications including the following: API RP 651, API RP 652, and API RP 1631, NACE RP 0169, and ASM International's *Metals Handbook*, Volume 13, *Corrosion*.

12.2 PROTECTIVE COATINGS

The use of protective coatings should be evaluated during the design phase of work. Protective coatings are applied to structures for a variety of reasons including, but not limited to the following:

- a. Protection of the structure from corrosion.
- b. Appearance.
- c. Regulatory requirements.
- d. Safety and operating efficiency.

Coatings provide protection to structures through one or more of the following processes:

- a. Prevent contact between structure and environment.
- b. Limit contact between structure and environment.
- c. Release inhibitors to mitigate corrosion.

- d. Produce a protective or electrolytic current (e.g., zinc rich coatings).
- e. Provide passive nonconductive films to electrically isolate the structure.

12.2.1 New or Complete Re-coat

New construction and total recoating of existing structures requires that the structures be cleaned sufficiently (according to at least the manufacturer's recommendations or better) before the coating system is applied. The coating system should be specified for the particular product and environment to which the structure is exposed. The use of lead and other heavy metal based coatings should be avoided.

12.2.2 Maintenance of Coatings

The facility preventive maintenance program should address the maintenance of coatings. Maintaining coatings will extend the life of the system at costs lower than total removal and recoating. Maintenance may include, but is not limited to, the following: top coating, touch-up, and other means of extending the life and providing protection. Maintenance of coatings is effective only if the existing coating is adherent and in good condition. Coating must be compatible to the product stored in the tank to ensure long life and good performance.

12.2.3 Coating System Evaluations

Evaluations of the coating systems on all structures should be conducted periodically. These evaluations should include the following items:

- a. Coating thickness.
- b. Condition and failure identification.
- c. Existing system type vs. changes in environment or product.
- d. Adhesion.
- e. Severity of any rusting/corrosion.

Evaluations should be performed by a knowledgeable person with experience in coating systems. Evaluations should include a recommendation on what action, if any, needs to be taken to maintain or replace the coating system. The evaluation process should include a prioritization process to rank the structures according to the quality and needs of the coating system and the consequences of coating failure.

12.2.4 Coating Selection

The selection of coating systems may be guided by the following factors:

- a. Environmental and product resistance.
- b. Appearance.
- c. Safety.

- d. Surface preparation requirements.
- e. Application and maintenance requirements.
- f. Substrate to be coated.
- g. Design life.
- h. Accessibility for future repair.
- i. Consequences of coating failure.
- j. Lead and heavy metals content.

12.2.5 Application Procedures

12.2.5.1 Surface Preparation

Surface preparation should be accomplished using the equipment necessary to achieve the desired profile and standard. Surface preparation should be in accordance with the referenced SSPC specifications, and standards. Safe work, entry permits, or hot work permits shall be issued as required by the nature of the work to be done (see 6.4).

12.2.5.1.1 Degreasing

Oil and grease should be removed from all surfaces to be coated or painted before subsequent surface preparation. Solvent cleaning should be done using a scrub and rinse process in accordance with SSPC SP-1.

12.2.5.1.2 Manual Cleaning

Surfaces prepared by manual methods should be cleaned by removing all loose paint, mill scale, rust, dirt, oil, grease, moisture, and other detrimental foreign matter by scraping, chipping, sanding, needle guns, wire brushing, or power buffing in accordance with SSPC SP-1, SP-2, and SP-3.

12.2.5.1.3 Blasting Specifications

All tags, labels, tank name plates, glass covers, pilot lights, fire equipment, fusible links on fire-safety valves, fire-system detectors, swivels, meter heads, valves with open stems and stem housings, rubber seals, pressure-vacuum vents, printer drives, motors, pumps, or other delicate equipment, should be completely covered at all times while blasting is in progress to protect against both direct blast and media entry. Other non-paint surfaces, such as aluminum, brick, tile, insulation, and transite should be covered as well. Blast finishes include the following:

- a. Brush-off blast cleaning—This specification is further expressed and qualified by the SSPC SP-7. Visual appearance of the surface may be that indicated for NACE No. 4/SSPC-SP 7.
- b. Commercial-blast cleaning—This specification is further expressed and qualified by the SSPC SP-6. Visual appearance of the surface may be that indicated for NACE No. 3/SSPC-SP 6.
- c. Near-white blast cleaning—This specification is further expressed and qualified by the SSPC SP-10. Visual appear-

ance of the surface may be that indicated for NACE No. 2/SSPC-SP-10.

d. White-blast cleaning—This specification is further expressed and qualified by the SSPC SP-5. Visual appearance of the surface may be that indicated for NACE No. 1/SSPC-SP 5.

Blasting is to be performed only with approved (silica free) blasting grit or other approved material. Blast cleaning shall be conducted in accordance with the requirements of API RP 2027. Grit and removed materials must be properly collected and removed to an appropriate disposal site.

12.2.5.2 Lead-based Paint Removal

Lead pigment has been a paint component for many years and has been widely used for coating piping and storage tanks. Eventually, lead-based systems become embrittled, lose adhesion, and may need to be removed. Removal of these coatings using conventional methods (hand tool, power tool, and blasting) creates friable dust that may be respirable and pose a health hazard to exposed persons. Consequently, lead-based paint removal must be performed in accordance with applicable regulations, including OSHA 29 CFR 1926.62, API RP 2027, and proper safe work procedures. Alternative methods, such as chemical paint strippers and frozen carbon-dioxide blasting may be useful in removing lead-based paint systems. All hazardous blast media and lead-paint waste must be properly controlled, collected, stored, and disposed according to the applicable hazardous waste regulations. Refer to 6.4 for appropriate safety procedures.

All unknown existing coating systems should be tested (and any lead-based paint systems found should be identified) before any coating removal is performed in the facility.

Encapsulation of the existing lead-paint system may be an appropriate alternative method. This is accomplished by removing only the defective coating and then applying suitable topcoats to the structure.

12.2.5.3 Coat Application

Coating should begin as soon as the surfaces are properly prepared and before formation of any form of corrosion or contamination from atmospheric moisture. Should the prepared surface become dirty or rusty before the first primer coat is applied, the surface should be re-cleaned to the degree initially specified. Additional information may be found in the SSPC *Steel Structures Painting Manual*, Volumes 1 and 2.

Typical coating application techniques include brush, roller, and spray.

12.2.6 Quality Control

All work performed should be subject to inspection by the owner's representative. It is recommended that a third-party NACE-certified coating inspector be employed on any major

coating projects in order to control the conditions and coating application, which experience has shown to be highly valuable for the long term integrity of the coating system. Any deficient equipment, materials, or techniques should be noted and corrected. Defective coating work or work not conforming to the specifications should be redone. Items that should be included in a quality assurance program include the following:

- a. Pre-surface inspection.
- b. Ambient conditions monitoring.
- c. Surface preparation equipment evaluation.
- d. Surface preparation monitoring.
- e. Witnessing coating mixing and application.
- f. Inspection of coating equipment and techniques.
- g. Wet and dry film thickness checks.
- h. Evaluation of cleanliness between coats.
- i. Holiday testing.
- j. Cure and adhesion testing.

12.2.7 Safety

All work must be performed in compliance with existing governmental safety and occupational health regulations, such as respiratory protection requirements in 29 CFR 1910.134 and 29 CFR 1926 and air pollution requirements. Blast cleaning and grinding shall be considered hot work and will require appropriate permits.

