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Document Name: API 2350: Overfill Protection for Storage Tanks in Petroleum Facilities

CFR Section(s): 49 CFR 195.428(c)

Standards Body: American Petroleum Institute

APPROVED

Official Incorporator:
THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

Overfill Protection for Storage Tanks in Petroleum Facilities

API RECOMMENDED PRACTICE 2350
THIRD EDITION, JANUARY 2005

API
American Petroleum Institute

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FOREWORD

This publication was prepared under the direction of a Support Group comprised of members of the API Safety and Fire Protection Subcommittee. The second edition of API RP 2350 *Overfill Protection for Storage Tanks in Petroleum Facilities* was rewritten and expanded with emergency spill prevention programs in mind and replaced the previous edition in whole and in part. This third edition builds on the second edition with an expansion of the Scope to include both Class I and Class II hydrocarbon liquids as well as tankage in broader usage. Appendixes to the document are intended to provide additional information only.

This document covers overfill protection for all aboveground storage tanks in petroleum facilities, including refineries, terminals, bulk plants, and pipeline terminals that receive Class I (flammable) or Class II (combustible) liquids. It is not intended to include service station tanks, process tanks or tanks used in initial crude oil production activities.

During the development of the current and prior editions of API RP 2350, careful consideration was given to the benefits provided by overfill protection for tanks in petroleum facilities relative to:

- Safety and environmental protection
- Optimization of the work place and operating practices
- Inspection, testing, and maintenance
- Equipment and system selection and installation
- Safe work and emergency procedures and training
- Management of change programs relative to tank overfill protection

All of the sections and appendixes in the document were revised and expanded with the second edition. Illustrations and a tank overfill protection summary chart are provided to help understand the tank capacity and level definitions. API RP 2350 covers overfill protection only. It does not address other issues related to aboveground storage tanks, such as management of large diameter storage tanks, tank fire protection, leak control, drainage, and other subjects that are covered by a number of API standards and other publications listed in the references.

Starting with the second edition the previous definitions for *overfill level*, *tank fill level*, and *normal fill level* were changed. For example, *safe fill level* became the normal maximum allowable tank capacity (normal operating level). The definitions used in the second edition continue in this third edition.

The essential elements of this publication are based on current industry safe operating practices and existing consensus standards. Federal, state, and local regulations or laws may contain additional requirements that must be taken into account when a tank overfill protection program is developed for a specific facility.

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

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Overfill Protection for Storage Tanks in Petroleum Facilities

1 General

1.1 INTRODUCTION

Preventing petroleum storage tanks from being overfilled is an important safety and environmental concern. The safe operation of a petroleum storage facility is dependent on the receipt of product into the intended storage tank within its defined capacity. Tank overfills can be effectively reduced by developing and implementing practical and safe operating procedures for storage facilities and by providing for careful selection and application of equipment, scheduled maintenance programs, and employee training.

In providing for overfill protection for storage tanks, the objective is to minimize product overflows that can result in environmental and safety hazards, loss of inventory, and damage to tanks and adjacent areas. Because the level of risk and potential loss varies from location to location, a flexible approach should be used in providing alternatives for meeting the objectives of the facility overfill protection program. Procedures should provide for options that include the use of trained personnel, safe operating practices, and technology.

Recognizing the need for flexibility, this document covers both manual procedures and automatic systems that can be used successfully to protect against overfills.

1.2 SCOPE

1.2.1 Applicability

The scope of this recommended practice (RP) is specifically limited to tanks associated with marketing, refining, pipeline and similar facilities containing Class I or Class II petroleum liquids. This RP does not apply to:

- Underground storage tanks
- Aboveground tanks of 1320 U.S. gallons (5000 liters) or less
- Tanks that are integral to a process
- Tanks containing Class III liquids
- Tanks containing non-combustible liquids
- Service stations
- Loading or delivery from wheeled vehicles (such as tank trucks or railroad tank cars)

1.2.2 Relationship of This Recommended Practice to NFPA 30

This document was prepared to include consistency with NFPA 30-2003 Edition, Chapter 4.6, which includes the following requirements:

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

1. Tanks gauged at frequent intervals by personnel continuously on the premises during product receipt with frequent acknowledged communication maintained with the supplier so that flow can be promptly shut down or diverted.
2. Tanks equipped with a high-level detection device that is independent of any tank gauging equipment. Alarms shall be located where personnel who are on duty throughout product transfer can promptly arrange for flow stoppage or diversion.
3. Tanks equipped with an independent high-level detection system that will automatically shut down or divert flow.
4. Alternatives to instrumentation described in 4.6.1.1(2) and 4.6.1.1(3), where approved by the authority having jurisdiction as affording equivalent protection.

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

4.6.1.3 Formal written procedures required 4.6.1.1 shall include the following:

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

1.3 DEFINITION OF TERMS

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

1.3.1 attended facility: A facility that has assigned personnel continuously on the premises during receipt of product from a mainline pipeline or marine vessel. An unattended facility does not have assigned personnel on the premises continuously during product receipt from a mainline pipeline or marine vessel.

1.3.2 authority having jurisdiction: The organization, office, or individual responsible for approving equipment, an installation, or a procedure.

1.3.3 capacity: The volume (amount) of product contained in a tank at predesignated levels.

1.3.4 detectors and detector systems: The following are terms related to detectors and detector systems:

a. **level detector:** A product level sensing device that actuates an initial alarm/signal that allows sufficient time for facility operating personnel ("persons in charge for marine terminals") to acknowledge or respond to divert or shut off product flow before the product in the tank reaches a predetermined level.

b. **high-high-level detector:** A product level sensing device in a single-stage detector system and in a two-stage detector system, usually located at or above the safe fill level, that actuates the alarm/signal to provide sufficient time to shut off or divert product flow before the overfill level is reached.

c. **high-level detector:** Product level sensing device in a two-stage detector system that actuates the first alarm/signal if a tank is filled to a predetermined level below the level where the high-high-level detector is set, and which allows sufficient time to shut off or divert product flow before the product in the tank reaches the high-high-level detector.

d. **single-stage detector system (high-high-level detector):** In a single-stage detector system the high-high-level detector shall be located at or above the safe fill level and shall alarm/signal to provide sufficient time to shut off or divert product flow before the overfill level is reached.

e. **two-stage detector system (high-level and high-high-level):** In a two-stage detector system, the first-stage (high-level) detector shall be located at or above the normal fill level and shall alarm/signal to allow sufficient time for product shutoff or diversion before the safe fill level is reached. The second-stage (high-high-level) detector shall be located at or above the safe fill level and shall alarm/signal to provide for sufficient time to shut off or divert product flow before the overfill level is reached.

f. **independent level detector:** A product level sensing device that is separate and independent from any automatic gauging equipment on the tank. High-high-level detectors in single-stage and in two-stage detector systems shall always be independent detectors. A high-level detector in a two-stage detector system may or may not be an independent detector.

Note: NFPA 30 allows for the use of non-independent, integrated level detector systems (such as radar, servo-gauging, and hydrostatic gauging systems), if approved by the authority having jurisdiction as providing equivalent protection

1.3.5 facility operator: The facility owner, operator (manager, supervisor, or other assigned person[s]) responsible for receiving product from the transporter; typically with decision-making authority.

1.3.6 flammable and combustible liquids: NFPA 30-2003 defines the following classes of liquids:

a. Class I liquid: a flammable liquid with a closed cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding 40 lb. per square in. absolute (2068 mm of mercury) at 100°F (37.8°C).

b. Class II liquid: A combustible liquid with a closed cup flash point at or above 100°F (37.8°C) and below 140°F (60°C).

c. Class III A liquid: A combustible liquid with a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).

d. Class III B liquid: A combustible liquid with a closed cup flash point at or above 200°F (93°C).

1.3.7 hazard: A condition or inherent physical or chemical characteristic (flammability, toxicity, corrosivity, stored chemical, electrical, hydraulic, pressurized or mechanical energy) that has the potential for causing harm or damage to people, property, or the environment.

1.3.8 mainline pipeline: A pipeline that transports petroleum products between facilities, or from refineries to terminals and other facilities, and does not include pipelines used to transfer products within facilities (except those used for product transfer from marine vessels).

1.3.9 marine vessel: A barge or tanker ship that delivers product directly into petroleum facility tanks (usually through facility pipelines).

1.3.10 normal fill level (normal capacity): The level up to which the tank is allowed to receive product at the maximum allowable receiving flow rate for a predetermined time prior to reaching the safe fill level. The predetermined time should be based on the facility operator's experience for the facility and the tank involved. The normal fill level is established at the lower of the following two levels so that appropriate action can be taken to prevent an overfill:

a. A level that allows sufficient time for the flow to be completely stopped or diverted before or when the level of the product in the tank reaches the pre-established safe fill level. (Normal fill level never exceeds safe fill level.)

b. A level, determined by the facility operator depending on the tank's physical condition (leaks, structural strength, and so forth) or the operating practices (e.g., partial or split product receipts, relief allowances, and so forth), that limits the tank capacity to less than that normally available at the usual safe fill level.

1.3.11 overfill level (maximum capacity): The maximum fill level of product within a tank as measured from the gauging reference point (that is, striker plate) above which level any additional product will overfill and spill out of the tank; or at which level contact or damage will occur between the floating roof and the tank structure or appurtenances.

1.3.12 person in charge: A trained and experienced individual designated as a person in charge of transfer operations at marine terminals (U.S. Coast Guard regulatory term from 33 *CFR* 154.700).

1.3.13 product: The Class I or Class II liquid received into tanks (such as from mainline pipelines or marine vessels).

1.3.14 risk: The probability of exposure to a hazard which could result in harm or damage.

1.3.15 risk assessment: The identification and analysis with judgements of probability and consequences, either qualitative or quantitative, of the likelihood and outcome of specific events or scenarios that result in harm or damage.

1.3.16 risk-based analysis: A review of potential hazards and needs to eliminate or control such hazards based on a formalized risk assessment.

1.3.17 safe fill level (tank rated capacity): The safe fill level up to which the tank is allowed to receive product delivery after the normal fill level is attained. The safe fill level is always below the overfill level. The safe fill level is established by determining the amount of time required to take the appropriate action necessary to completely shut down or divert product flow before the level of product in the tank reaches the overfill level. The safe fill level is established by facility operators for each specific tank depending on the type of tank, its internal configuration and condition, and operating practices and policies based on judgements of hazards and associated risks.

1.3.18 tank product levels: Levels established by facility operators are based on:

a. Field experience and operating practices for each facility and each specific tank;
b. Operating parameters for valves and manifolds;
c. Tank capacities and physical conditions;
d. Amount of product to be delivered; and
e. Rate of product flow into each tank.

See Appendices A and B for information on calculating tank product levels.

1.3.19 tank strapping chart (tank record): A chart (or record) developed for each individual tank specifying the essential values related to tank capacity, normal fill level, safe fill level, overfill level, and detector setting levels (see API Std 2550).

1.3.20 transfer operations: All activities associated with product receipt, including the associated notification (either verbal, electronic, or by other means) of a potential tank overfill and shutdown or diversion of product to prevent a potential tank overfill.

1.3.21 transporter: The mainline pipeline person or marine vessel person who is responsible for product transfer operations.

1.4 GENERAL PROVISIONS APPLICABLE TO ALL FACILITIES

1.4.1 Protection against tank overfill is best achieved by:

a. Awareness of available tank capacity and inventory, and
b. Careful monitoring and control of product movement.

Monitoring of available tank capacity is accomplished either manually or by use of an automatic tank gauging system. This, together with established orderly emergency shutdown and product diversion procedures, provides for overfill protection. Aboveground storage tank high-level and high-high-level detectors with alarm/signal systems constitute an additional means of protection against tank overfills and shall be used where required by facility operator or transporter policy or regulations.

CAUTION: High-level detectors and/or automatic shutdown/diversion systems on tanks containing Class I and Class II liquids shall not be used for control of routine tank filling operations. These devices are intended to signal a potential emergency and initiate certain manual responses or activate automatic response mechanisms.

Note: Detectors, when installed on tanks not covered by this document, may be an integral part of a product level gauging system device, provided that they do not perform any shutdown or safety interlock function.

1.4.2 The normal fill level (normal capacity), safe fill level (tank rated capacity), and overfill level (maximum capacity) for each tank in facilities covered by this document shall be established and entered in the tank strapping chart (tank record). The levels shall also be prominently displayed by the facility operator near the tank gauge hatches and/or ground level gauges where manual operations are performed, or where manual operations are required as a backup in the event of system failure. Appropriate tank gauging reference information should be available in the control room.

1.4.2.1 To assist in scheduling product receipts, facility operators shall indicate the normal fill level (normal capacity), safe fill level (tank rated capacity), overfill level (maximum capacity), and any other critical heights on the tank strapping chart, tank record card, computer record or calibration chart for each tank in the facility to which the document applies. It may be beneficial to provide this information in the area where gauging is conducted. This information shall also be provided to transporters when they are responsible for filling the tanks.

