Bottom Loading and Vapor Recovery for MC-306 & DOT-406 Tank Motor Vehicles

API RECOMMENDED PRACTICE 1004
EIGHTH EDITION, JANUARY 2003

American Petroleum Institute

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Downstream Segment

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FOREWORD

This Recommended Practice is intended to provide guidelines for the design and operation of bottom-loading and vapor-recovery systems of MC-306 & DOT-406 tank motor vehicles.

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Bottom Loading and Vapor Recovery for MC-306 & DOT-406 Tank Motor Vehicles

1 General

1.1 BACKGROUND

In 1960, the API Transportation Department studied bottom loading and prepared a report that pointed out the need for uniform standards for tank vehicle bottom-loading equipment. The API Marketing Department expressed interest in the project, and in 1961, a joint committee was formed to begin work on standardization.

By 1965, the joint committee reached a consensus on standardization procedures. To ensure interchangeability, a tank vehicle adapter had to be developed that would be available to all manufacturers and users. With the cooperation of all known interested manufacturers, recommended criteria for the adapter were established.

In October 1967, the first edition of API RP 1004 was published. In 1971, changes in the 1967 edition were necessary, and another joint committee was formed to produce a second edition, which was published in June 1972. Again, all known interested manufacturers cooperated in writing the revised standard.

The increasing requirements for vapor-recovery systems dictated a revision of API RP 1004 to expand the material on tank vehicle recovery systems, to provide additional guidance, and to promote the compatibility of equipment. In addition, a requirement for a standard electrical connection between the vehicle and the loading island became necessary to tie the systems together. To disseminate this new material, Change 1 to the second edition was prepared by the joint committee and was distributed in January 1974.

The joint committee was discharged after distribution of Change 1. It was soon apparent that a continual update of the bottom-loading and vapor-recovery information would be required. Task groups were set up within the Transportation Department to prepare the third and subsequent editions. These task groups work closely with the Marketing Department, all known interested manufacturers of bottom-loading equipment and tank vehicles, and other users of tank vehicles.

1.2 PURPOSE

The purpose of this Recommended Practice (RP) is to provide guidance to users and manufacturers in the design and operation of bottom-loading and vapor-recovery systems to provide greater reliability and interchangeability with safe features.

2 Scope

2.1 This RP covers required and recommended features of the following aspects of bottom loading and vapor recovery:

a. The configuration and operation of 4-in. (101.6 mm) adapters for bottom loading.

b. Tank vehicles equipped for bottom loading or vapor recovery.

c. Secondary shutoff control systems.

d. Loading installations equipped for bottom loading or vapor recovery.

2.2 Since most petroleum terminals serve more than one tank truck carrier, guidelines are necessary to ensure that the equipment is compatible. Sections 4 through 7 describe means of attaining operating flexibility with vehicles equipped for bottom loading and vapor recovery. Where compatible equipment is required, certain features must be standardized; these items are listed as required features. Other features are desirable but are not essential to interchangeability; these are listed as recommended features.

2.3 For this edition of API RP 1004, all dimensions in customary units have been converted to the International System of Units (SI) and carried to decimal figures.

3 References

API

RP 1007 *Loading and Unloading of MC306/DOT406 Cargo Tank Motor Vehicles*

RP 2003 *Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents*

NFPA[1]

70 *National Electrical Code*

U.S. Military Specification[2]

CID-A-A-59326 *Commercial Item Description Coupling Halves, Quick-Disconnect, Cam-Locking Type*

EPA[3]

Standards of Performance for New Stationary Sources (40 Code of Federal Regulations Part 60.501. "Definitions:" and Part 60, Appendix A, Method 27, "Determination of Vapor Tightness of Gasoline Delivery Tank Using Pressure Vacuum Test")

Standards of Performance for Bulk Gasoline Terminals, (40 Code of Federal Regulations 60 Subpart XX, 60.500)

[1]National Fire Protection Agency, 1 Batterymarch Park, Quincy, Massachusetts 02269-9101

[2]U.S. Army Tank-automotive and Armaments Command, ATIN: AMSTAR D/210, Warren, Michigan 48367

[3]U.S. Environmental Protection Agency, U.S. Government Printing Office, Washington, D.C. 20402

TTMA[4]

RP No. 54-97 *External Work on Cargo Tank Motor Vehicles Which May Have Been in Service*

4 Bottom Loading for Tank Motor Vehicles

4.1 ADAPTER USED FOR BOTTOM LOADING

4.1.1 Required Features

4.1.1.1 Type

To mate with loading couplers, the tank vehicle adapter must have the basic configuration shown in Figure 1 (all tolerances are provided in the appropriate figure). In the open position, the adapter must have a clear, unobstructed opening 2 in. (50.8 mm) in depth, measured from the outer face or closure of the valve as shown in Figure 1. If a poppet device is used, the adapter poppet must have a travel of 2 in. (50.8 mm), measured from the sealing surface, as shown in Figure 1. The front face of the adapter poppet must be flat within 0.004 in. (0.102 mm), excluding the corner radius. No fastening device shall protrude above the general plane of the adapter face.

If an interlock control is installed on the adapter, its dimensions must conform to those shown in Figure 2. Table 1 provides equivalent SI values for the customary dimensions shown in Figures 1 and 2.

4.1.1.2 Actuation

The primary liquid control must be by means of the set stop meter on the loading island or a self-contained system on the tank vehicle. The coupler may be opened for loading by manual or automatic means.

4.1.1.3 Size of Product Opening

The adapter must have a product opening 4 in. (101.6 mm) in diameter at the exposed outer face or closure of the valve.

4.1.1.4 Pressure Rating

The adapter must be designed for a working pressure of 75 pounds per square in. (psi) (517 kilopascals) and shall not leak at 1.5 times working pressure.

4.1.1.5 Mounting

The mounting must be accomplished by using a Truck Trailer Manufacturers Association (TTMA) standard, lightweight, 8-hole, 4-in. (101.6 mm) flange.

[4]Tank Truck Manufacturers Association, 1020 Princess Street, Alexandria, Virginia 22314

Table 1—Conversion of Customary Units in Figure 1 and 2 to SI Units

English Dimensions (in.)	SI Dimensions (mm)
0.002	0.051
0.005	0.127
0.015	0.381
0.0625	1.588
0.125	3.175
0.190	4.826
0.250	6.350
0.375	9.525
0.750	19.050
1.000	25.400
1.500	38.100
2.000	50.800
2.060	52.324
2.250	57.150
2.440	61.976
4.000	101.600
4.250	107.950
5.250	133.350
5.750	146.050
6.000	152.400
6.500	165.100
7.250	184.150

4.1.1.6 Mating Action

The mating action must be of the push type, with provision for locking without rotating the loading coupler body. The coupling range must permit mating of the coupler to the adapter in any position in a range of 360 degrees, without any coupler contacting an adjacent adapter spaced on 10-in. (254-mm) centers.

A safety interlock or two-step action must be provided on the coupler to prevent any liquid flow while coupling or uncoupling.