12.2.8 Tanks

The following items should be considered before performance of work on tanks:

- a. Depending upon the level of the roof, and the facility's confined space classification system, the area on top of open floating roofs may be considered a permit-required confined space area and shall be addressed accordingly (see 6.2 and 6.4, API Std 2015, and API Publ 2026).
- b. A fall prevention policy requiring the use of appropriate fall hazard abatement system during elevated work activity shall be developed and implemented where applicable (see 6.2, 6.10, OSHA 29 CFR 1910.36, 66, and OSHA 29 CFR 1926, Subpart M).
- c. All floating-roof pontoons and areas between the primary and secondary seals shall be checked and monitored with a combustible gas indicator. If a flammable vapor-air mixture is found, corrective action shall be taken to provide a safe work area (refer to 6.4, 7.2 and API Std 2015).
- d. No blasting or air powered cleaning shall be done on a floating roof unless the vents, pontoons, and the rim seals are in good condition and protected from the effects of the blast (see API RP 2027).
- e. Due to the filling, emptying, or agitation of product in the floating-roof type tank, all coating operations shall be coordinated with the owner before the work starts. No blasting or coating involving hotwork shall be allowed when the tank is

being filled and for a sufficient period after being filled to minimize potential exposure to vapors (see 7.2). Environmental conditions shall be monitored throughout the blasting and coating operation. The potential for vapor emissions from other tanks in the same or adjacent dikes should be considered. Blasting or use of coating involving hotwork shall not be permitted when tanks in the same or adjacent dike areas are receiving flammable liquids and vapors are released to the atmosphere.

- f. The blasting equipment, including the nozzle, shall be electrically bonded to the tank. Blasting nozzles shall be equipped with a dead man switch (see API RP 2027).
- g. No blast media should be allowed on an IFR. Any media that does collect on the roof should be removed (see API RP 2027). Roof openings covered for blasting or painting should be uncovered at the end of the day or during any cooling to prevent vacuum in the tank.
- h. All roof openings should be protected to prevent entry of blast media into tank interior during any cleaning operations (see API RP 2027).
- i. The external floating-roof drain should be checked to ensure that it is open after all work (blast cleaning and other) has been completed.

12.2.9 Loading Rack Area

The loading rack area contains items that are sensitive and must be treated with caution. In particular, the meters, electrical equipment, and any fire-detection and fire protection (nozzles) equipment should be protected during cleaning and coating application. Surface preparation techniques must be selected that address potential hazards and safety requirements of this area (see 6.4 and 11.3).

12.2.10 Piping

Piping should be protected from corrosion attack with coatings that are suitable for the environment and piping service. Buried piping should also be cathodically protected (see 12.4).

The atmosphere-to-soil interface may require additional attention due to the corrosion cell formed at this location. All coatings in this area should be properly applied according to manufacturers specifications and inspected periodically to ensure there is no disbondment, shielding, or water entrapment. The coating should extend at least 6 in. (15 cm) above the ground level to overlap the existing coating below grade or a minimum of 12 in. (30 cm) below grade. The coating must adhere well to the pipe.

The interface area between pipe supports and the underlying pipe may require additional attention due to the potential for corrosion at these areas. The pipe should be painted before installing the pipe support. In addition, non-metallic

(i.e., fiberglass) pads or coatings can also be used in the interface area to prevent corrosion.

12.2.11 API Color Code

The use of API product color code (API RP 1637) for identifying the product flowing through lines or valves should be considered for petroleum terminals (see 11.13).

12.3 INTERNAL TANK LINING

The use of internal tank linings should be evaluated during the design and maintenance of tanks. Steel storage tanks are often lined to prevent failure due to internal corrosion attack and compatibility with product stored in the tank. For tanks in petroleum service, the complete interior of underground storage tanks is usually lined while typically only the floor and a small portion of the adjacent shell surface of above-ground storage tanks are lined. For additional information, see API RP 652.

The decision to line a tank interior should include the following considerations:

- a. Corrosion prevention.
- b. Ease of tank-cleaning operations.
- c. Reduction of tank-cleaning waste generated.
- d. Tank design and operation.
- e. Tank condition and history.
- f. Product stored; corrosivity or purity requirements.
- g. Environmental considerations.
- h. Service change.
- i. Upset conditions.
- j. Federal, state, and local regulations.
- k. Affect on the performance of future tank-bottom inspections.

12.3.1 Lining Selection

12.3.1.1 Linings for tanks in petroleum service are normally divided into three classes:

- a. Thin-film Linings—Thin-film linings are classified as a lining less than 20 mils (0.051 mm). These linings are usually applied to new tanks and to tanks with minimal corrosion. Coal tar epoxy and epoxy phenolics are two common examples of thin-film linings.
- b. High-build Film Linings—High-build film linings are greater than 20 mils (0.051 mm) thick. These systems may be used on new tanks as well as older tanks with more extensive corrosion. Polyurethanes, and vinyl-ester coatings are common examples of high-build film linings.
- c. Reinforced Linings—Reinforced linings are usually high-build epoxy or polyester resin linings with the addition of fiberglass mat, glass flake, or chopped glass to provide additional strength.

12.3.1.2 The selection of which lining system to install should include the following considerations:

- a. Intended services of the tank. The lining must be compatible and resistant to chemical attack by the stored commodity.
- b. The severity of any corrosion attack (particularly, pitting corrosion).
- c. Anticipation and extent of tank bottom flexing.
- d. Resistance of lining to water and product.
- e. Resistance to scraping action of metallic shoe seals.

12.3.2 Tank Entry

Most tank lining applications and surface preparation are performed in a confined space and require safety precautions for permit required confined space entry and hotwork. See 6.4, OSHA 29 CFR 1910.146, API Std 2015, and API RP 2016 for additional guidance.

12.3.3 Tank Repairs

All repairs to tanks should be completed and inspected per the guidelines of API Std 653 before the lining is applied (see 6.1). This process includes repairing all holes or large pits in floor or shell, modifications to tank, and weld repair. This procedure will reduce the chances for mechanical damage to the newly installed lining.

12.3.4 Surface Preparation

Proper surface preparation is critical to ensure satisfactory adhesion and lining performance. Continuous immersion is considered to be severe service for protective coatings. Surface preparation provides for a clean surface with the proper profile or anchor pattern to enable good chemical and mechanical adhesion to the structure. Usually, abrasive blast cleaning to at least a minimum of a near white metal finish (SSPC SP-10 or SSPC SP-5) is required. All burrs, sharp edges, and weld spatter should be ground out to prevent thinning or pinholes in the lining.

12.3.5 Dehumidification

Dehumidification equipment may be used to reduce and control the humidity level inside the tank before and during coating application. The humidity should be at the level recommended by the coating manufacturer to ensure a good, clean, rust-free surface and an adequate cure. The use of such equipment may help ensure that the desired blast cleaning standard is maintained.

12.3.6 Application

The coating material should be mixed, applied, and cured in accordance with the manufacturer's recommendations. Adhesion, film integrity, and performance may be adversely affected if the coating is applied incorrectly. Workers should

be trained and qualified in coating application, confined space entry, and potential health hazards, and should be provided with and trained in the use of appropriate personal protective equipment (see 6.4 and 6.7).

12.3.7 Quality Control

Only qualified inspectors who have a thorough understanding of lining practices should be used. Each step of the process should be inspected, deficiencies noted, and repairs made before proceeding to the next step. Particular attention should be paid to surface preparation, material mixing, film thickness, adhesion, application temperature, hardness, and discontinuities. See 12.2.6 and API RP 1631 for additional information.

12.4 CATHODIC PROTECTION

Metallic structures, such as buried piping, tank bottoms, and containment walls (sheet piling) in contact with moisture in the soil are subject to localized or general corrosion. One way to prevent this corrosion is to force current from an external source onto the structure to be protected to counter or overcome any corrosion activity on its surface. The application of direct current electricity from an external source, an anode, onto the protected structure is called cathodic protection. Design, testing, installation, and maintenance of cathodic protection systems should be done by a person knowledgeable in the processes of corrosion control. Cathodic protection (CP) has been successfully applied for many years to mitigate corrosion of buried or submerged metallic structures including piping, cables, and tank bottoms (external); and in some cases, to protect the interiors of tanks containing conductive electrolytes. Anodes have also been installed between tank bottoms and detection/containment liners to prevent corrosion of the tank bottom. See API RP 651, API RP 1631, and NFPA 30 for additional information. The selection of cathodic protection systems should be based upon the design objectives, maintenance, operating costs, and appropriate regulatory requirements.