1.4.2.2 If acceptable calibration charts are not available, tanks shall be calibrated and charts developed in accordance with API Std 2550.

1.4.2.3 The normal fill level (normal capacity), safe fill level (tank rated capacity), and overfill level (maximum capacity) for the tank(s) receiving product shall be noted on the tank product transfer or receipt form. This information shall be confirmed with the transporter prior to receipt and provided to the transporters when they are responsible for filling the tanks.

1.4.3 Prior to product receipt, the tank(s) designated to receive product shall be gauged manually, or by an independent automatic gauging and measuring system, to confirm that adequate capacity is available to receive the amount of product scheduled for delivery. Any expected volume increase due to product temperature rise in the tank(s) shall be considered when determining the available room for product. This information shall be recorded on the tank product transfer or receipt form(s) and made available to the transporter, as appropriate. Where automatic gauging and measuring systems are used, regular inspection, maintenance, and checks of their capability and performance are required.

1.4.4 All documentation of the above activities associated with the receipt of product from transporters shall be maintained on file in the facility for an appropriate period of time as determined by facility operator policy, or as established by regulation or other authority. Documentation relating to inspection and maintenance of systems shall be maintained for a minimum of 1 year (NFPA 30, Section 2-10.2) or longer, as required by operator policy, regulation, or other authority.

1.5 REFERENCED PUBLICATIONS

1.5.1 The following recommended practices and standards are referenced in this document:

API

RP 500	*Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*
RP 2003	*Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*
RP 2009	*Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries*
RP 2021	*Management of Atmospheric Storage Tank Fires*
Publ 2021A	*Interim Study—Prevention and Suppression of Fires in Large Aboveground Atmospheric Storage Tanks*
RP 2026	*Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service*
Publ 2201	*Safe Hot Tapping Practices in the Petroleum & Petrochemical Industries*
Std 2545	*Method of Gaging Petroleum and Petroleum Products*
Std 2550	*Measurement and Calibration of Upright Cylindrical Tanks*
Std 2610	*Design, Construction, Operation, Maintenance and Inspection of Terminal and Tank Facilities*
MPMS 3.1A	*Manual Gauging of Petroleum and Petroleum Products*

EPA[1]

40 *CFR* 112	*Spill Prevention Control and Countermeasure (SPCC) Rule*

NFPA[2]

30	*Flammable and Combustible Liquids Code*

OSHA[3]

1910.120(q)	*Hazardous Waste Operations and Emergency Response—Emergency Response Program*
OSHA 2254	*Training Requirements in OSHA Standards & Training Guidelines—1998 (Revised)*

USCG[4]

33 *CFR* 700 Part 154	*Subpart D—Facility Operations for Facilities Transferring Oil or Hazardous Material in Bulk*

1.5.2 Other Reference

Magraw-Hill, *Aboveground Storage Tanks* by Phillip E. Myers, ISBN: 007044272X.

2 Attended Facilities

2.1 ATTENDED FACILITIES WHERE DETECTORS ARE NOT INSTALLED ON TANKS

2.1.1 To protect against overfills at attended facilities where detectors are not installed on tanks, written procedures for product receipt, shutdown and diversion shall be developed by the facility operator, with assistance from the transporter, or which are acceptable to the transporter. The requirements in 2.1 and Section 4 of this RP shall be included in the written procedures.

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

[2]National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169. www.nfpa.org

[3]Occupational Safety and Heatlh Administration, Department of Labor, 200 Constitution Avenue, NW, Washington, D.C. 20210. OSHA Regulations are posted on, and can be downloaded from, the OSHA web site: www.osha.gov

[4]U.S. Coast Guard Marine Safety Center (part of DOT), Available from the U.S. Government Printing Office, Washington, D.C. 20036. www.uscg.mil

2.1.2 During product receipt, frequent acknowledged communication shall be maintained between the facility operator and the transporter, to shut down or divert product flow, if necessary.

2.1.3 The tank(s) designated to receive product shall be checked by personnel responsible for facility operations ("person in charge" at marine facilities) immediately after the start of product transfer to verify that product is flowing into the correct tank and that the gauging equipment, where installed, is operative.

2.1.4 During product receipt, tanks shall be checked periodically by personnel responsible for facility operations, in accordance with established facility procedures, to ensure that the product continues to flow into the correct tank and that the tank capacity remains sufficient to receive the amount of product scheduled for delivery. Gauge readings shall be taken and recorded when checking tanks during product receipt.

2.1.5 During product receipt, the tank farm area shall be periodically inspected by personnel responsible for facility operations to ensure the integrity of the piping, tanks, pumps, dikes and/or other containment and drainage systems, and to ensure that no unauthorized activities are taking place that would affect product receipt.

2.1.6 If a tank is to be filled above its normal fill level (normal capacity) up to its safe fill level (tank rated capacity), a trained and qualified person shall be assigned by the facility operator to be present at the tank.

Note: API does not recommend the practice of routinely filling a tank above the safe fill level (tank rated capacity). This increases the risk of overfill and shall be avoided whenever practical.

2.1.6.1 The assigned person shall continuously monitor the product receipt as the product level in the tank approaches the safe fill level (or as the capacity approaches the tank rated capacity).

2.1.6.2 During this period, the assigned person shall be provided with a direct means of communication to the transporter, to notify the transporter to immediately stop or divert product flow in the event of an emergency.

2.1.6.3 Monitoring shall continue until the transfer is complete, all product flow has stopped and the tank receipt valves are closed.

2.1.7 To prevent other consequential damages, such as hydraulic shock or overpressuring of the piping systems, the shutdown or diversion procedure should be compatible with the transporter's operations.

2.2 INSTALLATION OF DETECTORS AT ATTENDED FACILITIES

2.2.1 Level detectors are not required for tanks at attended facilities. The facility operator's decision whether or not to install overfill protection equipment at an attended facility should be based on an evaluation of the following factors:

a. Facility's location (e.g., tanks located in areas where a tank overfill might endanger a place of habitation or public assembly).
b. Tank size.
c. Tank diking and spacing.
d. Soil and groundwater conditions.
e. Operating practices.
f. Other factors that would be affected by an overfill.

Note: It is recognized that all aboveground storage tanks and particularly those in excess of 150 ft in diameter which contain Class I or Class II liquids have the potential for a significant emergency condition should an overfill occur. Single-stage high-high-level or two-stage high-high-level and high-level detector, alarm/signal and shutdown systems may be installed on these and other tanks at attended facilities at the discretion of the facility operator to provide additional overfill protection, or as required by government regulation or an authority having jurisdiction.

2.2.2 Where level detectors are installed at attended facilities, the requirements of Section 3 of this RP shall apply. If an electrical or mechanical failure occurs that affects the level detectors, product receipt shall stop and not recommence until (a) detectors are functioning properly or (b) manual operations and procedures are implemented in accordance with those required in 2.1 of this document for attended facilities without detectors.

3 Unattended Facilities

3.1 INSTALLATION OF DETECTORS AT UNATTENDED FACILITIES

3.1.1 At unattended facilities, receipt of product is not usually monitored by personnel on site or in the immediate area of the receiving tank(s). The product flow is controlled from remote locations that are equipped with alarm/signal annunciators activated by independent level detectors installed on tanks at each receiving facility. These annunciators alert personnel at the remote locations so that an orderly shutdown or diversion of product flow can be accomplished in time to prevent tank overfills.

3.1.2 Product transfer to an unattended facility shall be continuously monitored from a control center by the facility operator, transporter, or by a computer.

3.1.3 If a mechanical, electrical, or other detector system failure occurs, the product receipt shall be immediately stopped until such time as manual operations in accordance with those in 2.1 for attended facilities without detectors can be implemented.

3.1.4 The high-high-level detector in a single or two-stage system shall be designed to activate an alarm/signal that allows for sufficient time for an orderly shutdown or diversion of product to take place before an overfill occurs. The amount of time required will depend on operating conditions and facility practices, including both manual and automatic shutdown or diversion procedures.

3.1.4.1 Single detector (high-high-level detector) system: When only one detector is used, this high-high-level detector shall be located at or above the safe fill level and shall alarm/signal to provide sufficient time to shut off or divert product flow before the overfill level is reached.

3.1.4.2 Two-stage detector (high-level and high-high-level detector) system: In a two-stage system, the first-stage high-level detector is usually located at or above the normal fill level and shall alarm/signal to allow sufficient time for product shutoff or diversion when the safe fill level is reached. The second-stage high-high-level detector shall be located at or above the safe fill level and shall alarm/signal to provide for sufficient time to shutoff or divert product flow before the overfill level is reached.

3.1.5 When used for overfill protection, the high-high-level detector in a single-stage system, and the high-high-level detector in a two-stage system, shall be independent of the automatic tank gauge system to provide greater reliability and to comply with the requirements of NFPA 30-2003, Section 4.6.1.1(2) and 4.6.1.1(3)

Note: State-of-the-art equipment with integrated (not independent) hardware can provide superior reliability for detecting high and high-high levels. NFPA 30-2003 Section 4.6.1.1(4) allows for the use of non-independent alternative systems, provided they are approved by the authority having jurisdiction.

3.1.6 Where installed, two-stage (high-level and high-high-level) detector systems shall comply with at least one of the two following requirements:

a. If an automatic tank gauge is incorporated as a component of the high-level (first-stage) detector, an independent high-high-level (second-stage) detector shall be provided.

b. Both the high-level (first-stage) detector and the high-high-level (second-stage) detector shall be independent of the automatic gauging system on the tank.

Note: State-of-the-art equipment with integrated (not independent) hardware can provide superior reliability for detecting high and high-high levels NFPA 30-2003 Section 4.6.1.1(4) allows for the use of nonindependent alternative systems, provided they are approved by the authority having jurisdiction.

3.1.7 Where a two-stage system is installed, the first-stage (high-level detector) shall activate when product flow into the tank reaches a predetermined level that provides sufficient time for appropriate action to stop or divert product flow before the second stage (high-high-level detector) is reached.

3.1.8 If a tank is to be filled above its normal fill level (normal capacity) up to its safe fill level (tank rated capacity), a trained and qualified person shall be assigned by the facility operator or the transporter to monitor the operation and, if necessary, take action to stop or divert product flow to prevent an overflow.

Note: API does not recommend the practice of routinely filling a tank above the safe fill level (tank rated capacity). This increases the risk of overfill and shall be avoided whenever practical.

3.1.8.1 During this period, the assigned person shall be provided with a direct means of communication to notify the transporter to immediately stop or divert product flow in the event of an emergency.

3.1.8.2 If the transporter does not acknowledge appropriate compliance, the assigned person shall be instructed to take immediate action within the facility to stop or divert the flow.

3.1.8.3 Monitoring of the operations by the assigned person shall continue until the transfer is complete, all product flow has stopped and the tank receipt valves are closed.

Note: It should be recognized that all aboveground storage tanks and particularly those in excess of 150 ft in diameter, which contain Class I or Class II liquids, have the potential for a significant emergency condition should an overfill occur. These concerns are discussed in API RP 2021 *Management of Atmospheric Storage Tank Fires* and Publication 2021A *Interim Study—Prevention and Suppression of Fires in Large Aboveground Atmospheric Storage Tanks*.

3.1.9 To prevent other consequential damages, such as hydraulic shock or overpressuring the piping systems, the shutdown or diversion procedure should be compatible with the transporter's operations.

3.2 INSTALLATION OF INDEPENDENT DETECTION AND AUTOMATIC SHUTDOWN OR DIVERSION SYSTEMS AT UNATTENDED FACILITIES

Note: This section is consistent with the requirements of NFPA 30-2003, Section 6.1.1(3).

3.2.1 Tanks in fully automated operation at unattended facilities shall be equipped with independent single-stage high-high-level or two-stage high and high-high-level detector systems that automatically initiate shut down procedures or divert product flow when product in the tank reaches a predetermined level. These systems shall also activate shutdown or diversion in the event of a power failure in the level detection system.

3.2.2 Product transfer to an unattended facility shall be continuously monitored from a control center by computer.

3.2.3 Automatic shutdown or diversion can be accomplished by one of the following methods:

a. Automatically closing the product inflow valve on the tank.
b. Shutting down the pumping system.
c. Diverting the flow with automatic valves to another tank or pipeline.
d. Closing the intake valve at the pipeline manifold or connection.

3.2.4 Where automatic shutdown systems are provided, the receiving valve or valves for each tank and/or the intake valve at the pipeline connection, as well as valves controlling product diversion, shall be equipped with power actuators.

3.2.4.1 The power actuators may be either electrically, hydraulically, or pneumatically operated and shall incorporate a disconnect feature to permit manual override operation.

3.2.4.2 The valve closure rate should prevent excessive hydraulic pressure or hydraulic shock when the valve is closed. The control system should close the valve at a rate previously agreed to by both the facility operator and the transporter.