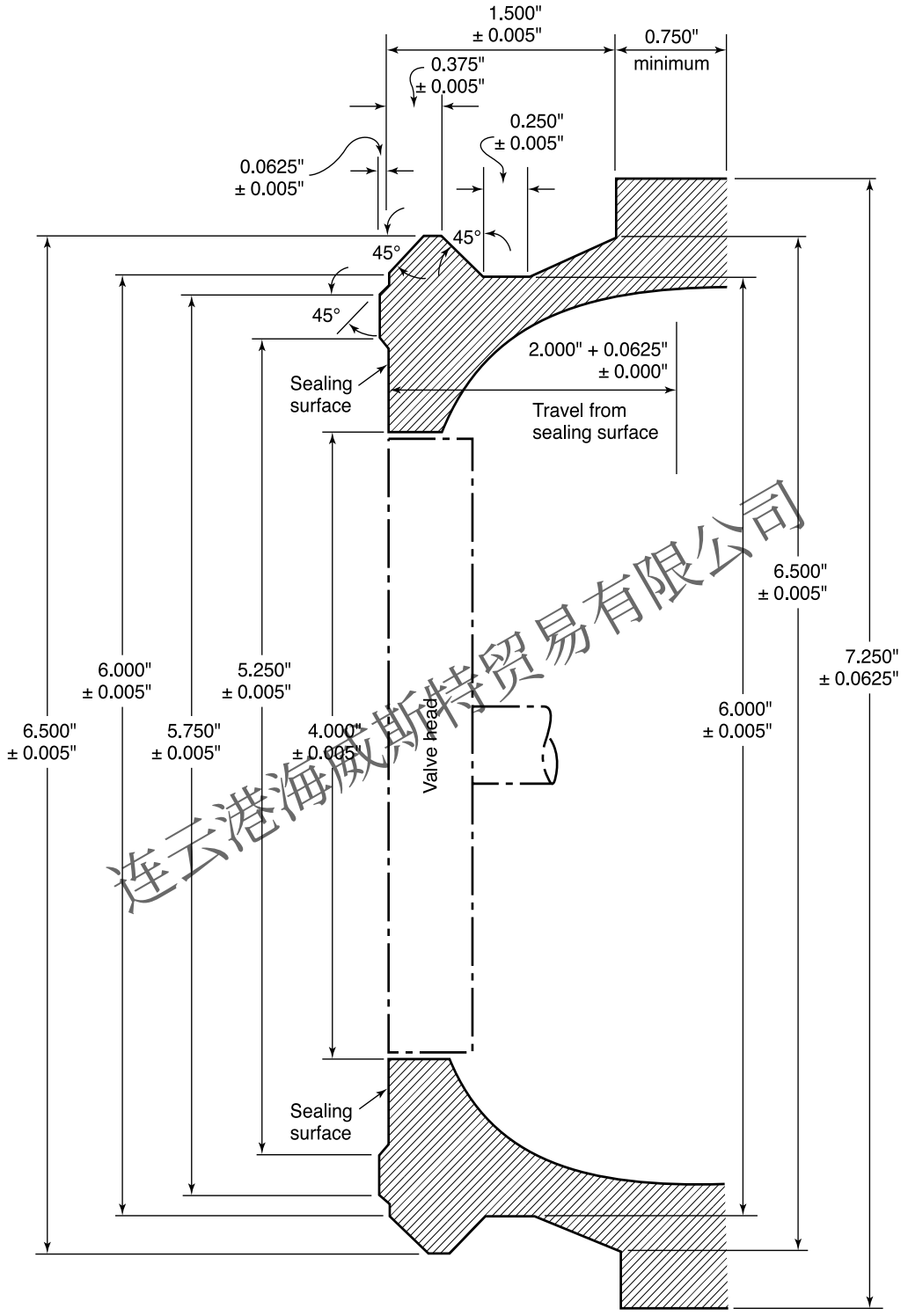
4.1.1.7 Sealing Surface

As shown in Figure 1, the sealing surface must have a circular finish of not more than 63 μin. (see Table 1 for SI conversions of customary units).

4.1.2 RECOMMENDED FEATURES

4.1.2.1 Overall Size

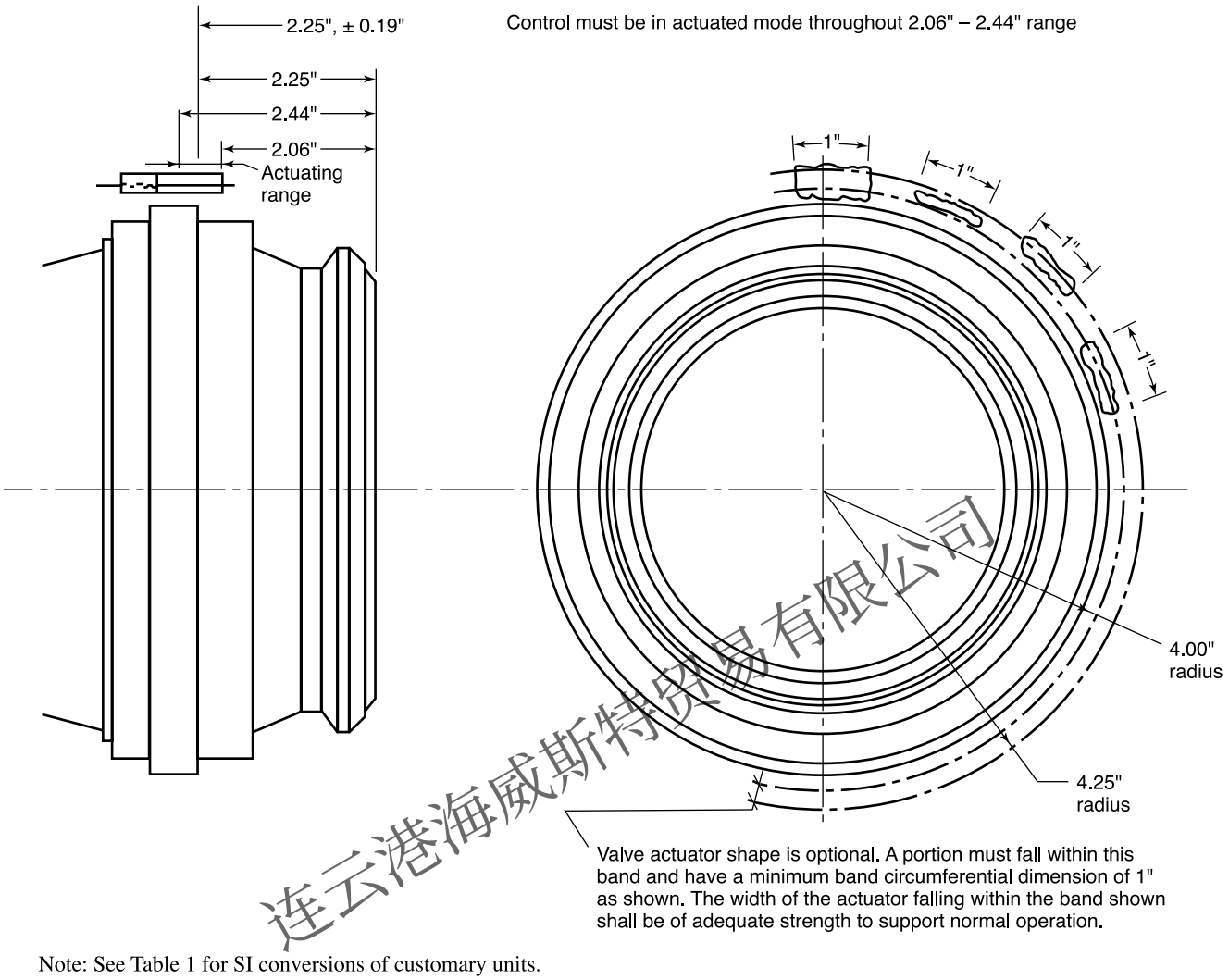
The adapter should be as compact as is practicable for adequate design. The overall size of the adapter and the coupler, including the operation of any handles or controls, should permit adjacent adapters to be spaced on 10-in. (254-mm) centers. Adapters should be easy to operate with heavily gloved hands.



Notes:

1. All corners must be broken. No corner shall have a radius of more than 0.125 in.
2. The details of the adapter body and internals, other than those shown on the drawing or specified as standard criteria, are to be determined by the manufacturer.
3. The valve head must be flush with the sealing surface within ± 0.015 in.
4. The sealing surface shall have a circular finish of not more than 63 μin. (see Table 1 for SI conversions of customary units).
5. Couplers must be capable of mating with the maximum dimensions shown.
6. See Table 1 for SI conversions of customary units.

Figure 1—Standard Tank Vehicle Adapter for Bottom Loading and Unloading



Note: See Table 1 for SI conversions of customary units.

Figure 2—Standard Interlock Control for Bottom-loading Adapter

4.1.2.2 Pressure Loss

The combined pressure-loss objective for the adapter and the coupler should be as low as is practicable when loading at a flow rate of 1000 gallons per minute (3.785 m^3ps).

4.1.2.3 Two-way Flow

Two-way flow, with an external means of opening and closing the adapter valve for unloading, may be provided. The pressure drop through the adapter should be as low as is practicable when unloading by gravity at a flow rate of 500 gallons per minute (1.893 m^3ps).

4.1.2.4 Liquid Seals

The adapter's liquid seals and sealing surfaces should be protected from mechanical damage. The mating liquid seals should be part of the coupler for loading and part of the hose connection for unloading. The elastomers or nonmetallics for all of the seals should be suitable for liquids that have high aromatic or olefinic content.

4.1.2.5 Liquid Loss

Under normal loading conditions, when the coupler is disconnected from the adapter after loading, the loss of liquid should not exceed an average of 5 cm^3 per disconnect, based on three consecutive disconnects.