12.4.1 System Types

There are two fundamental methods of applying cathodic protection: (a) galvanic systems and (b) impressed current systems.

12.4.1.1 Galvanic Systems

Galvanic systems use metals that are more electronegative than the structure to be protected, to naturally produce the protective current. The anodes connected directly to the protected structure are consumed or sacrificed and replaced periodically. Metals commonly used as galvanic or "sacrificial" anodes are magnesium, aluminum, and zinc in ribbon or cast forms. The anodes are generally buried around or under the

structure in the same electrolyte. Galvanic anode systems have limited capacity and are generally restricted to low current density requirements typical of well-coated pipelines or small surface area applications.

12.4.1.2 Impressed Current Systems

Impressed current systems have external power sources to force current from the anode to the structure. Impressed current systems employ a rectifier that converts AC to DC and provides the desired voltage that forces the protective current to flow from the anode through the soil or electrolyte onto the structure. Improper installation could result in reversal of the direction of current flow and result in rapid corrosion of the structure.

12.4.2 Design Objectives

The major objectives of a cathodic protection system design should include the following:

- a. Protect tank bottoms and piping in contact with the soil.
- b. Minimize stray current effects.
- c. Provide flexibility and capacity so that facility changes may be accommodated.
- d. Install rectifiers and anodes to minimize effects on operations and maintenance.
- e. Provide monitoring of system and protection performance.

12.4.3 Design Considerations

The following items should be considered during the design of a cathodic protection system:

- a. Current and voltage requirements.
- b. Soil/electrolyte resistivity.
- c. Environment temperatures.
- d. Impervious tank dike or other containment liners.
- e. Foreign structures.
- f. Water table.
- g. Coatings used.
- h. Isolation from the electrical grounding system.
- i. Influence of adjacent cathodic protection systems.

12.4.4 Cathodic Protection Criteria

The criteria for determining the effectiveness of the cathodic protection systems are detailed in NACE RP 0169, RP 0285, and RP 0193 and API RP 651. The most commonly used cathodic protection criteria for terminal facilities are the following:

- a. –850 millivolt (mV) potential with system energized and voltage drops other than those across the structure-to-electrolyte boundary considered.
- b. 100 mV polarization or depolarization after interruption.

c. –850 mV polarized potential with system momentarily interrupted.

(These potential measurements are made between the structure and a saturated copper-copper sulfate reference electrode contacting soil adjacent to the tank or piping.)

12.4.5 Maintenance and Records

The performance of cathodic protection systems should be periodically monitored by qualified persons for attainment of CP criteria, properly functioning equipment, and to ensure that the appropriate level of CP is applied to control corrosion.

The design, installation, operation, maintenance, and effectiveness of the cathodic protection system should be properly documented by drawings and record keeping. These documents are often required by regulatory agencies to provide evidence of proper operation and maintenance of the system. Typical documentation would include potential measurements, effectiveness of isolating devices, and rectifier operation. The documentation should be retained as long as required by applicable regulations or for as long as the system is in service.

12.4.6 Safety

The installation and operation of a cathodic protection system (particularly an impressed current system) requires special safety considerations including the following items:

- a. Excavation should be done carefully to ensure that cathodic protection anodes or cables are not damaged. Where cables are damaged, waterproof splice kits should be used to reconnect the severed cables.
- b. If piping components such as valves or piping spools are to be removed in an impressed current cathodic protection system, the following safety procedure should be performed (see API RP 2003) in accordance with lockout/tagout (LOTO) procedures:
 1. Turn off and lock out the cathodic protection system.
 2. Connect a bond wire between the tank and beyond the valve or line to be removed to prevent arcing.
 3. Disconnect equipment to be removed and replaced.
 4. Remove bond wire and turn on cathodic protection system.

13 Structures, Utilities, and Yard

13.1 STRUCTURES

The requirements for the design of new structures and alterations or additions to existing structures, such as administrative buildings, office facilities, warehouses, and garages, are listed in the applicable codes and standards referenced herein or other applicable local regulations.

13.1.1 Building Codes and Standards

All structures shall be constructed in accordance with the applicable building codes and standards. The requirements for the design of buildings are listed in the NFPA 5000, the *BOCA National Building Code (NBC)*, the *ICC International Building Code* and the *Uniform Building Code*, the SBCCI *Standard Building Code (SBC)*, ACI 318, AISC 335, and other locally recognized codes and standards. The requirements for the means of egress and other construction features are found in the above building codes and NFPA 101.

13.1.2 Fire Safety Codes and Standards

All occupancies shall adhere to the applicable fire and life safety codes. The requirements for general fire safety are listed in NFPA 1 *Uniform Fire Code*, *BOCA National Fire Code*, the *ICC International Fire Code*, SBCCI *Standard Fire Protection Code (SFPC)*, NFPA 30, NFPA 101, NFPA 111, OSHA 29 CFR 1910 Subpart L, or other applicable local statutes. See Section 5 for fire protection.

13.1.3 Safety Regulations

All structures shall comply with occupational safety and health codes and standards. The requirements for the design of new facilities and modification to existing facilities are listed in 29 CFR 1910.119 and 29 CFR 1926.64 or other applicable state/local safety regulations.

13.1.4 ADA Regulations

The applicable requirements for the design of new facilities and alterations or additions to existing facilities as defined by the Americans with Disabilities Act (ADA) are listed in DOJ 28 CFR 36.

13.2 UTILITIES

13.2.1 General

The design and layout of terminal and tank facilities should include a comprehensive plan for the utility service systems required for the facility operation. These systems may include, but are not limited to, the following:

- a. Electrical.
- b. Storm and sanitary sewers.
- c. Potable water.
- d. Water for fire fighting.
- e. Steam.
- f. Air.

- g. Natural gas.
- h. Communications.

13.2.2 Electrical Systems

Electrical systems should be designed in accordance with API RP 540, or other applicable codes and should comply with the appropriate electrical area classifications. Area classification drawings should be prepared and maintained for the facility. The requirements for the design and installation of electrical systems and lighting are listed in NFPA 30, NFPA 70, API RP 500, API RP 2003, and 29 CFR 1910, Subpart S. The following is a list of typical electrical systems that should be provided at terminal facilities:

- a. Electrical Power Service and Distribution System: Figure 1 portrays in single-line form a typical electrical service distribution system applicable to terminal facilities. Some general design guidelines are as follows:
 1. A three-phase grounded neutral service is recommended.
 2. Service conductors and feeders to motor control centers and motor starter racks should be sized initially for future load increases. For example, an allowance of 25% – 50% may be considered.
 3. The service disconnecting means should be either a three-pole circuit breaker or fused switch. Ground fault protection should be provided.
 4. Depending on the size and configuration of the facility, consideration should be given to installing the metering cabinet, main service disconnect, main panel board, lighting transformer and panel board, and (where feasible) combination motor starters as factory-assembled coordinated packages.
- b. Emergency Shutdown System: Such systems, typically consisting of push buttons, relays, alarm lights, and horn, should be designed to shut down all supply pumps to a loading area, such as the tank truck loading rack, tank car loading rack, or the marine-loading location. In addition, the following functions should be performed as applicable:
 1. Close all automatically controlled valves in supply lines.
 2. Close all solenoid-operated valves at the loading rack.
 3. Shut down incinerator for vapor-disposal system.
 4. Open all motor-operated terminal entrance and exit gates.
 5. Sound alarm and notifications to pipeline, facility personnel and where required, emergency response services.

See 11.9 for additional information.