3.2.4.3 Position indicators should indicate valve positions and valve operation.

3.2.5 The facility piping system should be analyzed to determine whether a relief system will be needed to protect low pressure manifold piping. To prevent other consequential damages, such as hydraulic shock or overpressuring of the piping systems, the design and operation of the shutdown system or diversion procedure should be compatible with the transporter's operations.

3.2.6 When notification is received that the product in the tank has reached its predetermined high-high detector level in a single-stage or two-stage system, a signal activates a typical automatic valve control system that shall perform the following functions:

a. If the valve is being opened remotely when the appropriate high-level detector signal or high-high-level detector signal is received, the valve should immediately stop opening and immediately start to close at the predetermined rate.
b. If the valve is being closed remotely when the appropriate high-level detector signal or high-high-level detector signal is received, the valve shall continue to close at the predetermined rate.

3.2.7 If a mechanical or electrical failure of the detector system occurs, product receipt (or pumping) shall be immediately stopped. For receipt to recommence, manual operations in accordance with those required in 2.1 for attended facilities without detectors shall be implemented.

4 Procedures

4.1 GENERAL WRITTEN OPERATING PROCEDURES

4.1.1 To provide for protection against overfills, written operating procedures shall be established by the facility operator and, where appropriate, coordinated with and agreed to by the transporter. When developing written procedures the following should be considered:

a. These procedures shall comply with the requirements of NFPA 30-2003, Section 4.6.1.3, and with applicable federal, state and local codes, regulations, and requirements.
b. Facility operators should consider recognized industry safe work practices covered in this and other referenced API documents and standards.
c. The written operating procedures shall describe an orderly, simple shutdown and/or product diversion procedure, and any other actions to be taken in the event of an emergency, including loss of communications, power, and so forth.

4.1.2 Facility operators shall conduct reviews or inspections of product receipt operations to ensure that procedures are followed to prevent tank overfills.

4.1.3 In accordance with good management of change practices, the written operating procedures shall be reviewed on a regular basis and rewritten or amended as facility operator and/or transporter practices, products, equipment, tanks and tank assignments, instrumentation, systems and conditions change, or whenever applicable regulatory requirements change.

4.1.4 Because equipment, instrumentation, tanks, and types of facility and transporter operations differ, one set of general operating procedures cannot apply to all facilities, and may not even be applicable to all tanks or operations within a facility. Therefore, when necessary, written operating procedures shall be prepared for specific locations, tanks, and local conditions that address the items covered in this document.

4.2 PLANNING THE PRODUCT RECEIPT

4.2.1 To ensure that sufficient tank capacity will be available, prior to delivery the product quantities to be received shall have been determined and the written procedures established. Planning shall be conducted sufficiently ahead of delivery so as to minimize the need for last minute product transfers or withdrawals from the designated receiving tank prior to receipt.

4.2.1.1 To provide for a safety margin with respect to overfill, the normal capacity (normal fill level) of each tank should be used in calculating available capacity.

4.2.1.2 The anticipated final liquid product level in each tank shall be determined prior to each specific scheduled receipt and should not exceed the safe fill level.

4.2.2 The facility operator shall assign required duties to designated personnel prior to start of the receipt.

4.2.3 Specific written instructions for the receipt shall be prepared and reviewed, as appropriate, with personnel from all involved transporters and facility operators. These instructions shall include normal operational controls and procedures for tank receipts that fill tanks to the normal fill level. A higher level of readiness and control is needed when tanks are filled above the normal fill level and when switching from one tank to another during the same receipt.

4.2.4 Before the product is transferred or received, a proper valve line-up shall be verified to ensure that the product will be delivered into the designated tank or tanks. Where piping is connected from the same receiving manifold to different tanks, care must be taken to ensure the following:

a. Only the inlet valves for those tanks designated to receive product shall be open.
b. The inlet valves for all other tanks should be closed.

4.2.5 Drain valves for dikes where receiving tanks are located (secondary containment) should normally be kept closed during product receipt.

Note: Dike drain valves should *always* be kept closed except when draining water out of dikes.

4.2.6 Prior to starting product transfer to attended facilities, communications shall be established between the transporter and the facility operator, and maintained throughout the product transfer.

4.3 ELECTRONIC SYSTEM INTEGRITY TESTS

4.3.1 Prior to starting product transfer to unattended facilities, transporters shall ensure that electronic supervision and alarm/signal systems are operating properly by conducting a system electronic integrity test.

4.3.1.1 System electronic integrity operational tests should be conducted within 24 hours prior to every receipt.

4.3.1.2 If receipts are so frequent that conducting the system operational tests prior to each receipt are impractical, tests should be conducted at least weekly.

4.3.1.3 System operational tests should be conducted monthly for each facility and in addition within 24 hours prior to each receipt for facilities where receipts occur less than once a month (see 4.3.1.1).

4.3.1.4 Other appropriate methods of system electronic integrity tests, such as automatic continuous self testing, are acceptable.

4.3.2 Documentation of system electronic integrity operational checks should be maintained on file as required by facility operator policy or regulation.

4.3.3 In the event that the system on the tank designated to receive product is not operational and repairs cannot be made in time, the receipt shall be handled in one of the following ways:

a. Directed into an alternate tank with a functioning alarm/signal system,
b. Handled as a receipt into a tank in an attended facility without overfill protection systems (see 2.1),
c. Cancelled (see 3.1.3).

4.4 MONITORING THE RECEIPT

4.4.1 The written operating procedures shall require regularly scheduled monitoring of product receipts in accordance with 2.1, 2.2, 3.1, and 3.2. Monitoring may be conducted on site or remotely, either manually or electronically, and shall include written or computer records of product movement and changes in flow rates during receipts. The written operating procedures shall require that regularly scheduled comparisons and recording of the following information be made, based on the initial tank capacity, the initial or changed flow rates, and the estimated filling time:

a. The remaining available tank capacity shall be compared to the remaining volume of product to be received.
b. The product level indicated on the instruments shall be compared to the expected level at any given time during the product transfer.

4.4.2 Tanks that are connected to the same product manifold but which are not scheduled to receive product shall be monitored to ensure that their inlet valves are closed and that they are not receiving flow through partly open or defective valves.

4.5 COMPLETING THE RECEIPT

At the conclusion of the receipt, the facility receiving system shall be secured. This includes closing tank inlet valves that were opened for product receipt, and where appropriate, closing the facility product receipt valve(s) or manifold valves, dock valves, and other safeguards appropriate for the facility.

4.6 EMERGENCY PROCEDURES AND PLANNING

4.6.1 Both the facility operator and transporter shall prepare and have available orderly, clearly written emergency procedures and operating instructions for handling various types of potential emergencies, including the following:

a. Action (emergency shutdown or product diversion) to be taken in the event of an alarm/signal.
b. Action to be taken in the event of an overfill and subsequent product and vapor cloud release.

See Table 1 for a summary of actions to be taken for tank overfill protection.

4.6.2 Emergency procedures and instructions shall be revised as needed to reflect changes in operating conditions or regulatory requirements.

4.6.3 Appropriate emergency procedures to be followed in the event of a mechanical, instrumentation, or electrical failure shall be in writing and available at the facility. For facilities with manual operations (see requirements of 2.1), and facilities where the transporters control receipts, the emergency procedures shall be developed by the facility operator, with the assistance of the transporter, as required, and be available, in writing, at the facility and at the transporter's point of operation or control.

4.6.4 Provisions shall be made for appropriate means of communications between transporters and facility operators in the event of an emergency, including, but not limited to, pipeline telephone systems, public or private telephones, computer networks, and facility radios.

4.6.5 Facility operator and transporter personnel shall be trained in the facility emergency procedures, emergency response, and means of communications. In the United States, OSHA 1910.120(q) requirements may apply to training for facility personnel serving as emergency responders—even if only at the "First Responder Awareness" level.

4.7 PERSONNEL PERFORMANCE AND TRAINING

4.7.1 Knowledgeable and qualified personnel are an important element of every tank overfill protection program, regardless of the sophistication of the overfill protection system. Programs shall be developed by facility operators and transporters to train personnel engaged in transfer operations, including those persons assigned to test, inspect, and maintain overfill protection systems. These programs shall be reviewed, and altered as necessary, as operating procedures, equipment, instrumentation or regulatory requirements change. Personnel from facility operators, transporters, and/or contractors who are assigned to test, inspect, and maintain overfill protection systems shall be trained and qualified in the specific procedures associated with such systems.

4.7.2 Before personnel from facility operators and transporters are assigned to participate in a product transfer or receipt, they shall be thoroughly familiar with the written procedures and operating instructions, their duties, the operation of the overfill protection system, the alarm/signal system, the emergency procedures and shall have received any mandatory training.

4.7.3 The training given to personnel shall be documented. This documentation shall include the type and content of the training programs and materials, the training date(s), the names of the persons trained, and the names of the instructors or supervisors.

Table 1—Tank Overfill Protection Summary Chart

Point of Action	Attended Facilities Without Automatic Detectors	Attended & Unattended Facilities with Automatic Detectors	
Product Level	**Manual Action**	**Signal**	**Automatic/Manual Action**
Overfill level (maximum capacity)	Initiate immediate response and/or emergency action.	After H-HL	Initiate immediate response and/or emergency action.
Safe fill level (tank rated capacity)	Product level not to be exceeded. Immediately shut down or divert flow so overfill level not reached.	H-HL	High-high-level signals if safe fill signal level exceeded. Immediately shut down or divert flow either manually or automatically so overfill level not reached.
Normal fill level (normal capacity)	Start manual overfill prevention to shut down or divert flow so safe fill level not exceeded.	HL Pre-signal	High-level signals if normal fill level exceeded. Start automatic or manual overfill prevention to shut down or divert flow so safe fill level not exceeded.
Pre-signal[a]	n.a.	Gauge[a] System	Product at level where initial manual or automatic action may be started.
Loss of monitoring data (power loss or system failure)	n.a.	No Signal	Stop or divert product flow.

Notes:
1. In single-stage and two-stage detector systems, the high-high-level (H-HL) detector shall be independent of the gauge system.
2. When a high-level (HL) detector is used only for pre-signal purposes, it may he connected to the gauge system.
[a]The gauge system may also be used for pre-signal purposes, independent of high-level and/or high-high-level detection devices.

4.7.4 To maintain competency, the performance of facility operator and transporter personnel shall be regularly monitored by supervisors or other appropriate personnel, and remedial or refresher training shall be provided as necessary, or when operating conditions, equipment, instrumentation, or regulatory requirements change.

4.8 TESTING, INSPECTION, AND MAINTENANCE

4.8.1 Written procedures for testing, inspecting, and maintaining an overfill protection system shall be developed by the facility operator. Where appropriate, the facility operator shall consult with the transporter regarding the development of these procedures.

4.8.1.1 The manufacturer's recommendations should be taken into consideration when developing procedures for testing, inspecting, and maintaining an overfill protection system.

4.8.1.2 The testing procedures should be in a sequential format to ensure safe, consistent practices, and the testing procedures should be accessible to personnel responsible for the testing, inspection, and maintenance of the system.

4.8.1.3 Industry standards, government regulations, facility operator policies, and special situations may necessitate additional inspection, testing, and maintenance procedures.

4.8.2 Schedules shall be established as shown below for periodic testing, inspection, and maintenance to ensure the accuracy and proper operation of tank level gauges, detector alarms/signals, floats, displacers, automatic shutdown systems, electronic supervision, and other equipment and instrumentation associated with product transfer:

a. An overfill protection system shall be tested on initial installation and retested frequently enough as required thereafter to determine its reliability and to develop data that establishes the testing, maintenance, and inspection schedules.
b. The facility operator shall establish these schedules based on experience and performance; however, the inspection and testing interval shall not exceed 1 year.
c. Specific recommendations of the relevant equipment manufacturer should be considered when establishing inspection and maintenance procedures and intervals.

4.8.3 Testing and inspecting overfill protection systems should be simple and easy. The testing should duplicate an actual high liquid level situation as realistically and as closely as possible; however, the test should not require filling the tank above its normal capacity. Most systems have provisions for simulating conditions that activate the detector and alarm/signal.

4.8.4 Inspection procedures that are specific to the system in use should be established, similar to the following example:

a. Open the switch mechanism and inspect for moisture, corrosion, and cleanliness of the contact points. It should be noted that although the switch is normally located outside the tank vapor space, access may constitute a confined space entry.
b. From the outside, without entering the tank, visually inspect the internal mechanism to ensure that the displacers are hanging free, cables are not kinked, and so forth.
c. Thoroughly inspect the internal mechanism and the detector setting whenever the tank is out of service for internal work or inspection.

4.8.5 Maintenance instructions should include diagnostic routines to permit prompt identification and repair of failures in accordance with manufacturers' recommendations.