4.1.2.6 Drainage

When the adapter is mounted in a horizontal plane, drainage should be as complete as possible after unloading. The body of the adapter need not be concentric.

4.1.2.7 Dust Cover

A dust cover with a liquid tight seal should be provided to prevent leakage and to protect the bottom-loading adapter. (The dust cover should be part of the adapter, not part of the tank.) To deter theft of product, a sealing or locking feature designed for use with wire-to-tape seal should be provided.

4.2 TANK VEHICLES USED FOR BOTTOM LOADING

4.2.1 Required Features

4.2.1.1 Location of Adapters

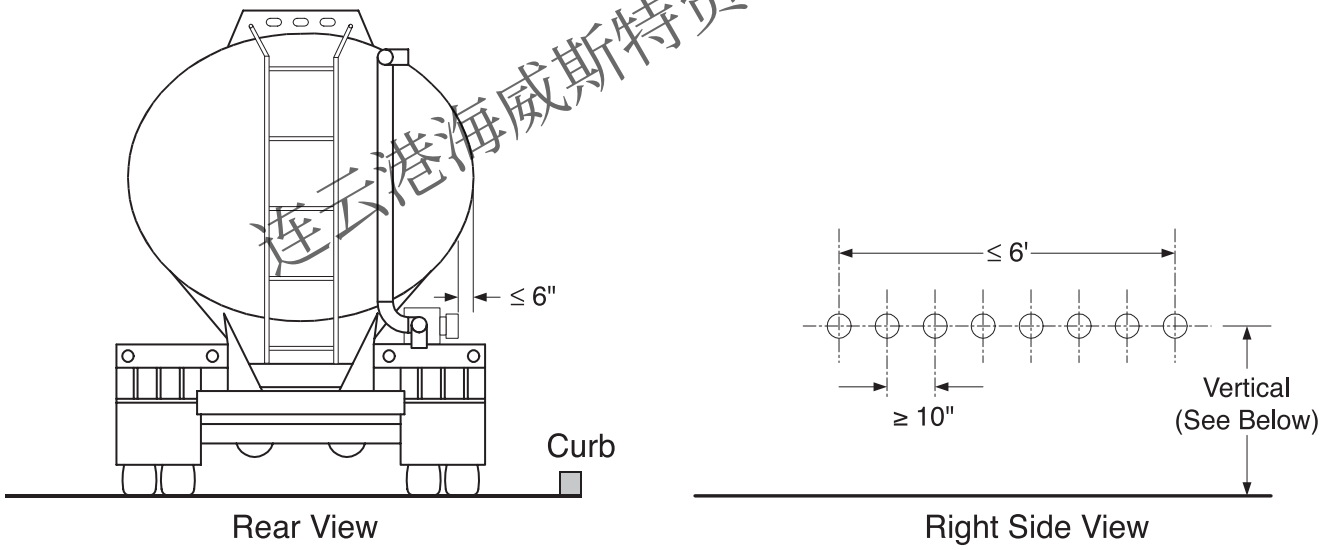
The bottom-loading adapter or adapters must be installed on the curb side of the tank vehicle (see Figure 3).

4.2.1.2 Horizontal Spacing of Adapters

Where more than one tank vehicle adapter is provided, the vertical centerlines must be at least 10 in. (254 mm) apart. The face of the adapter must be in a vertical plane and must be located no more than 6 in. (150 mm) inside the maximum width of the vehicle in the adapter area. When multiple adapters are installed, adapters must not be horizontally spaced on more than 6 ft (1.83 m) center (see Figure 3).

4.2.1.3 Vertical Spacing of Adapters

The tank vehicle adapters must be installed on centers that are not more than 4.5 ft (1.37 m) above grade when the vehicle tank is empty and not less than 2 ft (0.61 m) above grade when the tank is full. Experience indicates that for ease of loading, a height of not more than 3.75 ft (1.14 m) and not less than 2.75 ft (0.84 m) is desirable (see Figure 3).



Vertical Dimensions		
≤ 4.5'	When empty (max)	54"
3.75' to 2.75'	Desired Range	45" *39" 33"
≥ 2'	When full (min)	24"

* Midpoint of desirable range

Figure 3—Horizontal and Vertical Spacing of Adapters

4.2.1.4 Piping

The tank vehicle's piping system including components between the loading adapter and any positive shutoff valve, must be designed for a working pressure of 75 psi (517 kilopascals) and must not leak at 1.5 times the working pressure. Any component that does not meet this requirement, such as lower rated gravity air eliminators, nonpressure manifolds, or meters, must be isolated from the bottom-loading systems.

4.2.1.5 Venting

The vents installed on tank vehicles used for bottom loading must have sufficient capacity to prevent damage to the vehicle tank from vapor pressure at the maximum loading rates when the tank is vented at atmospheric pressure. This may require supplementary venting in addition to the breathing vents.

4.2.1.6 Liquid Flow Control

The minimum requirements for control of liquid loading are a preset loading-island meter with a set-stop valve for loading a predetermined quantity of liquid and an independent secondary shutoff control system to prevent overfill (see Section 5).

4.2.1.7 Equipment Safeguard

Provisions must be made on the tank vehicle to prevent the vehicle from being moved while any loading or vapor lines are connected.

4.2.2 Recommended Features

4.2.2.1 Deflector

When a tank is bottom loaded, the liquid should be effectively controlled by a deflector that minimizes spraying, turbulence, and generation of static electricity (see API RP 2003).

5 Secondary Shutoff Control System

5.1 LIQUID FLOW CONTROL

The minimum requirements for liquid flow control are a primary set-stop or a two stage flow control valve (hereafter referred to as a "primary shutoff control" valve or PSC valve) and an independent secondary shutoff system (hereafter referred to as a "secondary shutoff control" or SSC) (see 4.2.1.6).

The primary control consists of a preset loading meter and a PSC valve that provides a positive means of selecting and loading a predetermined quantity.

The secondary control consists of a level sensor in each compartment being loaded that signals high level to an independent automatic secondary SSC system that activates the PSC valve and an independent SSC valve to stop flow. The PSC valve and SSC valve at the loading rack must be separate independent devices (See Figure 4A and 4B).

5.2 SECONDARY CONTROL SYSTEMS

5.2.1 Loading-island Mounted

A loading-island-mounted system requires an interface connection between the loading-island PSC valve and the tank vehicle. The high-level sensor, through a rack overfill controller, deenergizes the Preset or PSC valve and the independent SSC valve to stop flow. (Electrical requirements are detailed in 5.4.) Figure 4A and 4B show general schematics for lane shutdown and rack shutdown, respectively.

5.2.2 Tank Mounted

Tank-mounted systems require a vehicle emergency valve that can stop flow when triggered by a signal from a high-level sensor. Systems that operate with either air or liquid are available. Tank-mounted systems are most often used on aviation refuelers; however, an electrical interface between the loading island and the vehicle is necessary when loading at a rack.

5.3 TYPES OF SECONDARY CONTROL SYSTEMS

5.3.1 General

In systems discussed in 5.3.2 and 5.3.3, the sensor must be deep enough in each of the tank vehicle compartments to assure that once the sensor has been activated, product flow stops before the compartment is completely full. Determination of the proper depth must take into account the maximum product flow rate, shutoff valve response times and tank compartment volume (that is, the available outage).

5.3.1.1 *Maximum product flow rate at the loading rack.* For bottom-loading racks, this typically ranges from 600 – 900 gallons per minute (gpm) (2.27 – 3.40 cubic meters per minute (m^3pm) per loading arm. At 900 gpm (3.400 m^3pm) the flow is 15 gallons per second (gps) (0.057 cubic meters per second (m^3ps). This flow rate may be different depending upon product and facility, however, tankers should be prepared to load safely at any facility.

5.3.1.2 *Shutoff valve response time.* Normal flow shutdown time with a properly functioning preset loading meter control (PSC) valve is 1 – 2 seconds. In the rare case when the PSC valve is not functioning properly, the loading flow will be stopped by the independent secondary shutoff (SSC) system and 2 – 4 seconds is typically required. This 2 – 4 second time includes the overfill protection system's activation time and time for the independent valve (SSC) to close.