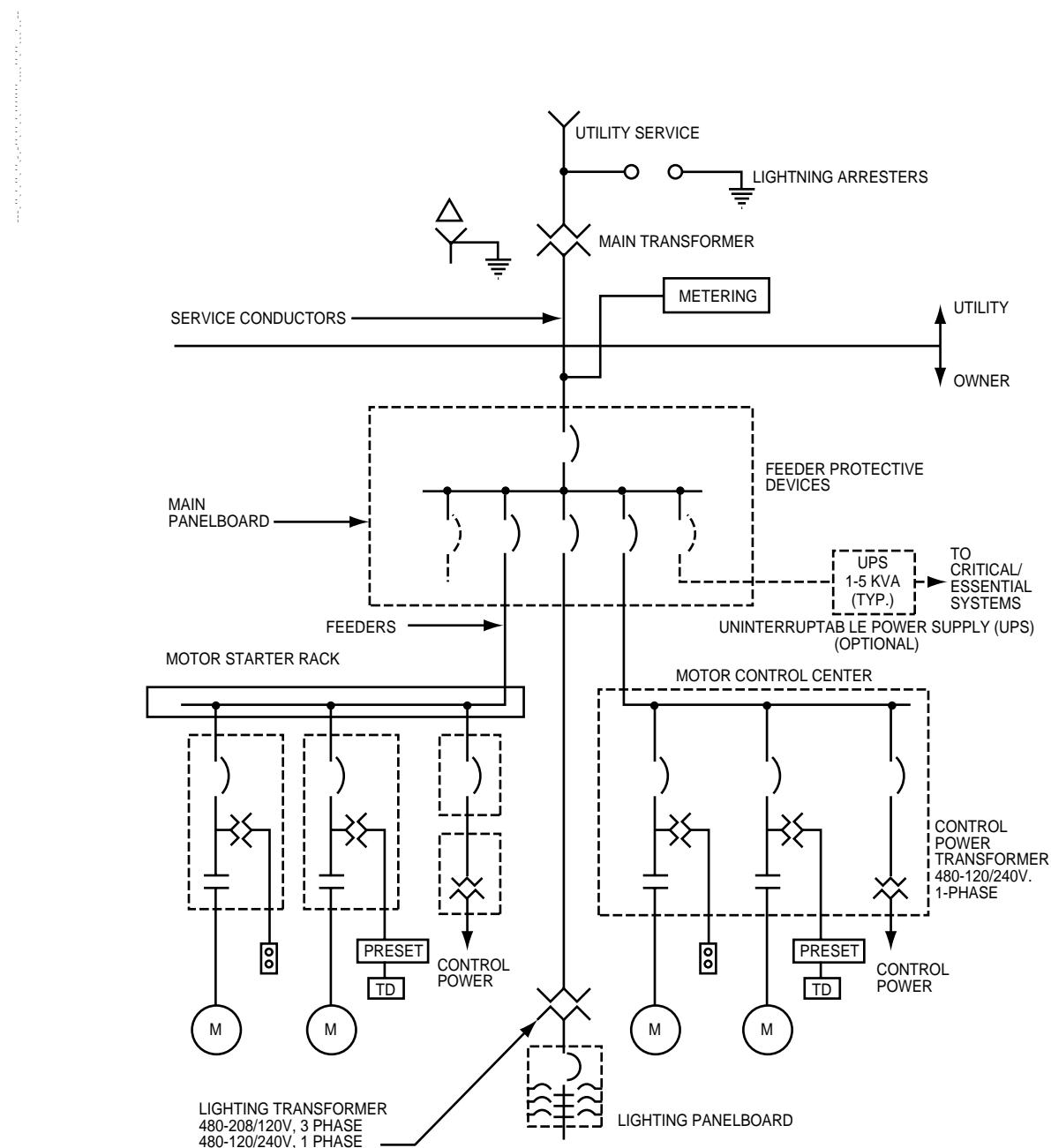


Figure 1—Typical Electric Service and Distribution System Terminals and Bulk Plants

- c. Tank Trucks, Tank Car, or Marine Vessel Loading Electrical Systems.
- d. Provide the following as applicable:
 - 1. Start-stop control of loading pump motors.
 - 2. Grounding and bonding of loading racks and tank trucks, bonding of loading lines, and stray current protection for loading spur railroad tracks.
 - 3. Loading control and metering system.
 - 4. Tank truck high level shut-off system.
 - 5. Card lock or Key lock System—These are typically provided at truck loading installations to provide security and data acquisition capability. Coded cards or keys are used for access to and control of terminal functions.
- e. Vapor-collection and Disposal System—Provide for main power, control power, annunciator, and emergency shutdown.
- f. High-level Tank Alarms—Provide as required by NFPA 30 and as described in API RP 2350.
- g. Auxiliary Facility Systems—Provide electrical service for own-use fueling, pump back, meter prover, and truck engine heaters. The service should include pump controls, interlocks, and disconnects as required.
- h. Lighting—Sufficient lighting and proper electrical classification should be provided for loading racks, yard and tank farm areas, gate card reader, own-use fueling, pump back and meter prover facilities, loading pumps, motor starter racks, office, garage and warehouse lighting. Additional sources of information on this subject are the *IES Lighting Handbook* and OSHA 29 CFR 1910.56. The following general guidelines also apply:
 - 1. Illumination of outdoor areas may be achieved with various types of high-intensity discharge lamps, such as mercury vapor or high-pressure sodium lighting. Generally, high-pressure sodium lighting is recommended because it provides high lumen output per watt.
 - 2. Application of mercury vapor and high-pressure sodium lamps at low temperatures should be referred to the manufacturer for special consideration.
 - 3. On energizing high-intensity discharge lamps, such as mercury vapor and high-pressure sodium lamps, require time to reach full lumen output. Areas that require immediate return of lighting after power dips or outages should be provided with interspersed incandescent lighting fixtures. The use of instant re-strike lighting eliminates the need for interspersed incandescent lights.
 - 4. Photoelectric cell control should be considered where automatic switching of yard and rack lighting is required.
 - 5. Lighting fixtures installed in Class I, Division 1 and 2, Group D locations should conform to the requirements of NFPA 30 and NFPA 70.
 - 6. Explosion proof lighting installed in Class I locations should be maintained in good condition.

See 11.2 and 13.3 for additional information.

- i. Motor Starters and Motors—Motor starters should have a circuit breaker, a temperature-compensated overload relay, and

except where a common control power transformer has been approved, a fused control power transformer. The control power transformer should be sized to supply the additional burden of control relays, indicating lamps, or solenoids that may be connected in the control system. Motors, in general, should be supplied with totally enclosed, fan-cooled (TEFC) enclosures. Explosion proof motors are required if they are installed in Class I, Division 1 locations. Motors should comply with the requirements of NFPA 70 and API RP 500.

- j. Conduit and Wiring—The following guidelines should be considered for the design and installation of conduit and wiring:

- 1. Above grade conduit should be rigid aluminum or galvanized steel. Below grade conduit should be rigid galvanized steel.
- 2. Conduit may be routed above grade on pipe ways, sleepers, or other structures. In the absence of structural supports, conduits should be installed below grade. To minimize corrosion, below grade conduits should be completely covered with a corrosion protective coating (see 12.2). Where additional mechanical protection is required for safety, a red concrete slab (or block) should be installed over the conduit runs. Alternatively, the conduits may be encased in concrete.
- 3. Wire and cable should be supplied with copper conductors.
- 4. In Class I, Division 2 and all non-classified outdoor locations, conduit connections to motors, valves, set stops, and other equipment that may move or vibrate should be made with flexible conduit that meets the requirements of the electrical classification.
- 5. All conductors should be identified.
- 6. Where required, fire protected cable/conduit shall be used.