4.8.6 The source of false alarms/signals should be determined and corrected as quickly as possible. If false alarms/signals are experienced frequently, they can cause personnel to lose confidence in the overfill protection system and lead to deviation from the established operating and emergency response procedures.

4.8.7 Written records of overfill protection system testing, inspection, and maintenance shall be maintained for at least three years (or longer if required by facility operator policy or regulations).

4.9 ABNORMAL CONDITIONS

4.9.1 Facility operators and transporters shall develop written procedures and train personnel to provide for the proper course of action in the event that the overfill protection system fails. In the event of abnormal conditions (operating, equipment, environmental, weather related, and so forth), these procedures shall include assigning personnel to be in attendance at normally unattended facilities during product receipt from transporters.

4.9.2 Facility operators and transporters shall develop written procedures that provide for the proper course of action in the event that a mechanical or electrical power failure affecting the detector system occurs in an unattended facility. These procedures shall be written in accordance with the manual gauging operations given in 2.1 for attended facilities without detectors, which provides for using on-site personnel to gauge tanks during product transfer until such time that the detector system is repaired and back in operation.

APPENDIX A—OVERFILL PROTECTION SYSTEM INSTALLATION

A.1 General

A.1.1 It is important for an overfill protection system to be installed correctly, inspected and tested after installation, and then inspected and tested periodically to ensure its reliability. Where work requires personnel to go onto floating roofs reference should be made to API RP 2026 *Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service.*

A.1.2 The method of overfill protection system installation depends on the following criteria:

a. The type of liquid level detector and alarm/signal system used.
b. The type, size, configuration, and condition of the tank.
c. Whether the tank is existing (either in or out of service) or a new construction.
d. The desirability of taking a tank out of service, if required, for installations involving hot work. (See API RP 2009 for guidance on hot work and API RP 2201 if hot tapping is required when installing overfill protection systems on tanks that are in service.)

A.1.3 Many methods exist for installing the various available liquid level detectors. The following two methods are the most commonly used:

a. In external installations, the detector is normally mounted in a chamber at grade level to allow for easy inspection, testing, and maintenance. An example of this method of installation is shown in Figure A-1.
b. Top mounting the detector on a tank does not usually require piping or hot work. This method of installation has been used successfully on covered and open-top floating-roof tanks and on cone-roof tanks with internal floaters. Examples are shown in Figures A-2 and A-3.

A.2 Positioning of Single-stage System High-high-level Detectors

A.2.1 In a single-stage system, the high-high-level alarm/signal activates when the product level reaches the high-high-level detector point. This point is usually set at a product level in the tank that is at or above the predetermined safe fill level (tank rated capacity), depending on the facility operator and transporter practices.

A.2.2 When a single high-high-level detector is installed on a tank, it should be positioned at a level point that will allow facility operator and/or transporter personnel adequate time to acknowledge and respond to the high-high-level alarm/signal before an undesired event occurs. Once this response lime is determined, the level height in inches equivalent to any number of minutes of product flow may be calculated using the formula in A.4.3.

A.3 Positioning of Two-stage System High-high-level Detectors

A.3.1 In a two-stage system, the first (high-level) alarm/signal activates when the product level surpasses the normal fill level (normal capacity) and before it reaches the safe fill level. The second (high-high-level) alarm/signal activates when the product level reaches the high-high-level detection point. This point is usually set at or above the safe fill level (tank rated capacity), depending on the facility operator and transporter practices.

A.3.2 In a single-stage system, where a single high-high-level detector is installed on a tank, it should be positioned below the overfill level (maximum capacity) to allow the facility operator and/or transporter personnel adequate time to acknowledge and respond to the high-high-level alarm/signal before an undesired event occurs. Once this response time is determined, the level height in inches equivalent to any number of minutes of product flow may be calculated using the formula in A.4.3.

A.3.3 In a two-stage system, the high-high-level detector should be positioned the same as the high-high-level detector in a single-stage system. In a two-stage system, the high-level detector should be set so that it is at least the same distance below the high-high-level detector as the high-high-level detector is below the overfill level.

A.3.4 When two-stage detector (high-level and high-high-level) systems are used, these systems shall be designed so that the failure of any component in the first stage (high-level detector) does not interfere with or incapacitate the operation of the second stage (high-high-level detector).

A.4 Determining Response Time

A.4.1 Response time is the maximum time allowable between the activation of an alarm/signal and the next subsequent predetermined event.

A.4.2 The high-high-level alarm/signal in a single-stage system and the high-high-level alarm/signal in a two-stage system shall be installed at levels designed to provide sufficient response time for an orderly shutdown or diversion of product to take place before an overfill occurs (see Figure A-4).

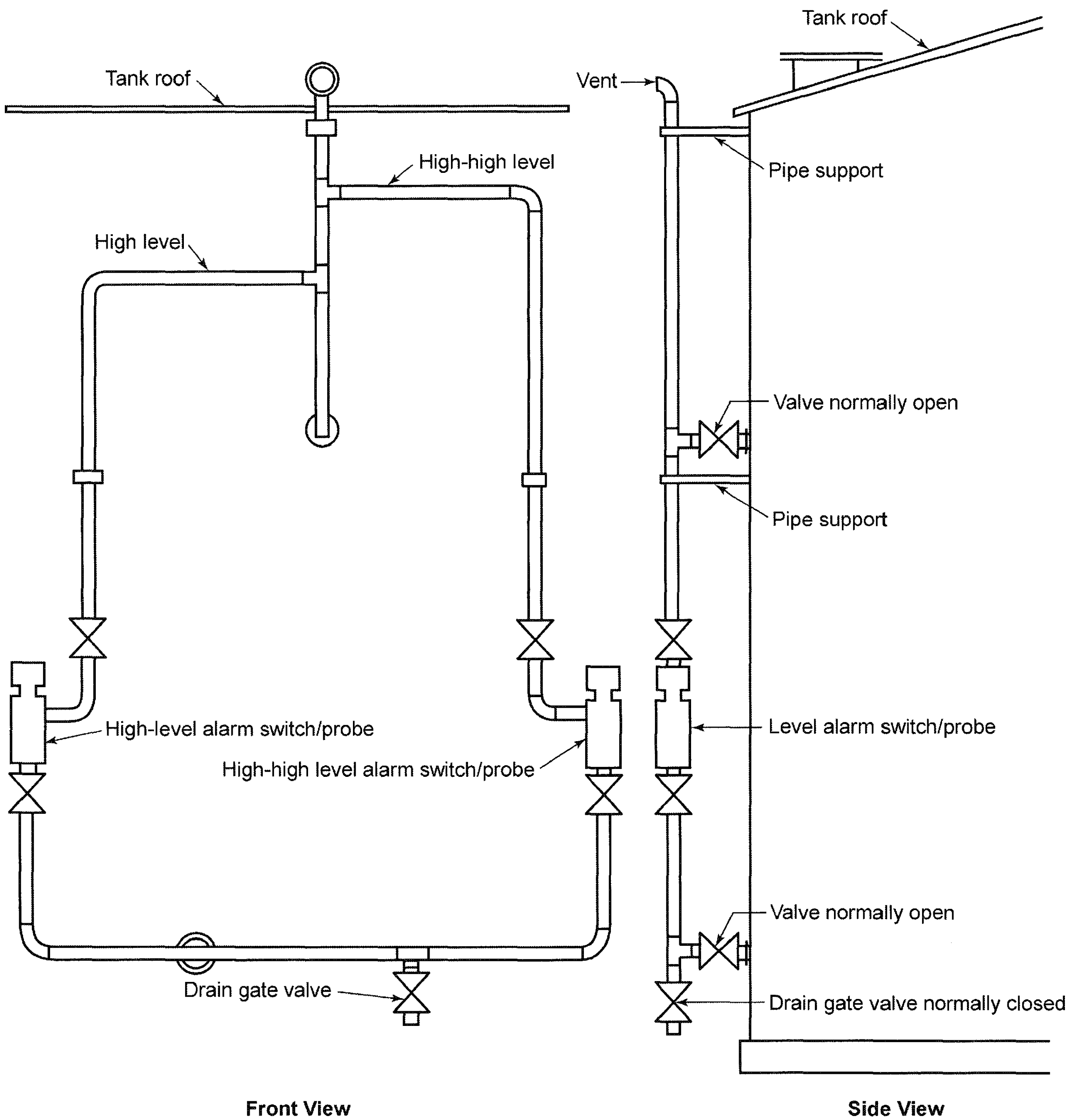
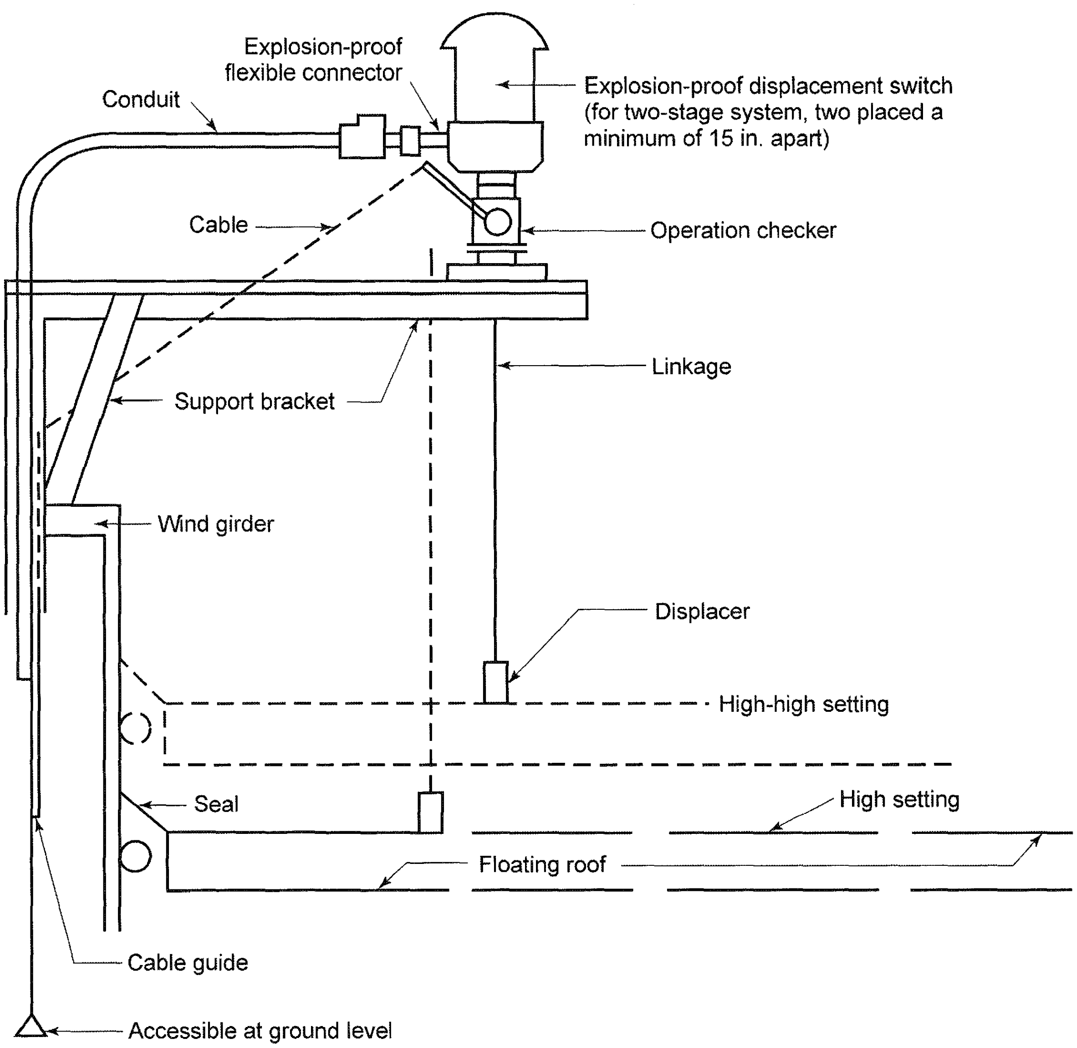
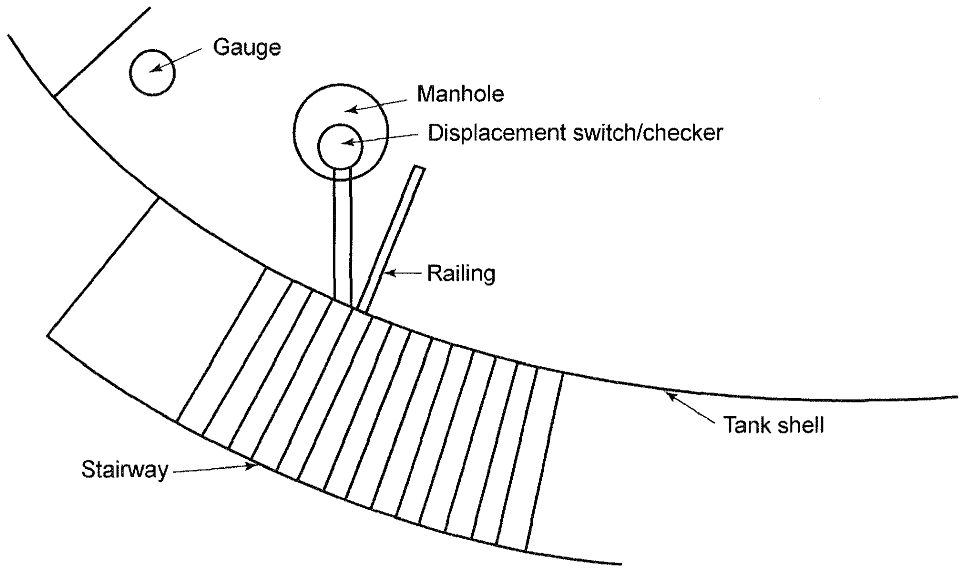