5.3.1.3 *Tank Compartment Volume.* The minimum outage requirement for each compartment's sensor setting is 60 gallons (0.227 m^3). Combining the 900 gpm (15 gps) [34.07 m^3pm (0.057 m^3ps)] maximum flow rate and the 4-second maximum shutdown time requires an empty space (outage) of 60 gallons (0.227 m^3) above the high level point, which is where the sensor senses liquid. To accommodate a 60-gallon

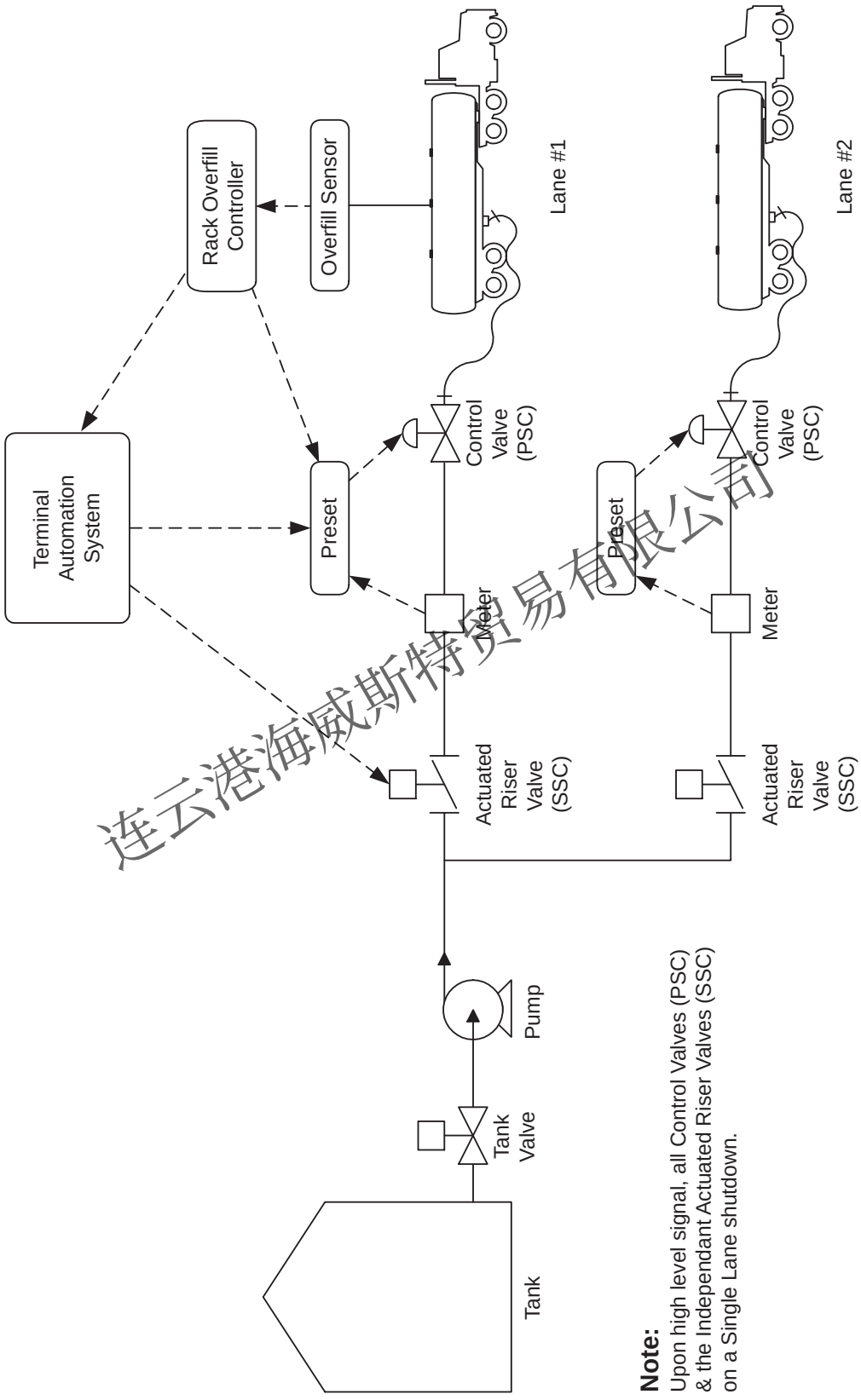


Figure 4A—Functional Lane Shutdown Diagram

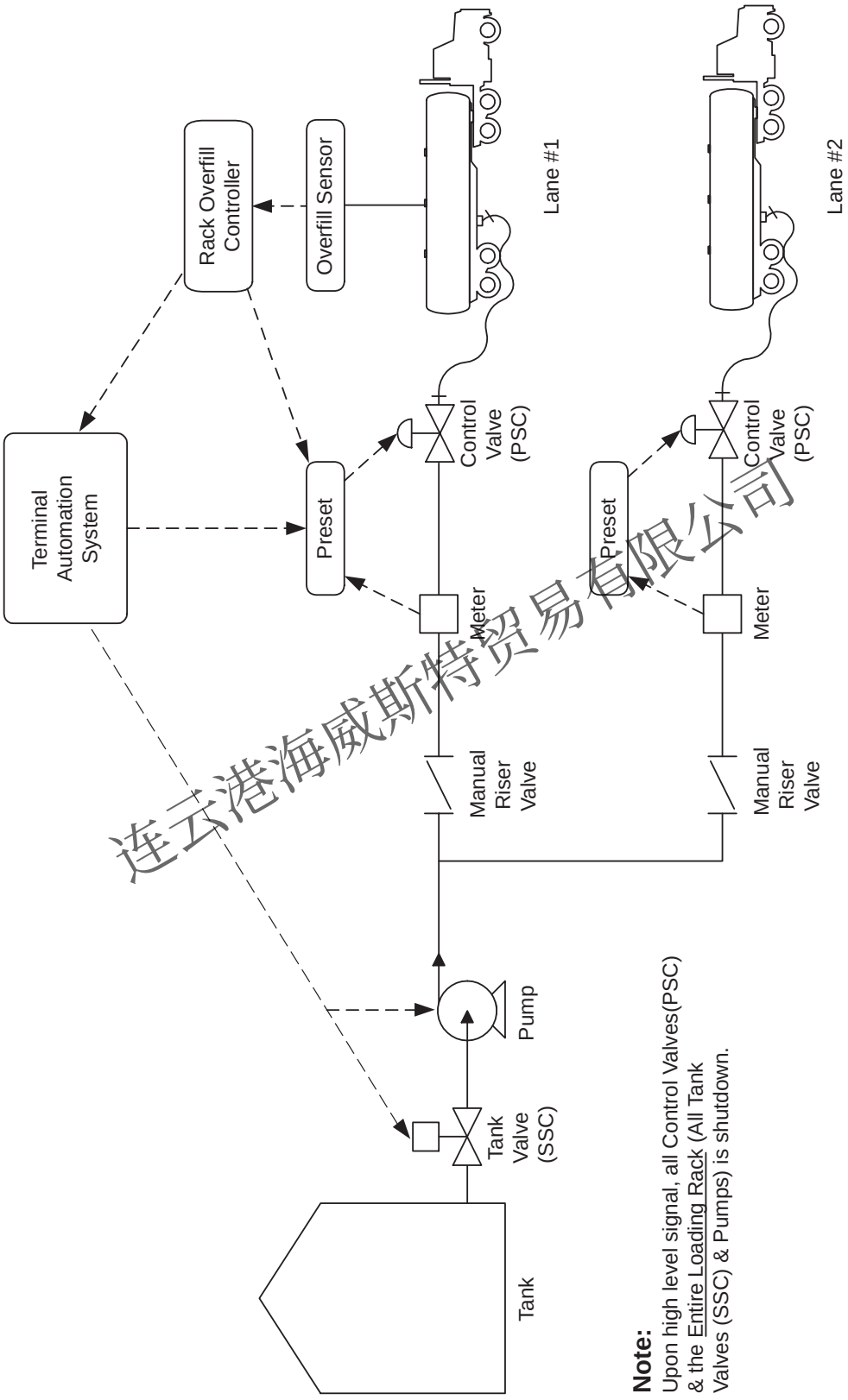


Figure 4B—Functional Rack Shutdown Diagram

(0.227 m^3) outage, the overfill sensor placement is critical and varies widely due to the range in tank truck/trailer compartment sizes (typically 300 – 9,000 gallons (1.13 – 34.07 m^3). Unlike the typical outage requirement of 3% for thermal expansion, the 60 gallon (0.227 m^3) outage quantity is not based on a percentage of the total compartment size. For example the 60 gallon (0.227 m^3) outage is 6% of a 1,000 gallon (3.79 m^3) compartment, but only 1.5% of a 4,000 gallon compartment (15.14 m^3). To safely accommodate the outage the high-level sensor must be installed at the correct depth depending upon tank compartment size, see Figure 5A. The exact sensor depth should be determined by reference to the tanks actual capacity chart (available from the tank vehicle manufacturer). Since sensors can be mounted directly into the top of the tank shell, or in the dome lid cover, an allowance for the added height must be made when mounting in the dome lid cover (the sensor must be longer, to offset the higher mounting), see Figure 5B.