- k. Terminal Automation Systems—Consideration should be given to providing a computer-based system that includes the following typical functions:

- 1. Records and reports product transfer volume information based on meter and user coded inputs, usually at locations with truck loading racks.
- 2. Receives and transmits accounting information (pricing and product inventories) between the terminal and a central office.
- 3. Monitors and records terminal access and egress information based on gate security inputs, such as card lock or key lock systems.
- 4. Where equipped, monitors tank inventory and pipeline receipts.
- 1. Uninterruptible Power Supply (UPS)—Consideration should be given to providing a UPS system for terminal automation systems, computers used to control loading systems, and other systems that warrant a back-up power supply.

13.2.3 Wastewater Collection and Treatment Systems

The design of wastewater collection and treatment systems for a petroleum terminal facility should be based on the segregation of contaminated sources of wastewater from non-contaminated sources and the elimination or minimizing of effluent discharge to adjacent property and waterways. This design procedure will reduce treatment cost and protect water quality. For further information, also see API Publ 4602.

Where required, separate systems should be provided for sanitary sewer, for non-contact storm water, and for petroleum contact wastewater including contact storm water. Further segregation may be appropriate based on contaminant concentration or stream source.

Existing facilities may have only two separate systems: one for sanitary waste and a combined system for non-contact storm water and petroleum contact wastewater. In some cases, a facility may be permitted to discharge a portion of its waste-

water to a POTW rather than to a surface receiving water under the NPDES permits.

Refer to Figure 2 for a simplified flow diagram for a typical terminal showing segregated wastewater streams.

The following guidelines should be considered in the design of wastewater collection and treatment systems.

13.2.3.1 Sanitary Wastewater System

a. The sanitary system includes waste from all toilets, showers, and washbasins. Sanitary waste should be discharged to the local municipal sewer system. Where municipal sewers are not available, sanitary waste should be discharged to an on site treatment/disposal system, such as a septic system or a package treatment unit.

b. The size of the sanitary system is governed by the total number of people normally using the facility. Per capita use of water is usually 50 U.S. gal/d (0.19 m³/d). For certain types of occupancy, local authorities may specify minimum quantities per person.

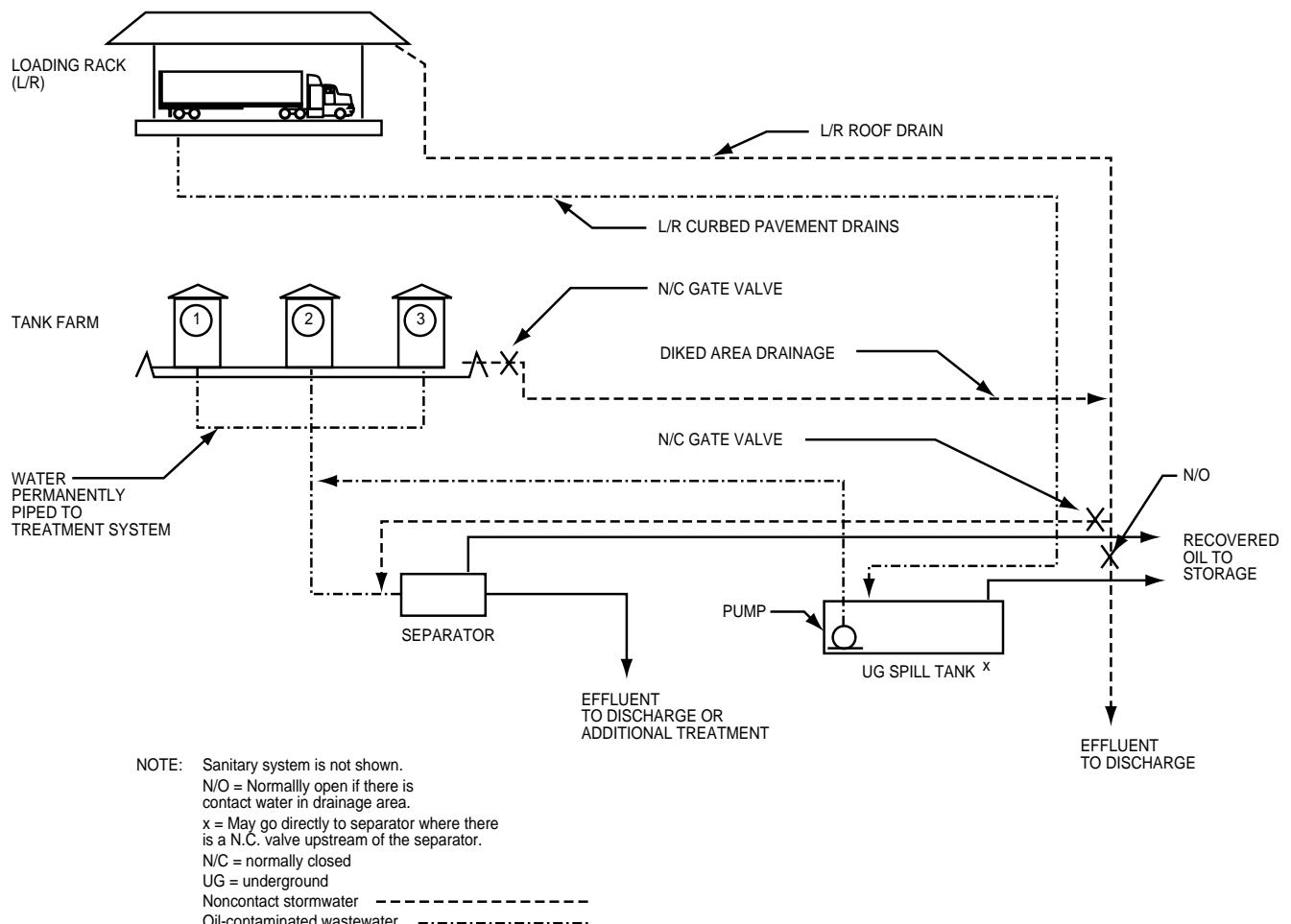


Figure 2—Segregated Waste Stream in a Typical Terminal

c. Where public sanitary sewers are not available, septic systems are the preferred design. Designs of septic systems should be developed per local code requirements and approved by local Public Health Authorities, where applicable.

d. Where soil conditions do not permit discharge of effluent to a leaching field, or where local regulations prohibit septic systems, a package treatment plant should be considered. Small units, available in various capacities, consist of an equalization section, an aeration section in which aerobic bacterial action is maintained by mechanical agitation or diffuser aerators, a settling section, and a disinfection section. An aboveground steel unit is the recommended design.

13.2.3.2 Non-contact Storm Water System

a. The non-contact storm water system includes storm water runoff from non-oily areas, such as building roofs, loading rack roofs, sidewalks, roadways, uncontaminated yard parking and storage areas, and grassy "green belt" areas. Paved areas at truck loading operations in bulk plant facilities, including storage areas and material handling areas where drips and spills may occur, should not be considered "clean" yard parking.

b. Non-contact storm water should be monitored and if satisfactory, discharged directly to a municipal storm water sewer system or natural drainage area, such as an available waterway, provided that any applicable NPDES or other local regulatory specifications are met.

c. Where tank dike areas are determined to be clean, treatment of the dike area storm water may not be necessary depending on local regulations. Before storm water drainage, diked areas should be visually inspected for contaminants. A means of diverting storm water to the oil-contaminated wastewater system should be provided.

d. Factors affecting the design of an adequate storm water system at a specific location include facility layout, applicable governmental regulations, local rainfall, and topography. Refer to 5.3.2 for discussion of items affecting non-contact storm water systems.

e. The rate at which storm water enters the system depends on storm intensity, area drained, topography, type of surface, and time of concentration. The time of concentration is the time required for storm water to flow from the farthest point of the catchment area to the treatment system component being sized. The design runoff flow rate entering the sewer should be based on the greater of the 10-year frequency, one-hour duration storm intensity, or designed firewater volumes. Necessary rainfall data may be obtained from the local weather bureau or similar government offices. Storm water impoundment volumes should be based on the 10-year fre-

quency, 24-hour duration storm intensity with consideration for firewater volumes.