Figure A-1—Example External Chamber-type Detector Installation

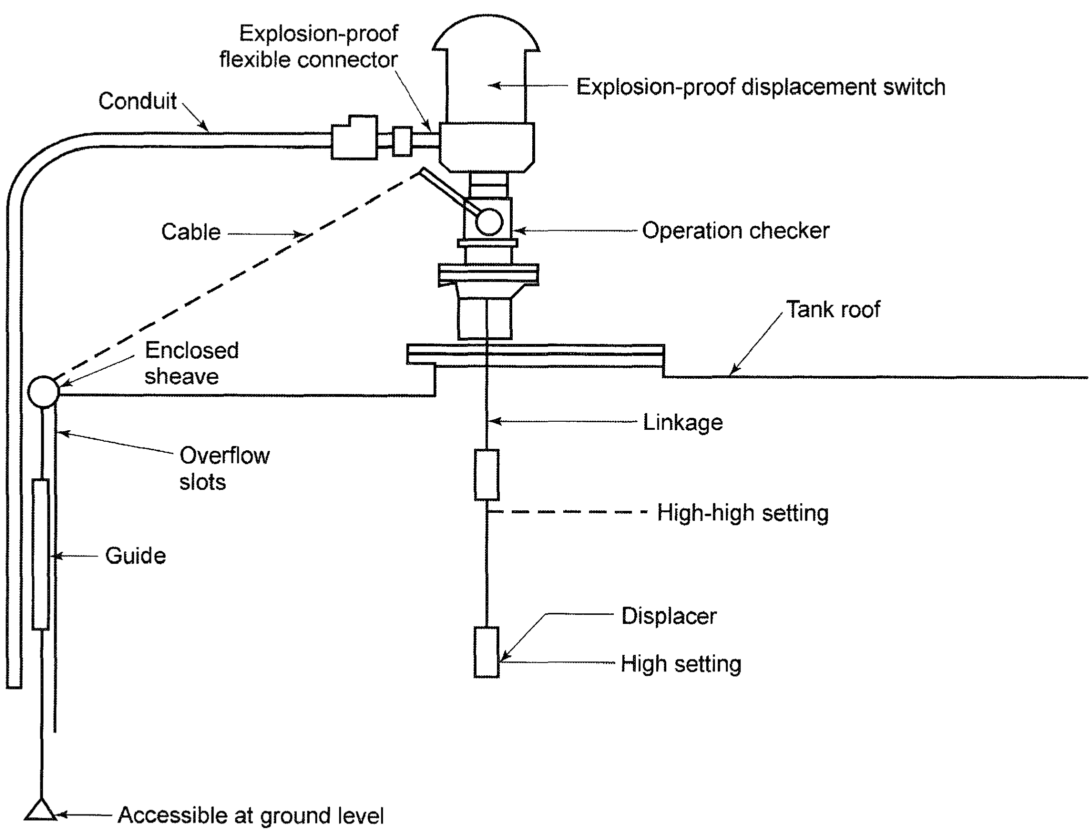


Note: External floating-roof tanks will require a support bracket attached to the tank exterior platform and stairway. It may be necessary to modify the existing platform to allow proper installation and safe inspection and maintenance of the alarm system. Electrical-conduit and operation-checker-cable mounts are to be secured to the tank top railing and stairway structure, using clamping devices.

Figure A-2—Example of a Two-stage Detector Installation for an External Floating-roof Tank

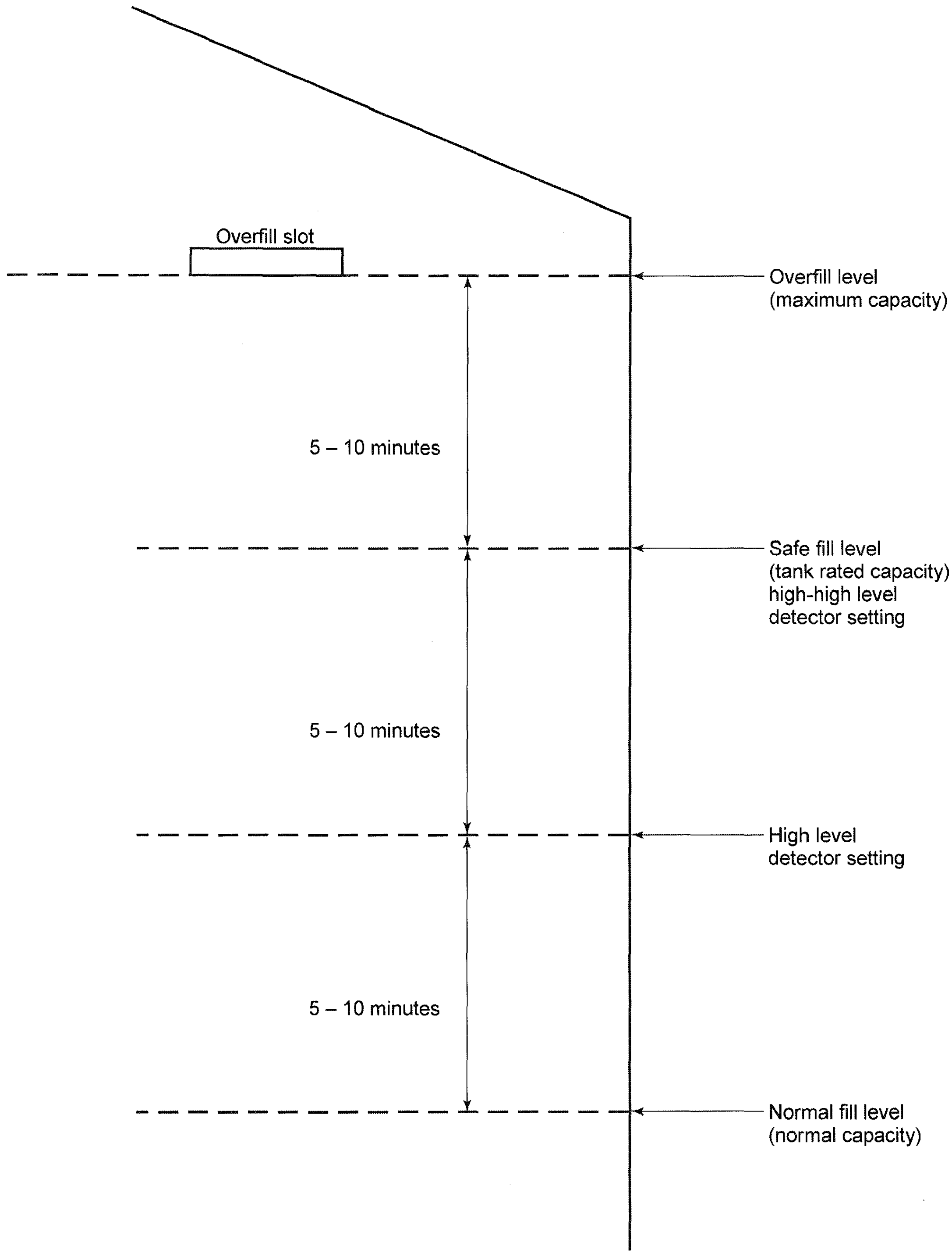


Plan



Elevation

Figure A-3—Example of a Two-stage Detector Installation for a Cone-roof Tank



Note: The times indicated are provided as an example only. Actual times may be longer or shorter, depending upon tank conditions and the facility operator practices.

Figure A-4—Example of Tank Level Settings Based on Response Time in a Two-stage Detector System

A.4.3 As a minimum, this amount of response time is determined by the volume of product that would enter the tank at the maximum fill rate:

a. During the time the facility operator (or transporter) would need to get personnel into position to start the shutdown or diversion, plus
b. The time required from the initiation to the completion of shutdown or diversion.

Once the amount of time required for response has been established by the operator (and agreed to by the transporter, where appropriate) the height differential in inches equivalent to any number of minutes of product flow into a specific tank may be calculated using the following formula:

$$h_m = TFH/5C$$

where

h_m = height differential, in inches,

T = minutes of product flow required to implement response action,

F = maximum flow rate into tank in barrels per hour,

H = total tank height, in ft,

C = tank rated capacity, in barrels.

A.4.4 Following are some considerations for determining total tank height:

a. *Floating-roof tanks*: When calculating total tank height for floating roof tanks (internal and external covered or open-top), some facility operators consider the floating roof high-leg setting or low-leg setting (depending on facility operator practices as to how legs are normally set for tanks in operation) to be the bottom of the tank. This is to prevent withdrawing so much product that a void space is created between the floating roof and the remaining product level. The overfill level is considered to be the point where the tank is filled as close to the top of the shell or overflows as permitted by facility operator procedures without a spill or overflow occurring, and where the floating roof does not contact any shell appurtenances or expose the roof seals.
b. *Cone-roof tanks*: When calculating the total tank height for cone-roof tanks, some facility operators consider the bottom to be the point at which the pump loses suction. This is to avoid pumping out tank bottoms. The overfill level is considered to be the point where the amount of product contained in the tank is as close to the top of the shell or overfills as permitted by facility operator procedures without a spill or overflow occurring.
c. *All tanks*: When calculating the total tank height for all tanks, facility operators must also consider physical tank conditions (leaks, structural strength, and so forth) or operating practices (partial or split product receipts, relief conditions, and so forth) that limit the tank capacity to less than normal.

A.4.5 To provide a safety factor, some facility operators consider the true working capacity of the tank to be the space between the bottom of the tank (as described above) and the safe fill level (tank rated capacity).

A.4.6 Following is an example using the formula in A.4.3 to calculate the height differential required to provide 15 min. of product flow time, which (in this example only) is deemed sufficient for reaction and shutdown or diversion of product by facility operator or transporter personnel before reaching the overfill level (maximum capacity):

Assuming that the maximum flow rate (F) is 4000 barrels per hour, the total tank height (H) is 50 ft, and the tank rated capacity (C) is 50,000 barrels; the detector will have to be placed 12 in. below the overfill level to provide 15 min. response time (T):

$$TFH/5C = h_m = (15)(4000)(50)/5(50{,}000) = 12 \text{ in.}$$

$$\frac{TFH}{5C} = h_m = \frac{(15)(4000)(50)}{5(50{,}000)} = 12 \text{ in.}$$

Note: Although 15 min. is used in the example, the actual time will vary depending on the operating conditions and the response requirements.

A.5 Automatic Tank Gauges

A.5.1 Many tanks are equipped with mechanical or electronic automatic tank gauges. A malfunction of these gauges may contribute to tank overfills.

A.5.2 Electronic automatic tank gauging systems with self-check features are available that can reduce the risk of a product overfill caused by the malfunction of an automatic tank gauge.

A.5.3 Failure of self-checking automatic tank gauging systems is possible. To meet the requirements of NFPA 30-2003, Section 4.6.1.1(2) and (3), independent level switches must be installed for single and two-stage level detector systems.

A.6 Selection and Installation of Contact Switches and Probes

A.6.1 In the selection of high-level and high-high-level detector contact switches/probes, consideration should be given to problems associated with vibration and with corrosion from humid or marine environments.

A.6.2 Many electronic level detector systems use probes as sensing devices. False alarms may occur due to condensation of vapors on these probes. To minimize vapor build-up on side mounted probes, probes should be installed at an angle of 20° or more from the horizontal.

APPENDIX B—DETERMINING TANK CAPACITY AND PRODUCT LEVELS

B.1 General

B.1.1 The capacity of a tank depends on the tank's type, size, configuration, and condition, and on the specified design liquid tank product levels. For internal and external (covered and open-top) floating-roof tanks, tank capacity also depends on the type of floating roof, roof seal, roof cover, internal tank construction, and appurtenances.

B.1.2 Each tank covered by this standard should have a current, up-to-date tank strapping chart (tank record) that depicts the actual conditions in the tank. The key values entered on the chart (or tank record) shall be calculated and/or established by the facility operator (see Figures B-1 and B-2). These values include:

a. Normal capacity (normal fill level),
b. Tank rated capacity (safe fill level), and
c. Maximum capacity (overfill level),

for each tank receiving product in the facilities covered by this document.