Note: Inspection of the sensor depth can be accomplished during the annual vapor tightness testing.

5.3.2 Thermistor System

A thermistor system uses a thermistor sensor (a temperature-sensitive resistor) that is heated by an intrinsically safe electrical signal from the loading rack. When in air, the sensor is warmer than the highest expected product temperature. When product comes in contact with the sensor, the thermistor is cooled, causing a change in resistance. This change is detected by the rack overfill controller, which shuts down the PSC valve and the independent SSC valve.

5.3.3 Optical System

An optical system uses a beam of light that is internally reflected from an exposed glass/air interface when the sensor is in air. An electrical photodetector intercepts this reflected light and produces a signal that is used to energize the loading-valve control system. When liquid touches the glass sensor, the beam is refracted into the liquid and is not reflected back into the photodetector. The control unit, which grants permissive control only when it receives a signal from the photodetector, shuts down the PSC valve and the independent SSC valve.

5.4 REQUIRED FEATURES

5.4.1 Electrical Requirements

Any electrical system used for secondary shutoff control must have an intrinsically safe output as defined in the *National Electrical Code* for Group D atmospheres.

CAUTION: The vehicle high-level control circuits must be isolated from other conduits and must use jacketed cable or dedicated conduits and junction boxes.

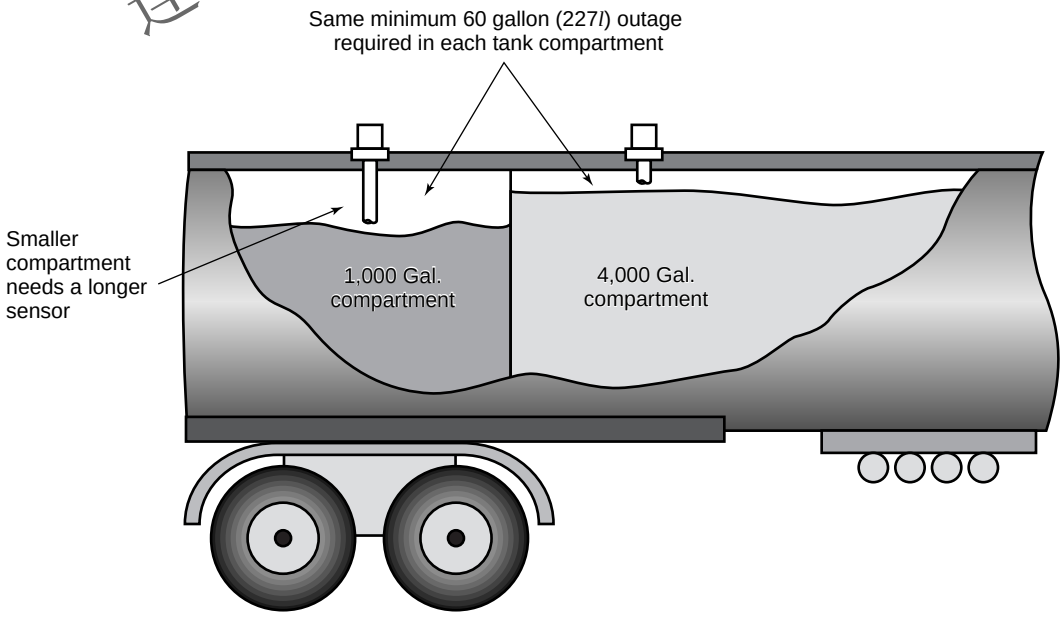


Figure 5A—Side View of Trailer Showing Need for Different Sensor Depths

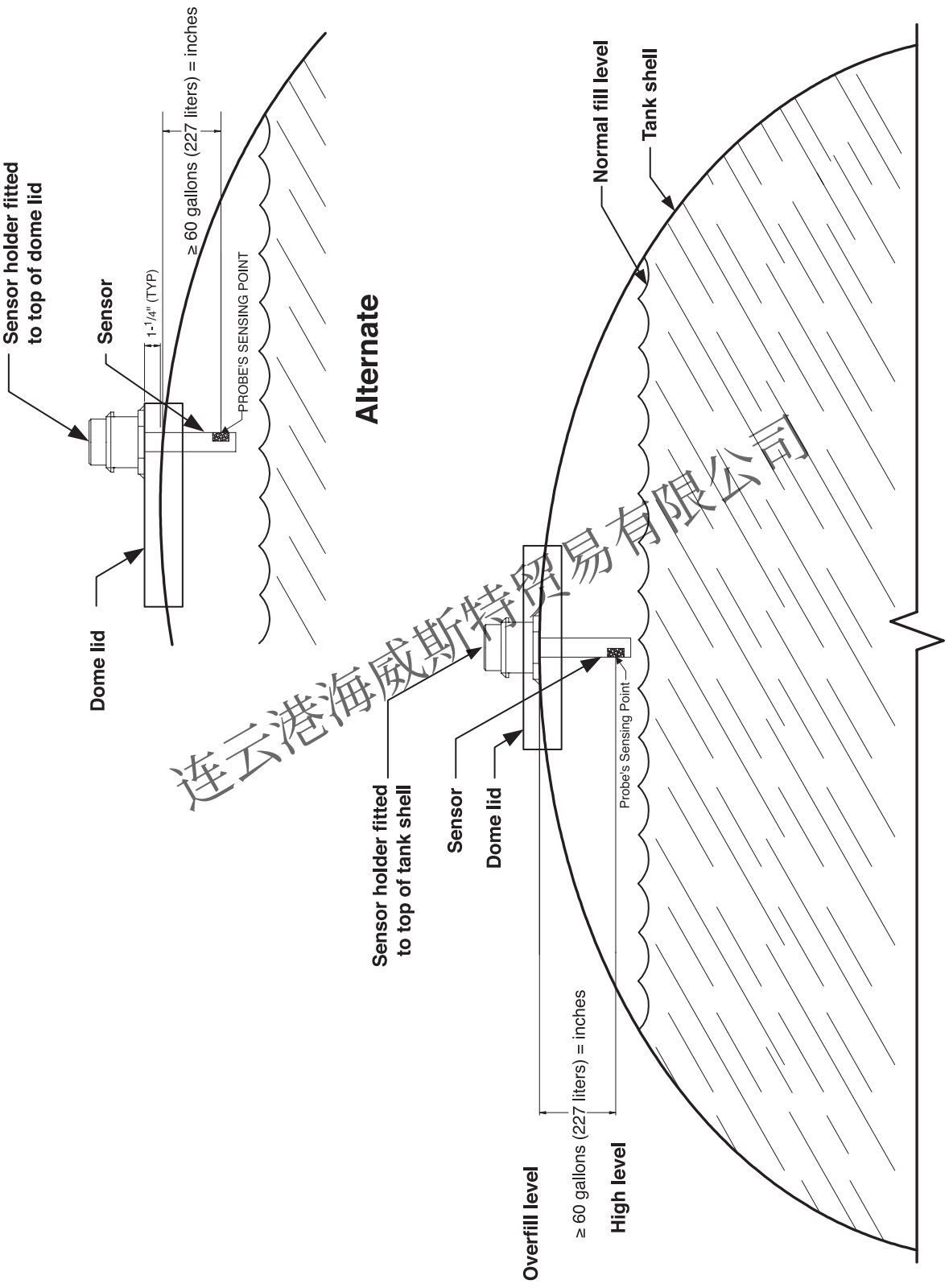


Figure 5B—End View of Trailer Showing Various Levels and Two Methods of Mounting Sensor

5.4.2 Electrical Connection to the Loading Island

5.4.2.1 Vehicles and loading islands equipped for thermistor overfill control systems must use a green color coded receptacle (socket) on the vehicle, and a green color coded plug on the loading island both featuring eight electrical contacts and four attachment j-slots/locking pins, respectively. Both the plug and the receptacle must be designed to be compatible with the receptacle and plug shown in Figure 6A and 6B, respectively.