13.2.3.3 Petroleum Contact Wastewater System in Petroleum Terminals

Sources of petroleum contact wastewater may include, but are not limited to the following:

- a. Loading areas.
- b. Tank water drawoffs.
- c. Recovered groundwater.
- d. Truck washing.
- e. Drainage from loading rack spill-containment systems.
- f. Other areas: Warehouse and garage washings, drips from curbed pump pads and process equipment, VRU pads, and laboratory wash water.
- g. Diked areas: If water from diked areas is contaminated, it should be discharged into the petroleum contact wastewater system.
- h. Hydrostatic test water.

13.2.3.4 Wastewater Treatment

Treatment of petroleum contact wastewater or both non-contact storm water and petroleum contact wastewater may be necessary depending on local regulatory requirements. See 5.3.2 for further information on wastewater treatment.

13.2.4 Piping Based Utility Systems

13.2.4.1 The design and installation of piping based utility systems, such as potable water, fire water, steam, air, and natural gas should be done in accordance with the applicable piping engineering practices, codes, and standards, including, but not limited to the following:

- a. ASME B31.3.
- b. AWWA C110, C115, C150, C151, C153.
- c. NFPA 24.
- d. NFPA 25.

13.2.4.2 Utility piping should be clearly marked with appropriate colors and identification. In addition, appropriate end fittings should be installed to prevent connection errors.

13.2.5 Communication, Security, and Control Systems

The design of communications, security, and control systems, such as telephone, card locks, security cameras, automated equipment and intercoms, may be performed as part of the services supplied by the vendors of the communications equipment. These systems should be installed so that service is maintained during emergency situations, such as a fire.

13.3 YARD

13.3.1 Yard Functions

13.3.1.1 The yard layout for new facilities should be arranged so that all truck operations may be accomplished in a sequential and efficient manner from the truck entrance to the truck exit. Primary yard functions or requirements to be considered are as follows:

- a. Ingress and egress from the street.
- b. Traffic pattern and adherence to one-way traffic.
- c. Location of the office and garage facilities. (The dispatcher or supervisor's office should have a clear view of the loading rack if not monitored by remote cameras.)
- d. Driver instructions for loading and delivery.
- e. Truck loading.
- f. Recording of loading information.
- g. Driver administrative transactions.
- h. Vehicle staging or vehicle inspection before entering the loading rack.
- i. Vehicle parking during shift changes.
- j. Temporary truck parking while drivers are getting instructions.
- k. Employee, visitor, and contractor parking.
- l. Fire fighting, fire prevention, and protection.
- m. Eyewash and safety shower.
- n. Driver rest room and locker room as required.
- o. A 24-hour telephone or other means of emergency notification.

13.3.1.2 Secondary yard functions that should be considered include the following:

- a. Telephone.
- b. Loading meter proving.
- c. Pump back for product return and for flushing and draining trucks for switch loading.
- d. Drive-through truck wash or garage with wash bay.
- e. Own-use island for truck fueling.
- f. Compressed air for truck tire inflation.
- g. Hot-start facilities for warming engines during cold weather.
- h. Flat concrete pad for parking trailers when connecting and disconnecting trailers from tractors.

13.3.2 Communications

For transmittal of loading instructions and records between truck drivers and dispatch office, the following alternatives should be considered:

- a. Elevate the dispatch office and install a pass-through window so that the dispatcher in the office may hand papers to a driver in a truck.

b. Install an intercom or pneumatic tube or both between the dispatch office, truck entrance and exit station or stations, and the loading rack.

c. Have the driver enter the office for all dispatched transactions and instructions.

d. Install a small building or shed on loading islands for key or card input and instructions. Location of this building should be in accordance with local codes or safety standards.

e. Install a small building or shed away from the loading rack for bill-of-lading (BOL) tickets so others may load while the driver picks up the BOL.

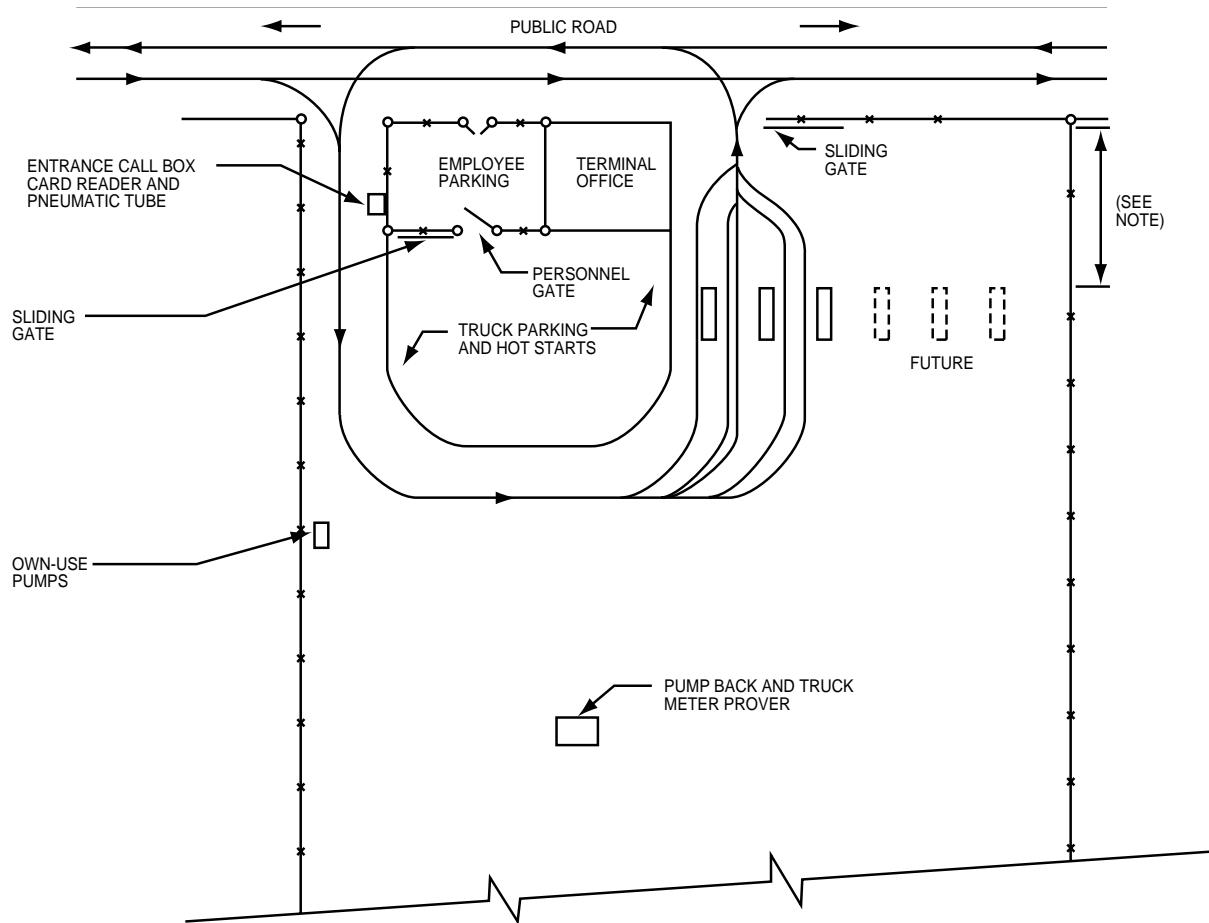
13.3.3 Yard Arrangements and Dimensions

13.3.3.1 Example layouts for tank truck loading yards are shown in Figures 3 and 4. Figure 3 illustrates an installation without a garage. Figure 4 illustrates an installation with a garage. The loading rack should be located so that there is a minimum of truck maneuvering within the yard area, particularly after loading. It is usually more efficient to locate the garage on the entrance side of the terminal away from the loading rack so that the trucks may be serviced before loading. Left turns for trucks are preferred to right turns for better visibility.