B.1.2.1 Facility operators shall indicate the normal capacity (normal fill level), tank rated capacity (safe fill level), maximum capacity (overfill level), and any other critical capacities and levels on the tank strapping chart, record card, computer record and/or calibration chart, and make this information available to transporters.

B.1.2.2 The overfill level should be verified by an inspection of the tank. The distance from the bottom of the overflow slot to the bottom of the tank should correspond to the last entry on the tank chart or record.

B.1.2.3 Tank capacity levels should be reflective of the floating roof and internal appurtenances.

B.1.2.4 If acceptable calibration charts are not available, tanks shall be calibrated in accordance with API Std 2550, and charts developed.

B.1.3 Management of change practices shall be applied and levels and detector settings adjusted whenever a tank is modified so as to affect its capacity. This includes, but is not limited to, operational changes (such as a change in receiving flow rates) and mechanical changes (such as providing a double bottom, adding an internal floating roof, changing construction of the floating roof, or placing a cover over an open-top tank).

B.1.4 Regardless of the capacity at any given level, if low pressure station piping relief is routed into a tank, extra capacity must be allowed for detector positioning.

B.1.5 Consult with the tank manufacturer if there is any question about tank capacity.

B.2 Normal Capacity (Normal Fill Level)

B.2.1 Normal capacity is the amount of product that can be contained in a tank when the tank is filled to its normal fill level.

B.2.1.1 The normal fill level is a predetermined distance below safe fill level (that is, normal capacity does not exceed tank rated capacity) and is usually as close to the top of the tank as permitted by facility operator procedures.

B.2.1.2 The normal fill level is a level that allows time for appropriate action for the flow to be completely stopped or diverted before the level of the product in the tank reaches the established safe fill level. This time depends on tank size, facility operator and transporter practices, the anticipated time of response, and the time for completion of the manual or automatic shutdown or diversion.

For example, if it takes 15 min. to effectively stop product flow, the normal capacity would be determined by setting the normal fill level at least 15 min. below the safe fill level.

B.2.1.3 The normal fill level may also be a level determined by the operator depending on physical tank conditions (leaks, structural strength, and so forth) or operating practices (partial or split product receipts, relief allowances, and so forth) that limit the tank capacity to less than normal.

B.2.2 CONE (FIXED OR SEMI-FIXED) ROOF TANKS (WITHOUT AN INTERNAL FLOATING ROOF)

Normal capacity for cone (fixed or semi-fixed) roof tanks (without an internal floating roof) is when the tanks are filled to a predetermined level below the safe fill level (tank rated capacity), and the amount of product contained in the tanks is as close to their safe fill level as permitted by facility operator procedures.

Note: In lieu of other information or if operating details are unknown, the normal capacity would typically be 90% of the maximum capacity of cone (fixed) roof tanks.

B.2.3 INTERNAL FLOATING-ROOF TANKS (AND COVERED EXTERNAL FLOATING-ROOF TANKS)

Normal capacity for internal floating-roof tanks and external (open-top) tanks that have been converted to covered floating-roof tanks is when the tanks are filled to a predetermined elevation below the safe fill level (tank rated capacity), as close to the safe fill level as permitted by facility operator practices, and the floating roof does not contact either the external roof or tank shell appurtenances.

Note: In lieu of other information or if operating details are not known, the normal capacity would typically be 80% of the maximum capacity of covered and internal floating-roof tanks.

B.2.4 EXTERNAL (OPEN-TOP) FLOATING-ROOF TANK

Normal capacity for external (open-top) floating-roof tanks is when the tanks are filled to a predetermined elevation below the safe fill level (tank rated capacity), which is as close to the safe fill level as permitted by facility operator practices, and the floating roof does not contact any shell appurtenances or expose the roof seals.

Note: In lieu of other information or if operating details are unknown, the normal capacity would typically be 85% of the maximum capacity of open-top floating-roof tanks.

B.3 Tank Rated Capacity (Safe Fill Level)

B.3.1 TANK RATED CAPACITY

Tank rated capacity is the amount of product that a tank can contain when the tank is filled to its safe fill level.

B.3.1.1 The safe fill level is set at a predetermined distance below the overfill level and is as close to the top of the tank as permitted by facility operator procedures.

B.3.1.2 The safe fill level is a level that allows time for appropriate action to be taken for the flow to be completely stopped or diverted before the level of the product in the tank reaches the established overfill level. This time depends on tank size, facility operator and transporter practices, the anticipated time of response, and the time for completion of the manual or automatic shutdown or diversion. For example, if it takes 10 min. to effectively stop product receipt, the tank fill capacity is determined by setting the safe fill level at least 10 min. below the overfill level.

B.3.1.3 The safe fill level is also determined by the facility operator, depending on physical tank conditions (leaks, structural strength, and so forth) or the facility operating practices (partial or split product receipts, relief allowances, and so forth) that limit the tank capacity to less than normal.

B.3.2 CONE (FIXED OR SEMI-FIXED) ROOF TANKS (WITHOUT INTERNAL FLOATING ROOFS)

The tank rated capacity for cone (fixed or semi-fixed) roof tanks (without internal floating roofs) is the contained product volume up to the horizontal leg of the angle at the top of the shell (where the shell joins the roof plate steel) or when the liquid is approximately 6 in. below the invert level of the side mounted foam piping or the tank vents, whichever is lower. The tank rated capacity is usually achieved when tanks are filled as close to their maximum capacity as permitted by facility operator procedures.

Note: In lieu of other information or if operating details are unknown, the tank rated capacity of cone (fixed) roof tanks is typically 97% of the maximum capacity.

B.3.3 INTERNAL FLOATING-ROOF TANKS (AND COVERED EXTERNAL FLOATING-ROOF TANKS)

The tank rated capacity for cone-roof tanks with internal floating roofs or decks (and external [open-top] floating-roof tanks that have been provided with fixed roofs [converted to covered internal floating-roof tanks]) is the contained volume when either of the following conditions exist:

a. The highest point of the internal floating roof or the deck is 6 in. below any contact with interior obstructions, or

b. The liquid is approximately 6 in. below the lower edge of the overfill scuppers, vent openings, or foam chambers.

The tank rated capacity is usually achieved when the tanks are filled as close as possible to their maximum capacity as permitted by facility operator procedures and to the maximum allowable elevation of the floating roof (without impacting the external roof or contacting tank shell appurtenances).

Note: In lieu of other information or if operating details are not known, the tank rated capacity is typically 90% of the maximum capacity of cone (fixed or semi-fixed) roof tanks with internal floating roofs or decks.

B.3.4 EXTERNAL (OPEN-TOP) FLOATING-ROOF TANKS (CAPPED AND UNCOVERED)

The tank rated capacity for external (open-top) floating-roof tanks and external (open-top) floating-roof tanks provided with weatherproof caps, geodesic domes, or similar covers is when the tanks are filled as close as possible to their maximum capacity as allowed by facility operator procedures (usually a predetermined distance below maximum fill height). For external floating-roof tanks, either open-top or with covers, the tank rated capacity is determined based on the following:

a. When only a mechanical shoe primary seal is used, the tank rated capacity is the contained volume when the topmost part of the shoe is approximately 6 in. above the shell rim.

b. When only a flexible wiper, resilient filled or other type of primary seal is used, the tank rated capacity is the contained volume when the topmost part of the upper seal is approximately 6 in. below the shell rim.

c. When a secondary seal is used in combination with any type of primary seal, the tank rated capacity is the contained volume when the topmost part of the secondary seal is approximately 6 in. below the shell rim.

d. The tank rated capacity must provide for approximately 6 in. of clearance between the roof and foam piping, appurtenances, or other shell protrusions.

Note 1: In lieu of other information or if operating details are unknown, the tank rated capacity of external floating-roof tanks is 95% of the maximum capacity of the tanks.

Note 2: When a weatherproof cap, geodesic dome, or similar cover is placed on top of an open-top floating-roof tank, the tank rated capacity shall be reevaluated to determine if a change is required.

B.4 Maximum Capacity (Overfill Level)

B.4.1 Maximum capacity is the level of product in a tank when the tank is filled to its overfill level. This is the level at which any additional product will overflow and spill out of the tank, and/or in the case of a floating-roof tank, where contact or damage will occur between the floating roof and the tank structure or appurtenances.

TANK DETECTOR LEVEL AND FILL LEVEL WORK SHEET

FACILITY ______________________________

TANK NO. ______________________________

LOCATION ______________________________

PREPARED BY ___________________________

DATE _________________________________

I. Receipt Information

1. Maximum fill rate = *A* ____________ (barrels/minute) (*A*)
2. Maximum time for facility operator or transporter to begin to start shutdown or diversion = *B* ____________ (minutes) (*B*)
3. Maximum time to achieve total shutdown or diversion after facility operator or transporter begins response = *C* ____________ (minutes) (*C*)
4. $D = B \times C$ ____________ (minutes) (*D*)
5. Volume received during time period $E = A \times D$ ____________ (barrels) (*E*)
6. Volume (*E*) with safety factor (*F*) $F = E$ x (factor) safety factor to be determined by facility operator ____________ (barrels) (*F*)

II. Detector and Fill Level Settings

1. Overfill Level (maximum capacity)

OFL = ____________ (barrels)

OFL = ____________ Feet ____________ Inches

2. High-level Detector Setting

OFL = ____________ (barrels)

Single and Two Stage Systems

OFL= ____________ Feet ____________ Inches

3. High-high Level Detector Setting

HLD = (HHLD) – (*C*) ____________ (barrels)

Two Stage Systems (only)

HLD = ____________ Feet ____________ Inches

4. Normal Fill Level (normal capacity)

Single Stage System

NF = (HHLD) – (*D*) ____________ (barrels)
NF = ____________ Feet ____________ Inches
NF = (HHLD) – (*B*) ____________ (barrels)
NF = ____________ Feet ____________ Inches

III. Tank Information

High Legs Level = ____________ Barrels = ____________ Feet ____________ Inches

Low Legs Level = ____________ Barrels = ____________ Feet ____________ Inches

Figure B-1—Tank Detector Level and Fill Level Work Sheet

TANK OVERFILL LEVEL WORK SHEET AND RECORD

FACILITY ______________________________

TANK NO. ______________________________

LOCATION ______________________________

PREPARED BY ___________________________

DATE _________________________________

Tank Height (*H*) = __________ Feet __________ Inches

Liquid Level (*L*) = __________ Feet __________ Inches

Available Storage (*S*) = __________ Feet __________ Inches

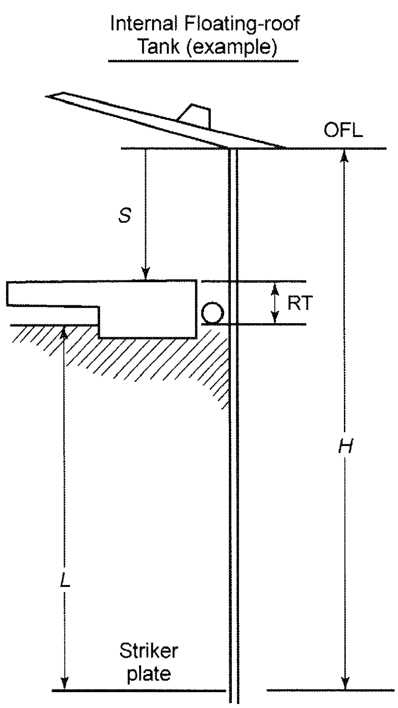
Other Allowances (*A*) = __________ Feet __________ Inches

Roof Thickness (Calculated) (RT) = __________ Feet __________ Inches

Overfill Level (Calculated) (OFL) = __________ Feet __________ Inches

(OFL) = *H* – RT – *A* = *H* (____) – RT (____) – *A* (____) = _____ Feet _______ Inches (*A* = 0 if no internal appurtenances)

Note: (*H*) and (*L*) must be measured from the same place (both from tank bottom or striker plate).