5.4.2.2 Vehicles and loading islands equipped for optical overfill control systems must use a blue color coded receptacle (socket) on the vehicle and a blue color coded plug on the loading island both featuring six electrical contacts and three attachment j-slots/locking pins, respectively. Both the plug and the receptacle must be designed to be compatible with the receptacle and plug as shown in Figure 7A and 7B, respectively.

5.4.2.3 Loading islands equipped with a secondary overfill control system that will accept both thermistor type vehicle systems and optic type vehicle systems and will automatically configure itself for proper operation of either type system (automatic-switching) shall be equipped with a black color coded plug on the loading island, featuring eight electrical contacts and four attachment locking pins.

Optionally, if it is necessary for the loading island to accommodate both thermistor and optic type vehicle systems with blue color coded receptacles (sockets) with three attachment j-slots/locking pins, a second, blue, three locking pin plug (with six-electrical contact) per 5.4.4.2 may be added to the loading island.

5.4.3 Wiring Standards

5.4.3.1 Thermistor System

The wiring of a thermistor system must be in accordance with Figure 8. The wiring must be color coded in accordance with Table 2. The electrical receptacle (socket) must be color coded green.

5.4.3.2 Optical System

The wiring of an optical system must be in accordance with Figure 9. The wiring must be color coded in accordance with Table 3. The electrical receptacle (socket) must be color coded blue.

5.4.3.3 Data communications may conduct through auxiliary pin 9 or optional pin 11 as shown in Figure 8 and Figure 9. If optional pin 11 is used, data shall be in a serial format compatible with known industry standards or a publicly documented format.

Note: The use of standard connectors alone does not ensure compatibility with all types of secondary control and shutoff systems (for example, tank vehicle secondary control systems supplied by one manufacturer and loading-rack shutoff systems supplied by another). Any secondary control system that uses one of these standard connectors shall be designed and wired so that no signal can be given to permit loading without control and protection from overfill. The use of adapters may not ensure compatibility between different systems. If the optional pin is used to transmit data, it must be proven to not interfere with existing functionality and safety of the overfill protection system which may include fault conditions.

5.4.4 Receptacle Construction Standards

5.4.4.1 Thermistor System

Construction details for thermistor receptacles and plugs are shown in Figure 6A and 6B, respectively.

5.4.4.2 Optical System

Construction details for optical receptacles and plugs are shown in Figure 7A and 7B, respectively.

Optionally, optic type vehicle systems, or vehicles equipped with onboard (the vehicle) control systems with optic type outputs may be equipped with a six electrical contact, blue color-coded receptacle (socket) featuring four attachment j-slots. This optional configuration (four attachment j-slots) optic socket is intended for use at loading islands with a "universal/auto-switching" secondary control system equipped with a black plug as described in 5.4.2.3.

5.4.5 Location of Receptacle

The plug receptacle on the vehicle must be located no more than 7 ft (2.13 m) to the front or rear of the centerline of the bottom-loading adapters and must not interfere with loading operations.

5.5 RECOMMENDED FEATURES

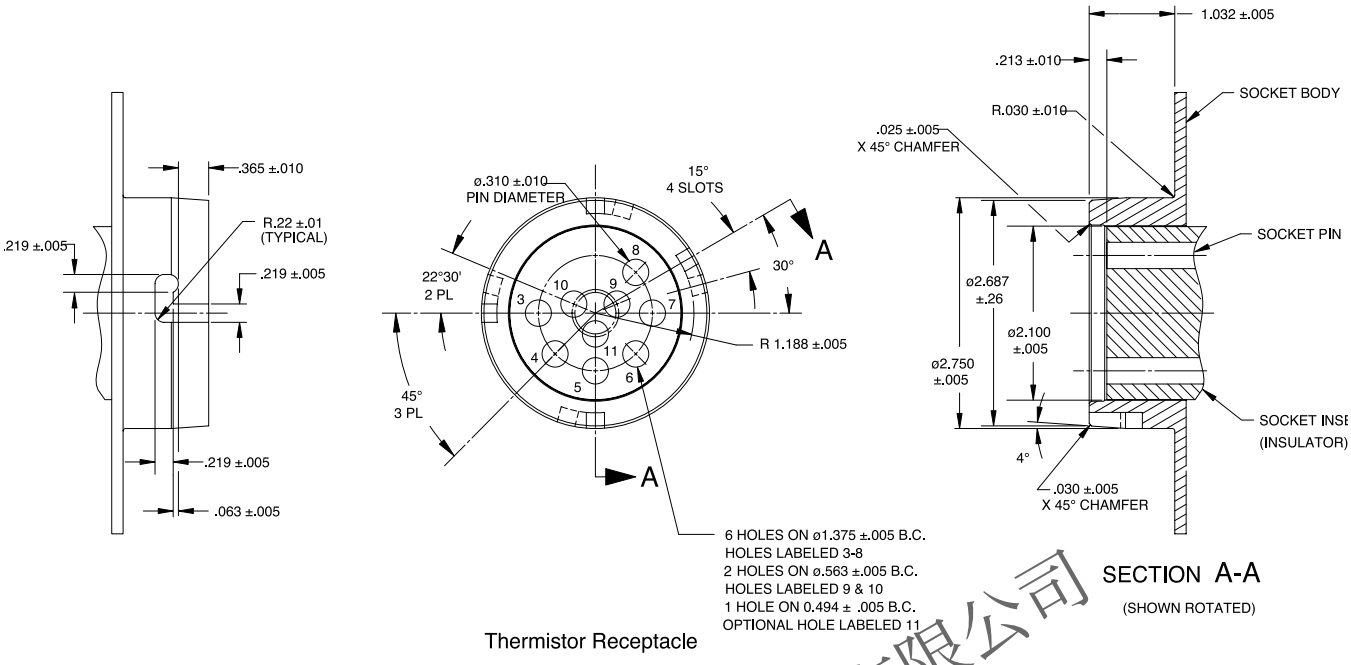
5.5.1 Maintenance

Under normal operating conditions, the SSC system is called upon infrequently. The SSC system should be tested at each regular inspection to ensure that it functions properly.

5.5.2 Labeling

Since different types of electrical interface connectors may be used on the same truck or loading island, clear and concise instructions should be readily available and should be obvious to any loader.

- Green color coded (thermistor) loading-island plugs connect to green labeled (thermistor) vehicle receptacles (sockets).
- Blue color coded (optic) loading-island plugs connect to blue labeled (optic) vehicle receptacles (sockets).
- An "auto-switching" loading-island control system with a black (four locking attachment locking pin) color coded plug will connect to either a green labeled (thermistor) electrical receptacle (socket) or a blue labeled, four attachment j-slot, (optic), electrical receptacle (socket).



Note: Unless otherwise specified, the dimensional tolerance is ±1/64" (±0.005 inch) and the angular tolerance is ±1/2 degree.

Figure 6A—Construction Details for Thermistor Receptacle (Green)