13.3.3.2 Entrance and exit roads should be sufficiently wide to permit a moving truck to pass a parked truck, or if practical, provide a minimum width of 20 ft (6 m). If the yard gate is near the street curb line, the road and gate should be 30 ft (9.1 m) wide, if practical, to allow extra space for a vehicle turning in from the street. At terminals where the driver must stop and open the gate, the entrance gate should be recessed from the road a distance equal to the longest vehicle.

13.3.3.3 An example of typical yard dimensions for movement to and from the loading rack are shown in Figure 5. These dimensions are based on trucks that are 8½ ft wide (2.6 m), require a turning radius of 60 ft (18.3 m), have 55-ft long (16.8 m) semitrailers, and 70-ft long (21.3 m) tank trucks with full trailers. Recommended yard widths are designed to allow a truck to turn 90° and obtain a straight path by the time it reaches the loading position. In locations with limited area, the minimum yard width may be used; however, truck maneuvering is more difficult and parked vehicles may cause congestion. The yard dimensions for bottom loading racks shown in Figure 5 allow an extra 15 ft (4.6 m) of length at the rack exit to ensure truck clearance to the safety gate.

13.3.3.4 Areas for own-use fueling of trucks as well as pump-off (pump-back) and drive-through wash stands should usually be located on the loading rack approach so that the trucks have a minimum deviation from the normal route through the yard to the rack.



NOTE: Allow enough space between loading racks and gate, at least two truck lengths, for trucks to be parked for driver settlement

Figure 3—Tank Truck Loading Yard Layout without Garage

13.3.4 Yard Drainage

13.3.4.1 The yard should be sloped to drain rainwater away from the concrete mat at the loading rack, truck fueling, truck scales, and pump back areas. The grade in the yard paving should be enough to ensure that irregularities in the paving will drain without the formation of puddles. Proper grade is especially important in freezing climates where ice spots become a hazard (see 6.2). Where feasible, the typical slope should be 1%.

13.3.4.2 The discharge and disposal of yard drainage water will depend on local regulations and whether the storm water drainage is determined to be clean or contaminated (see 5.4.2). Provisions for sampling and observation of storm water drainage should be included in the design. For disposal of uncontaminated storm water from small areas, local policy may permit the water to simply drain into the street. In large areas, where sufficient grade may not be provided for natural runoff, catch basins, drain piping, or pumps may need to be

installed for drainage disposal. Discharge and disposal of storm water are covered in 5.3.2.

13.3.5 Yard Paving

The yard paving is usually asphalt with concrete required for loading areas. Concrete paving may be used at the exit from the loading rack to provide a more durable surface. Asphalt pavement is subject to scuffing when the rear tandem wheels of the tractor and semi-trailer, that are not articulated, are dragged across the surface as the truck is turning. Where scuffing of asphalt may present a problem, concrete should be considered. Also, note that asphalt may be subject to degradation upon contact with petroleum products.

13.3.6 Fencing and Security

13.3.6.1 Fencing around the entire site should be employed to maintain facility security and prevent product loss and vandalism. The location of the fence line in relation to the property line shall conform to local code requirements.

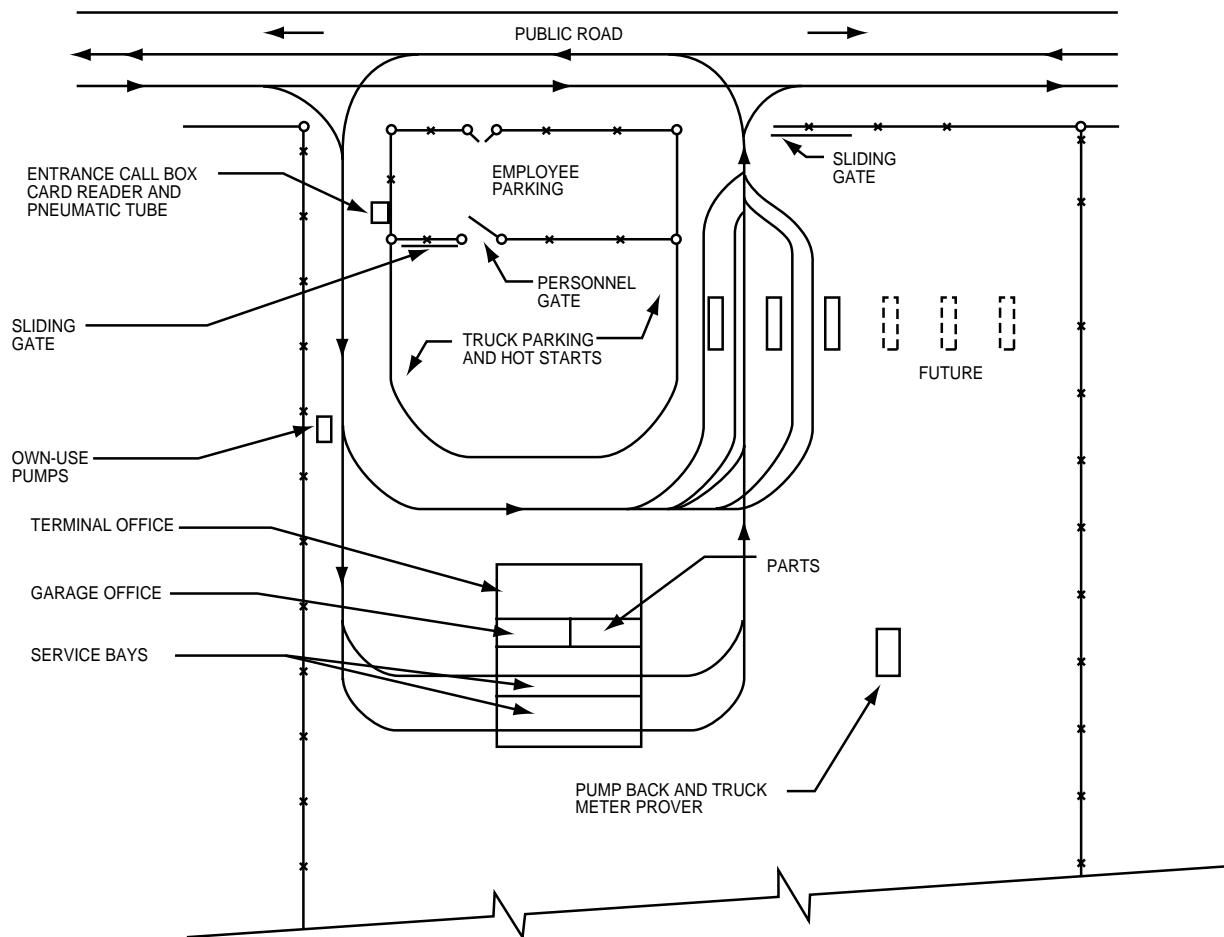


Figure 4—Tank Truck Loading Yard Layout with Garage

13.3.6.2 A review of the security requirements for the terminal facility should be included during the design consideration. The review should include physical security, disaster recovery planning, security incidents, area considerations, local and private protective services, security awareness, and security technology. The API documents *Security Guidance for the Petroleum Industry* and *Security Vulnerability Assessment Methodology for the Petroleum and Petrochemical Industries* provide information to help petroleum and petrochemical facilities assess their vulnerabilities and potential damage to attacks, and are a starting point for developing facility security plans.

13.3.6.3 Perimeter lighting may be provided to illuminate fences, access and egress gates, employee and truck parking, tank farm and manifold areas, loading racks, and marine docks. Refer to the *IES Lighting Handbook*, OSHA 1910.56, or other applicable state or local code.