Dimensions

(*H*) = Tank height (from floor or from striker plate)

(*L*) = Liquid level (from floor or from striker plate)

(RT) = Effective roof thickness (from liquid level to upper seal extension)

(*S*) = Storage available until overfill level is reached

(*A*) = Allowances for other appurtenances in the shell

(OFL) = Overfill level above which spill or damage will occur

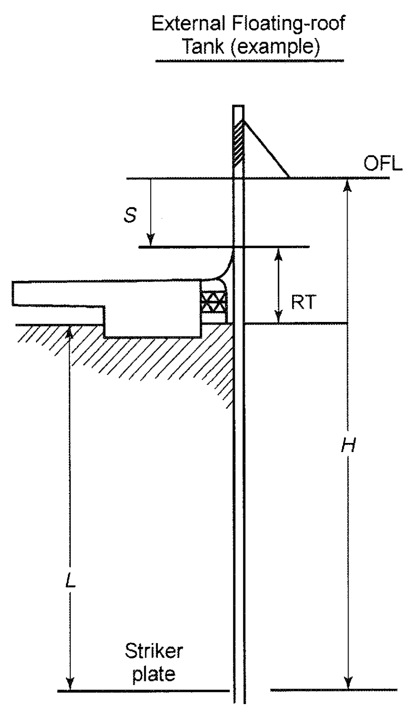


Figure B-2—Tank Overfill Level Work Sheet and Record

APPENDIX C—OVERFILL PROTECTION EQUIPMENT

C.1 General

C.1.1 Protection against tank overfill is best achieved by awareness of the available tank capacity and inventory and by the careful monitoring and control of product movement. The monitoring of available tank capacity may be accomplished either manually or by use of automatic overfill protection equipment. Automatic overfill protection systems are required at unattended facilities. They are not required at attended facilities.

C.1.2 Where overfill protection systems are provided on tanks that receive Class I or II liquids from mainline pipelines and/or marine vessels, they shall comply with the requirements of NFPA 30-2003, Sections 4.6.1.1, 4.6.1.2 and 4.6.1.3. Overflow protection systems shall be independent of any tank gauging device or system.

C.1.3 Depending on the specific design and type of operation, the overfill protection system typically includes the following basic components:

a. Liquid level detectors and alarm/signal switches/probes.
b. Alarm/signal control panels.
c. Audible and visible alarm/signals.
d. Power operated product flow control valves for automatic shutdown or product diversion.

C.1.4 Overfill protection system components must be compatible and work together to provide a dependable overfill protection system. An example of a typical overfill protection system is shown in Figure C-1.

C.1.5 Overfill protection systems shall be electrically supervised or provided with equivalent protection against failure, as required by NFPA 30-2003, Section 4.6.1.2. This means that an overfill protection system shall activate an alarm/signal either when power is interrupted or when the detector switch is activated because of an alarm/signal situation and the circuit is open.

C.1.6 Facility operators and transporters shall ensure that the overfill protection systems are in good operating condition at all times and are not disabled or disconnected. Operators and transporters shall inspect and maintain gauging equipment, detector instrumentation, and related systems at least once a year as required by NFPA 30-2003, Section 4.6.1.3(3).

C.1.7 Each facility and each tank covered by this document requires individual study and design criteria for the proper selection and installation of components to meet the operating and maintenance requirements of the facility operator and the transporter and to comply with this document and the applicable codes and regulations.

C.1.8 Since tanks covered by this document contain volatile, flammable hydrocarbon (Class I) or combustible hydrocarbon (Class II) liquids, the overfill protection system design shall specify equipment appropriate for the electrical classification of the area in which the equipment is to be installed (see API Std 500).

C.1.9 Where alternate Class I or Class II fuels, mixed fuels, and fuel additives are stored in tanks with overfill protection systems, the equipment and components shall be constructed of materials compatible with the liquids stored.

C.2 Liquid Level Detectors

C.2.1 Detectors are devices used to determine the product level in storage tanks and are activated as the product in the tank reaches pre-established levels. The following types of detectors (see examples in Figures C-2, C-3, and C-4) are typical of those used in tanks covered by this document:

a. Float detectors are used to determine product level in cone-roof tanks. As a tank is filled the product rises within the tank, lifting the float until a predetermined fill level is reached. The float then activates the alarm/signal.
b. Displacer detectors are sometimes used in lieu of float detectors to determine product level in tanks where product may be agitated, surging, foaming, or have low specific gravity.
c. Opto-electronic detectors are used to determine product level in all types of Class I and Class II liquid storage tanks. Opto-electronic level detectors have an infrared light source that passes through a light conductor, which is refracted at a different rate when surrounded by air or gas vapors. For example, when a product rising in the tank reaches the pre-established high-level and high-high-level points, the liquid spilling over into the detector changes the refraction rate in the sensor and activates the alarm/signal.
d. Weight (slack cable) detectors are used to determine product level in a floating-roof tank. As the tank is filled, the floating roof rises to a predetermined fill level where it contacts the weight. As the weight is lifted by the roof, the cable goes slack and the level switch opens, activating the alarm/signal.
e. Densitometer (measuring gauge type) detectors use radioactive devices to identify liquid levels at predetermined positions.
f. Other detectors also used include capacitance, thermal, infrared, optical, ultrasonic, radio-frequency emittance and gravity-mass measurement.

C.2.2 Float detectors may be used in cone-roof tanks, or displacer detectors may be used in tanks containing agitated, surging, foaming, or low specific gravity products.

C.2.2.1 When selecting float or displacer detectors, the facility operator must know the specific gravity of the product