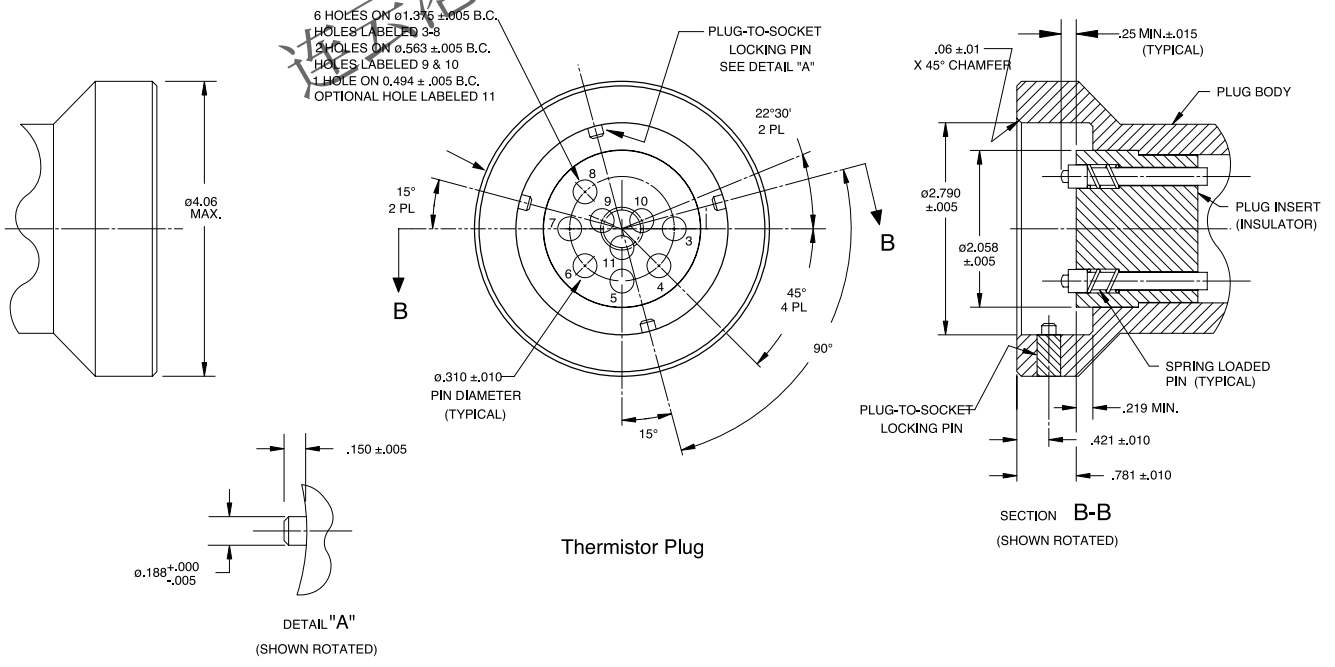
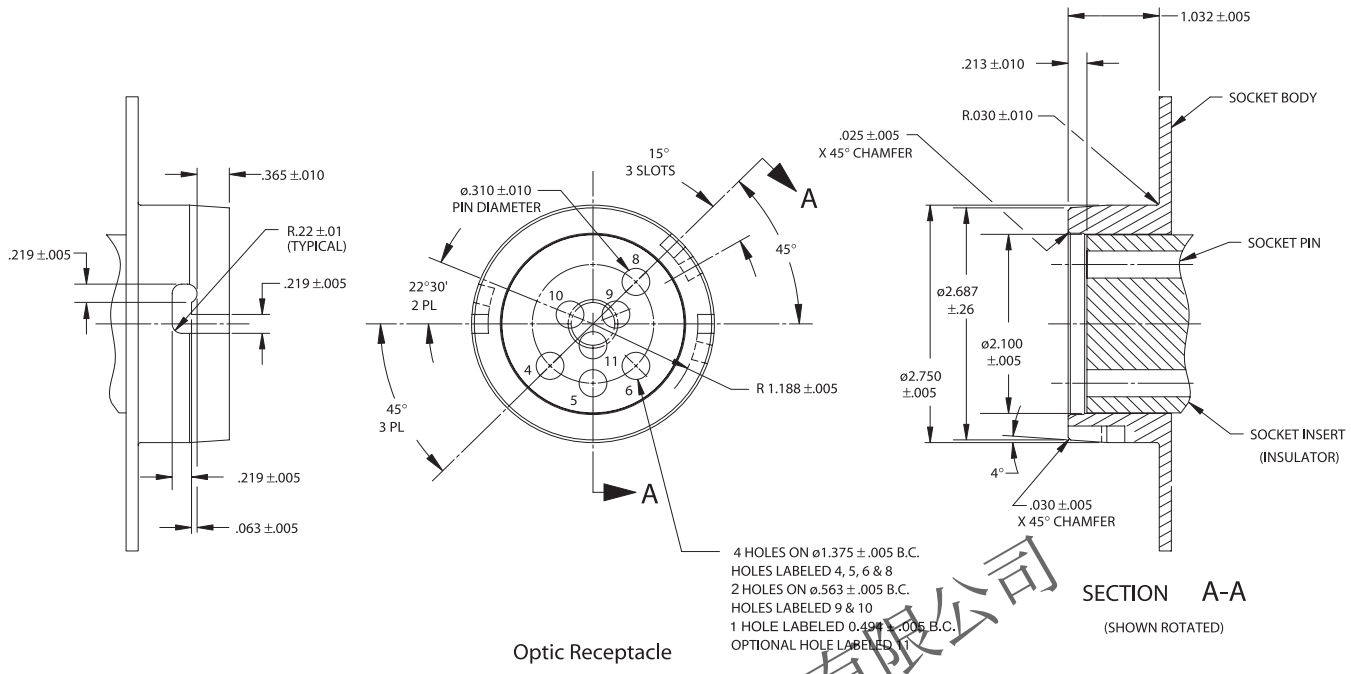


Figure 6B—Construction Details for Thermistor Plug (Green)



:: Unless otherwise specified, the dimensional tolerance is ±1/64"
:0.005 inch) and the angular tolerance is ±1/2 degree.

Figure 7A—Construction Details for Optical Receptacle (Blue)

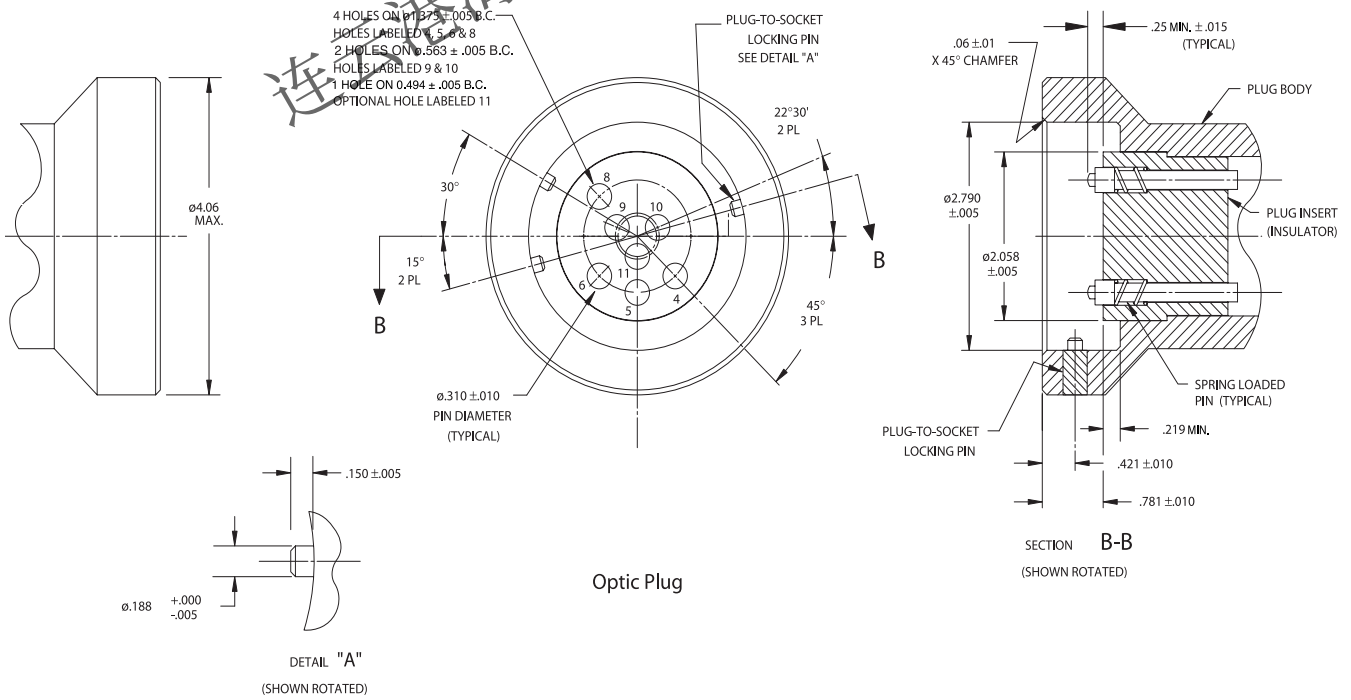


Figure 7B—Construction Details for Optical Plug (Blue)