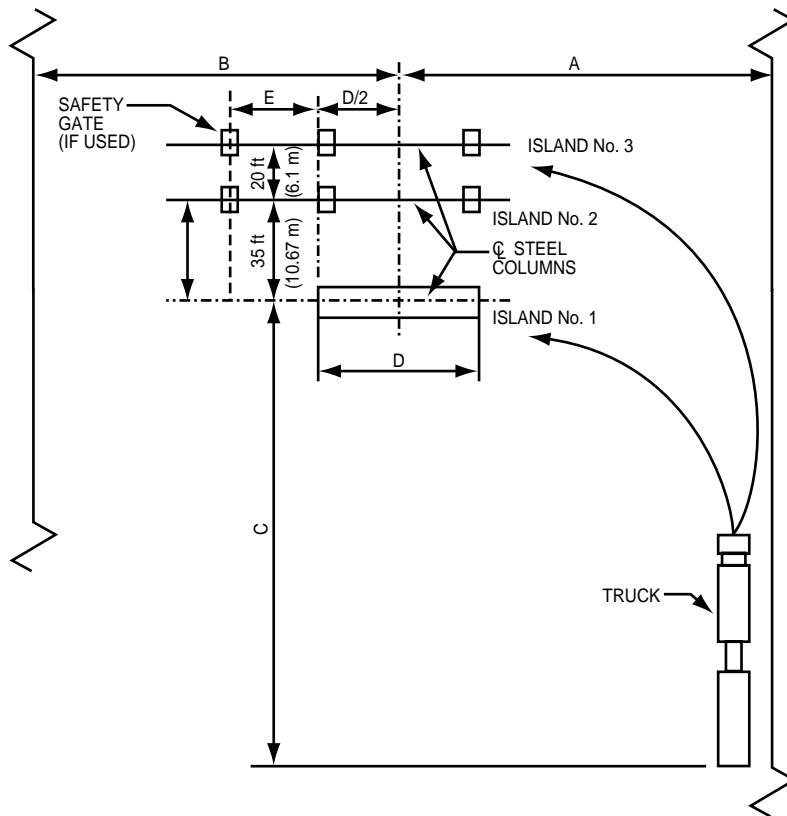
13.3.6.4 Barriers can be added to tank external ladders or stairways to restrict access.

14 Removals and Decommissioning of Facility

14.1 GENERAL

14.1.1 The guidelines in this section apply to the removal or decommissioning of facilities including the following: buildings, tanks, pumps, piping, foundations, steel structures, electrical equipment, or any other equipment that is part of a terminal facility.

14.1.2 Removal and decommissioning work requires proper planning, control, and closeout procedures. The most important considerations for all phases of this type of work should be to ensure the safety of all involved.



Trucks	Trucks Length	Yard Width				Yard Entrance	Island Lengths	Safety Gate	
		Minimum		Desirable					
		A	B	A	B		C	D	E*
Semitrailers (Supertruck)	55 ft (17 m) 60 ft (18 m)	100 ft (30 m)	115 ft (35 m)	120 ft (37 m)	135 ft (41 m)		130 ft (40 m)	35 ft (11 m)	32 ft (10 m)
Semitrailers & Trucks with Full Trailers	55 ft (17 m) 70 ft (21 m)	105 ft (32 m)	120 ft (37 m)	125 ft (38 m)	140 ft (43 m)		140 ft (43 m)	48 ft (15 m)	28 ft (8.5 m)

Island No. 1 Top Loading both sides.

Island No. 2 Bottom Loading left side only.

*This dimension should be checked in the field because of the different truck types and location of connections.

NOTE: Dimension B allows extra 15 ft (4.6 m) for truck to clear safety gate.

Figure 5—Yard Dimensions for Trucks (See Table Above)

14.2 SITE CONTROL AND PROTECTION

14.2.1 A representative of the facility owner, knowledgeable in its operation and familiar with this type of equipment, should be present during the removal work to assist with the safe and proper execution and appropriate documentation of the work.

14.2.2 Adequate control measures should be provided to protect personnel, equipment, surrounding environment, and adjacent property from injury or damage from falling debris, dust, vibration, product releases, or other hazards that may occur during the work. See 6.4 for a further discussion of safe work practices. All work shall be performed in accordance with the applicable federal, state, and local regulations.

14.3 PREPARATIONS

14.3.1 Tests should be conducted to determine the presence of hazardous substances or materials that would require special handling precautions during removal. These hazards would include asbestos and man-made fibers (found in some insulating materials), lead (found in tanks that have stored leaded gasoline or in some paints and primers), and contaminated soil (may be found in areas in proximity to equipment, such as tanks, loading and unloading areas, and pumps).

14.3.2 All safety and operational clearances and permits, including any jurisdictional permits shall be obtained. This includes preparation of manifests for any hazardous wastes that have been identified by the tests conducted according to 14.3.1.

14.3.3 The equipment to be removed shall be positively isolated and de-energized from all active equipment and interconnecting facilities, piping, and wiring (see 6.4).

14.3.4 All product, gases, and contaminants shall be removed from the equipment to be removed. Disposal of equipment, contaminants, and other contents shall be in accordance with operational and jurisdictional requirements. This includes such work as cleaning tanks and emptying piping systems by flushing or mechanical means. One source of information is API Publ 1638 for guidelines on the disposal of materials. Other references for requirements and guidelines on the cleaning of storage tanks are API Std 2015 and API RP 2016.

14.4 EXECUTION

14.4.1 Removal or idling work shall be performed in accordance with safe work practices outlined in 6.4.

14.4.2 Consideration should be given to removing underground piping that is being de-commissioned. However, if local regulations allow underground piping to be idled in place, adequate safeguards should be provided, such as evacuating the piping, plugging and capping the ends of piping to prevent potential contamination. If the situation warrants, fill the piping with an inert material.

14.4.3 If aboveground storage tanks are to be idled in place, adequate safeguards against unauthorized entry, such as providing bolted covers on manways and nozzles should be provided. A means to prevent flotation of the empty tanks by an accumulation of surface storm water, such as providing adequate drainage around the tank, should be provided. In areas subject to heavy rains or snow, tank external floating roofs should be supported by cribbing or other methods to prevent damage to the roof. Additionally, tanks in areas subject to extreme wind conditions, such as hurricanes, should be protected by anchoring or reinforcing as applicable.

14.4.4 If equipment such as storage tanks or underground piping may be re-commissioned in the future, then consideration should be given to corrosion protection systems, such as cathodic protection systems or protective coatings. See Section 10 for further information on this subject. In addition, permits from the local authority may be required to maintain tanks in an empty condition. (See NFPA 1 and IFC.)

14.5 SITE ASSESSMENT AND REMEDIATION

As part of equipment removal work, tests should be conducted to assess site contamination. Refer to API Publ 1628 and API Publ 1629 for guidelines on site assessment and remediation.

14.6 CLOSEOUT AND CLEANUP

14.6.1 All debris and waste are to be disposed of in accordance with applicable regulations, recognizing the potential future liabilities associated with improper disposal. See API Publ 1638 for guidance on tank bottoms disposal and API Publ 2202 for guidelines on disposing of steel scrap from leaded gasoline storage tanks.

14.6.2 At project completion, temporary structures and safeguards should be removed, and remaining buildings and equipment restored to a clean and usable condition.

14.6.3 The finished grade should be smooth and continuous with the surrounding finished grades. New grades should be protected against erosion and consideration should be given to storm water run-off.

Additional copies are available through Global Engineering Documents at (800) 854-7179 or (303) 397-7956

Information about API Publications, Programs and Services is available on the World Wide Web at: <http://www.api.org>



**American
Petroleum
Institute**

1220 L Street, Northwest
Washington, D.C. 20005-4070
202-682-8000

Product No. C26102