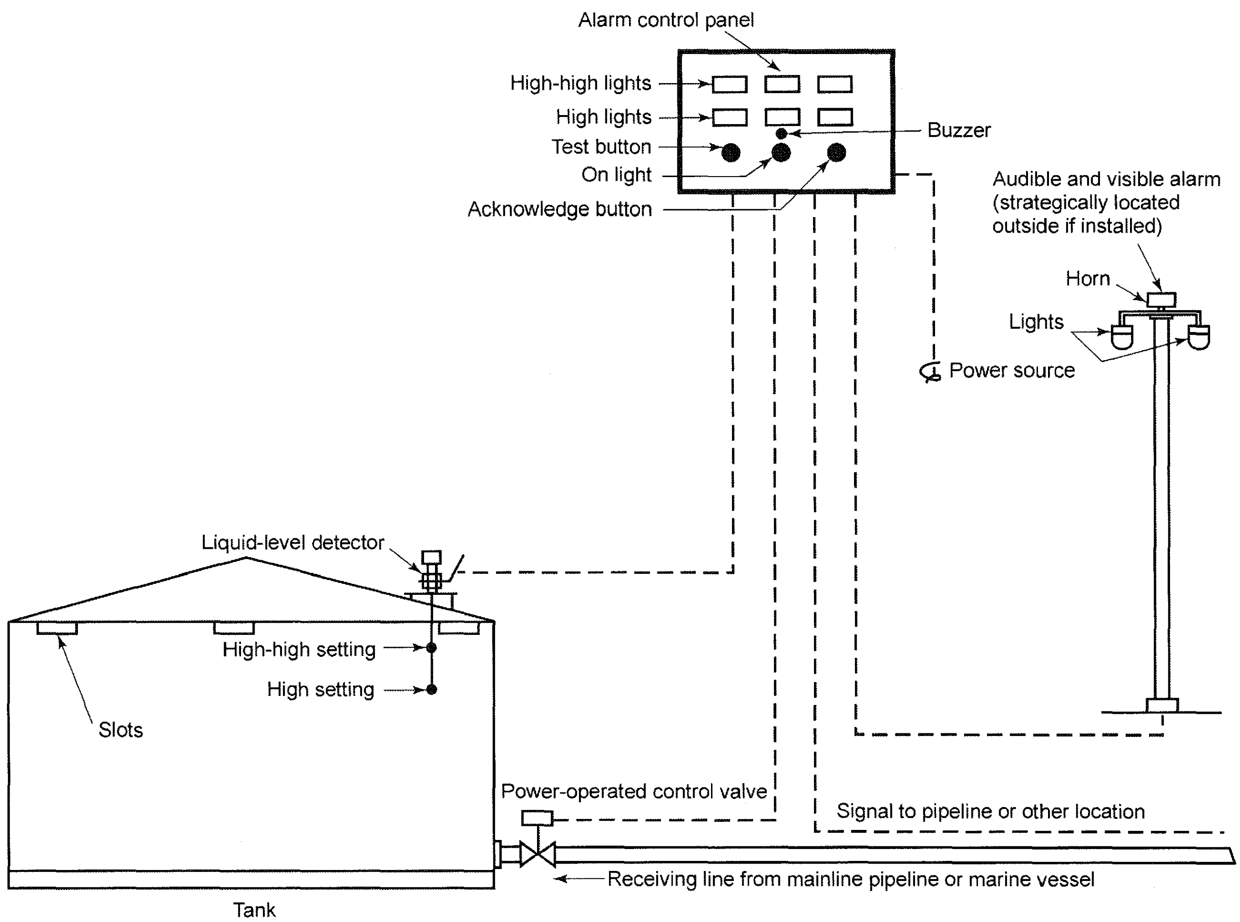


Figure C-1—Example of a Two-stage Overfill Protection System

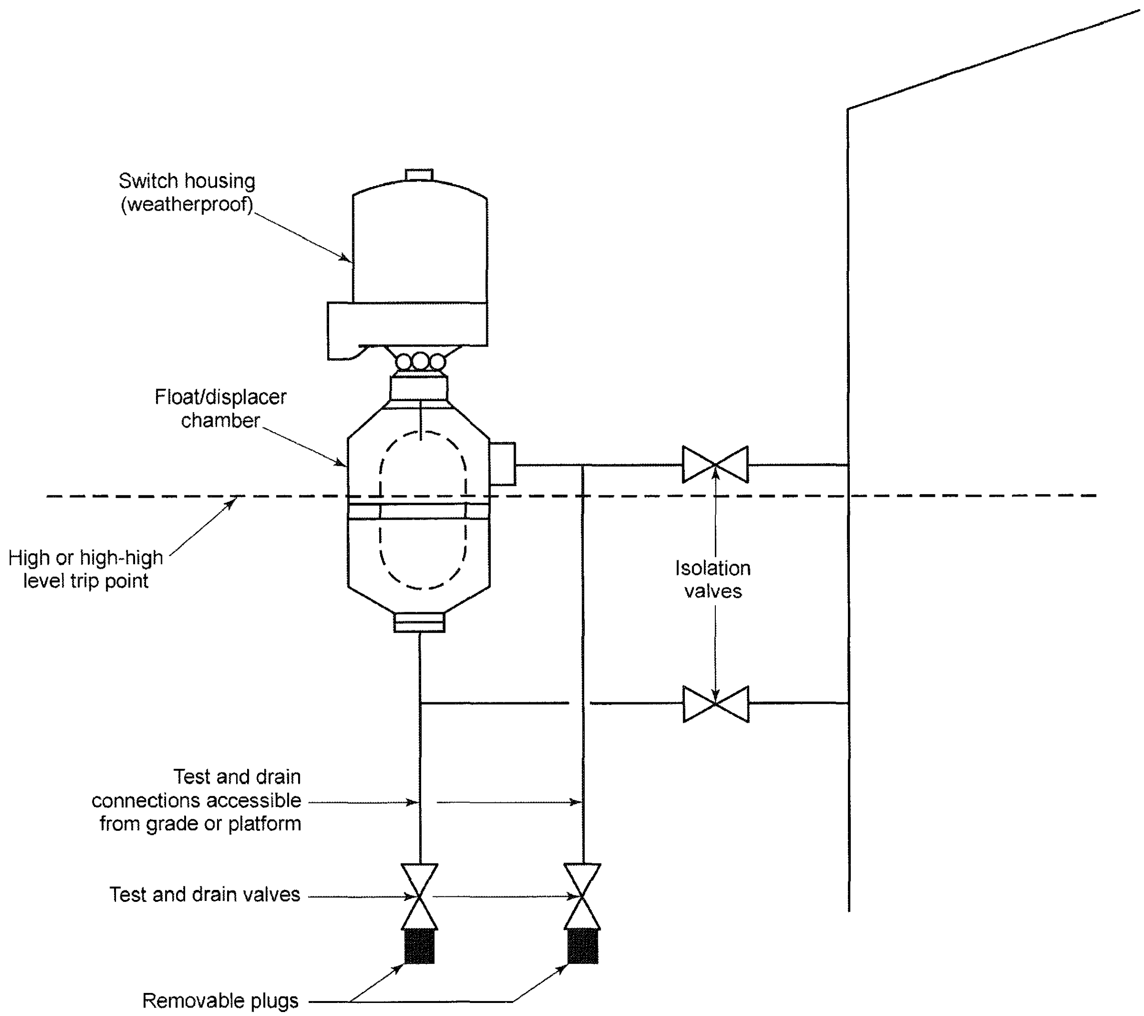


Figure C-2—Example of an External Chamber-type Float Switch

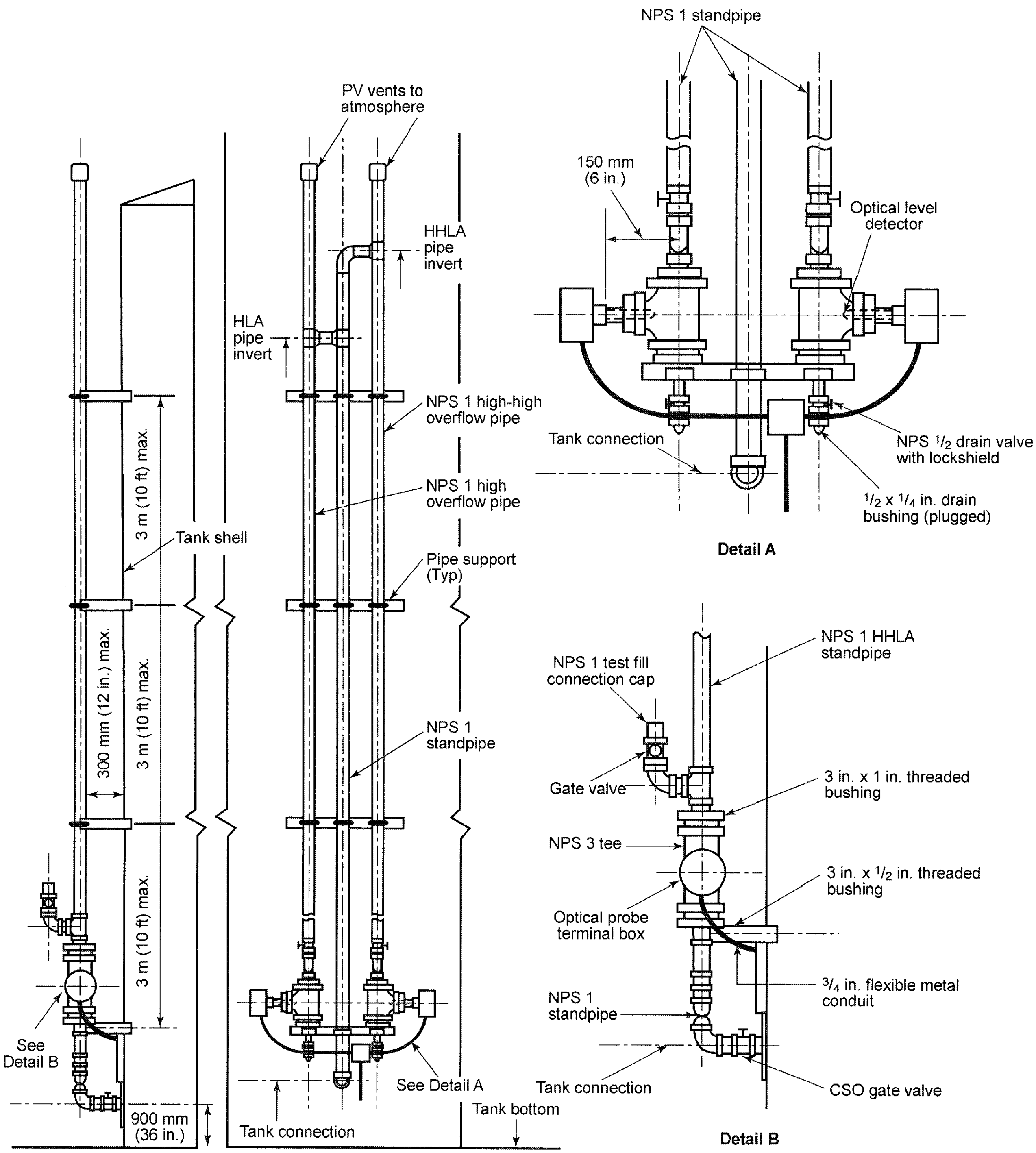


Figure C-3—Example of an Optical High-level Detector

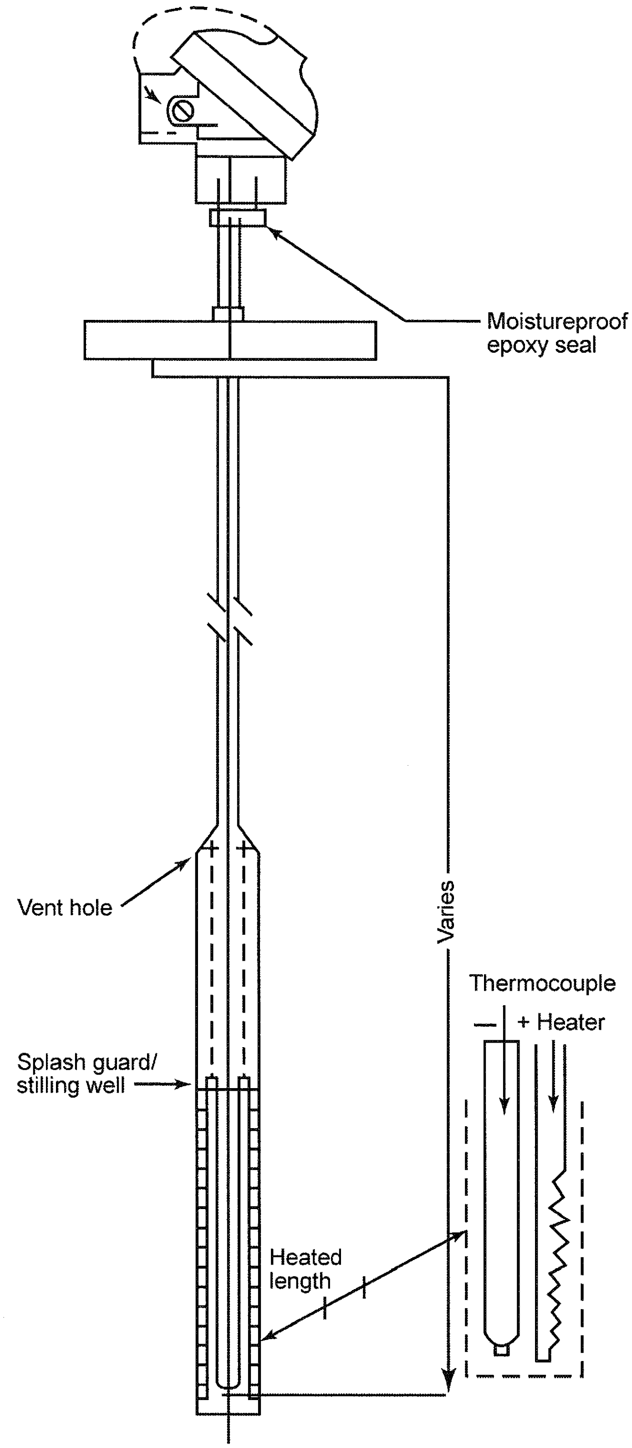


Figure C-4—Example for a Heated Thermocouple Assembly—High-level Probe stored in the tank to ensure that the float or displacer will float on top of the liquid surface and not be submerged.

C.2.2.2 Displacer and float detectors must be regularly inspected, tested, and properly maintained to ensure reliable operation.

C.2.3 If weight detectors are used, the specific gravity of the product stored must be determined so that the displacer will float on top of the product in the event that the floating roof sinks. Weight detectors require regular inspection and maintenance to ensure operability.

C.2.4 Capacitance, radio frequency emittance, and ultrasonic level detectors are recommended for tanks outside the scope of this standard which store heavy, viscous petroleum liquids, such as asphalt and residual fuel oil, because they are less affected than float or displacer types by product buildup on the detector element.

C.2.5 Opto-electronic detectors have control units equipped for simulation of alarm conditions to verify the operation of the control unit's circuit. An advantage of this type of detector is that the system can be easily tested, simulating actual alarm/signal conditions by subjecting the sensor to a small amount of liquid.

C.2.6 Selection of detectors depends on many factors, including but not limited to the following:

a. Type of tank, construction, tank appurtenances, and roof.
b. Product stored in the tank.
c. Weather, humidity, and other environmental conditions.
d. Electrical rating and classification requirements.
e. Type of alarm/signal required.
f. Inspection, testing, and maintenance requirements.
g. Facility operator and transporter policies, applicable codes and regulatory requirements.
h. Failure modes.
i. Static electricity discharge considerations.
j. Hot work requirements during installation.
k. Other factors resulting from local considerations and conditions.

C.2.7 Caution should be exercised in the selection and installation of liquid level detectors and other overfill protection system components in tanks, so that they do not create a point source for static electricity discharge from the surface of the liquid to the tank shell. (See API RP 2003).

C.2.8 Apply good management of change procedures whenever changes occur in operating practices, products stored, tank modification, and so forth to ensure that the proper detectors are used.

C.3 Alarm/Signal Control Panel (Annunciator)

C.3.1 The overfill protection system alarm/signal control panel (annunciator) shall be located so that assigned facility operator and/or transporter personnel are readily alerted to take response action when a detector signals that the liquid level in a tank has reached a predetermined height. (See Figure C-1).

C.3.2 Different types of alarm/signal control panels can be used to monitor detectors and to provide output to other operating devices. The final control panel selection depends on facility operator and transporter practices, the various functions desired, and the local requirements.

C.3.3 Alarm/signal control panels or other devices used in lieu of alarm/signal control panels (that is, annunciators, computer display systems, and so forth) shall include appropriate visible and audible alarms with test features, power backup, and communications to remote locations, such as, but not limited to, the following:

a. Alarm/signal indicator lights. Two visual indicator light lenses are recommended for each tank. If only one lens is used, the light should flash when the tank goes into alarm/signal condition and light steadily after the alarm/signal is acknowledged. Lens colors may be selected in accordance with facility operator or transporter practices or local requirements.
b. A control panel audible alarm/signal with an audible silence/acknowledge feature.
c. A control panel and overflow prevention system self test feature.
d. Device(s) to activate visible display signals and/or audible alarms to alert personnel at locations remote from the control panel location.
e. Device(s) to activate power-operated valves for automatic shutdown or diversion.
f. Device(s) to signal to, or communicate with, remote locations (that is, pipeline control centers, facility operator remote offices, marine dock, security services, and so forth).
g. A built-in battery system and alarm/signal to indicate a power failure to the alarm/signal control system.
h. An electrical supervision system or equivalent.
i. An alternate power supply when loss of main power system will result in an undetected high-level situation.

C.3.4 Alarm/signal control panels should not have an operating deactivation switch that turns off the system. The circuit breaker at the main electrical panel should be used only to deactivate the system for routine maintenance and testing.

C.4 Audible and Visible Alarm/Signals

C.4.1 In addition to the control panel alarm/signals, devices to alarm/signal high and high-high product level conditions in tanks should be installed in other facility areas, such as the storage tank area, marine dock, pipeline manifold, and/or transporter control location, where the devices can be readily seen and/or heard by the personnel in those areas who are responsible for initiating the corrective action to prevent an overfill. Facilities where personnel are not on duty full time during receipts shall ensure that the alarm/signals are activated at locations where personnel can respond and initiate action to prevent an overfill incident.

C.4.2 Selection of audible and visual alarm/signals (horns, lights, and so forth) shall comply with the electrical classification of the area in which they are installed (See API RP 500).

C.4.3 To prevent confusion when any emergency condition develops, audible and visual alarms/signals associated with the overfill protection system should be distinctive from other alarms/signals installed in the facility or transporter location. In addition, in two-stage detector systems, the high-level alarm/signal should be distinctive from the high-high-level alarm/signal.

C.4.4 The visual/audible alarms/signals shall be activated in the event of the following occurrences:

a. Product level in the tank reaches the predetermined alarm/signal level.

b. Loss of the main electrical power at the facility.

c. An electrical break or ground fault in the high-high-level detection system circuit or the alarm/signal device circuit.

d. The failure or malfunction of the high-high-level detection system control equipment (internal supervision) or signaling devices.

e. The removal of triggering devices (floats, displacers, and so forth) from the system.

C.5 Power-operated Valves

C.5.1 Power-operated valves may be used for automatic shutdown or product flow diversion. Power-operated valves may be electrically, hydraulically, or pneumatically operated.

C.5.2 When automatic shutdown or diversion systems are provided, the receiving valve or valves for each tank shall be equipped with a power actuator that has provisions for both local and remote control.

C.5.2.1 A hand-controlled switch should be provided that may be used to select the off, remote, or local control position.

C.5.2.2 Position indicators should be provided that show the valve position and operation.

C.5.2.3 The valve actuator shall also be equipped for manual operation.

C.5.3 The valve travel time should prevent excessive pressure or hydraulic shock when the valve is closed.

C.5.3.1 An analysis shall be conducted by the facility operator of the facility piping system to determine whether a relief system is needed to protect low-pressure manifold piping.

C.5.3.2 The design and operation of the shutdown system shall be coordinated with, and be acceptable to, the transporter.

C.5.4 When an alarm/signal is received that a tank has been filled to its predesignated automatic shut down or diversion level, the power-operated valve system shall provide for the following actions:

a. Immediately start to close the valve(s) at the predetermined rate established by the facility operator and the transporter.

b. Block out remote operation of the valve(s) until the alarm/signal resets after transfer.

c. The valve(s) should only be manually operable, at the valve location(s), as long as the product level in the tank remains above the high-high detector level setting.

d. If a valve is being opened remotely when the high-high-level detector alarm/signal is received, the valve shall stop opening and immediately start to close at a predetermined rate.

e. If a valve is being closed remotely when the high-high-level detector alarm/signal is received, the valve shall continue to close at the predetermined rate.