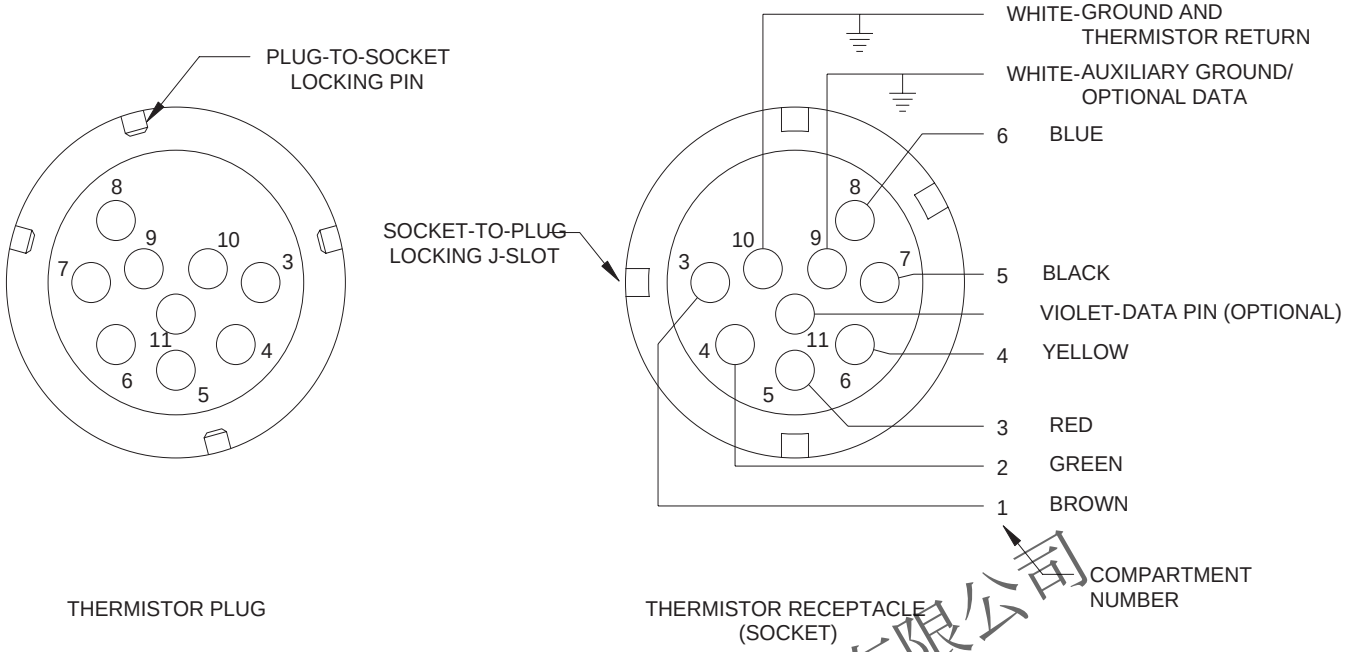


Figure 8—Wiring Schematic for Thermistor System

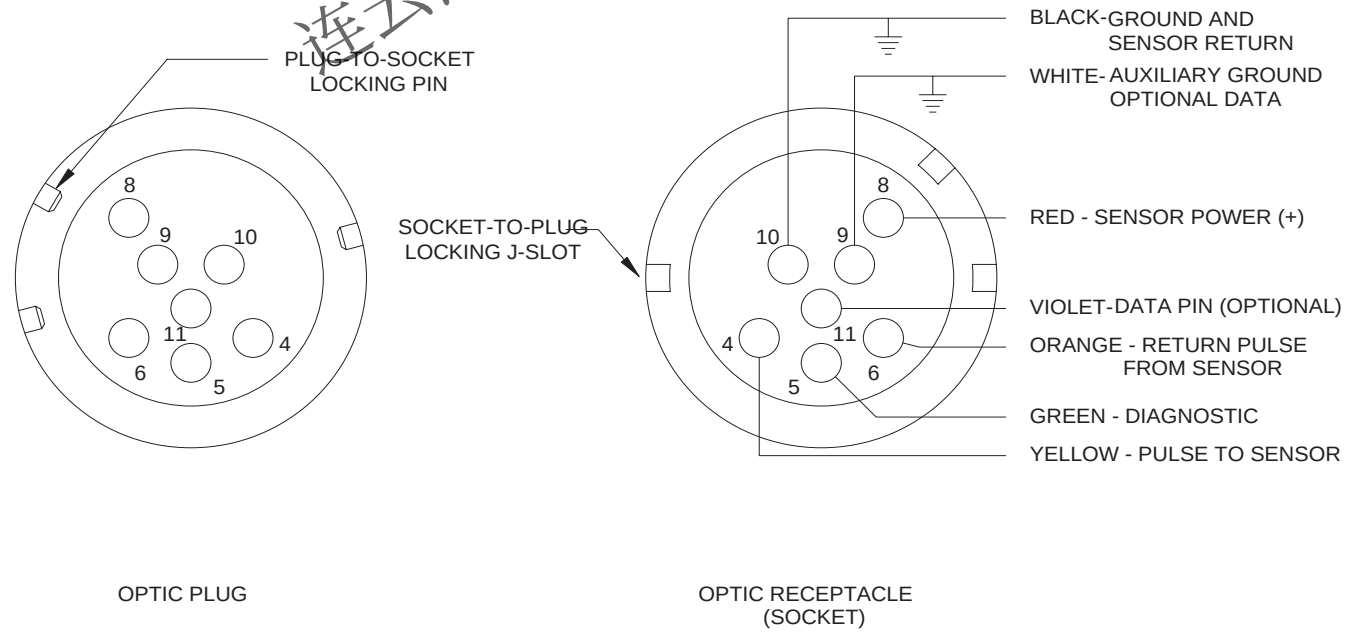


Figure 9—Wiring Schematic for Optical System

Table 2—Color Coding for Thermistor System Wiring

Pin	Description of Lead	Color
3	To Thermistor in Compartment 1	Brown
4	To Thermistor in Compartment 2	Green
5	To Thermistor in Compartment 3	Red
6	To Thermistor in Compartment 4	Yellow
7	To Thermistor in Compartment 5	Black
8	To Thermistor in Compartment 6	Blue
9	Separate Auxiliary Ground (Optional Data)	White
10	Ground and Thermistor Sensor Return	White
11	Data Pin (Optional)	Violet

Table 3—Color Coding for Optic System Wiring

Pin	Description of Lead	Color
4	Pulse to Sensor	Yellow
5	Sensor Diagnostic	Green
6	Return Pulse from Sensor	Orange
8	Sensor Power (+)	Red
9	Separate Auxiliary Ground (Optional data)	White
10	Ground and Sensor Return	Black
11	Data Pin (Optional)	Violet

6 Vapor Recovery for Tank Motor Vehicles

6.1 WHEN VEHICLES ARE BOTTOM LOADED AND VAPOR RECOVERY IS REQUIRED

6.1.1 Required Features

6.1.1.1 Vapor-recovery System

When a vapor-recovery system is installed on a vehicle equipped for bottom loading, the system must terminate in a 4-in. (101.6 mm) adapter as specified in 6.1.1.2. In no instance while loading, should the trailer vapor-recovery system exceed a pressure of 27 in. water column (6750 pascals) when there is a pressure of 18" W.C. (4500 pascals) at the truck vapor connection. More than one vapor hose may be required when loading multiple compartments simultaneously.

Note: When a vapor collection header is used, it must be either a separate header or headers or the overturn rail or rails. The only time the header will be used for vapor collection will be during the loading and unloading cycle. The header is not a product line as the vapor valves seal it from the product during transit. (A common header is adequate for vapor recovery when mixed loads are transported.)

6.1.1.2 Vapor-recovery Adapter

The vapor-recovery adapter must be a 4-in. (101.6 mm) cam-and-groove, quick-coupling type conforming to CID-A-A-59326. A bottom-loading adapter must not be used for recovery of vapors.

6.1.1.3 Location of Vapor-recovery Adapter (Loading)

Two locations are generally accepted for the tank vehicle vapor-recovery adapter(s) used during bottom loading:

a. Not more than 7 ft (2.13 m) to the front or the rear of the centerline of the bottom-loading adapters.
b. At or near the rear bulkhead of the cargo tank.

The adapter(s) must be installed on a center not more than 5 ft (1.52 m) above grade when the vehicle tank is empty and not less than 2 ft (0.61 m) above grade when the vehicle tank is full.

6.1.1.4 Testing of Vapor-recovery Systems

To ensure adequate vapor tightness during operation, tank vehicles equipped for vapor recovery shall be tested via DOT requirements or local requirements if applicable.

6.1.2 Recommended Features

6.1.2.1 Vapor-recovery System

The vapor-recovery system should be designed to allow complete drainage by gravity of any liquid accumulating in the system. The design should also provide for degassing the entire cargo tank including vapor-recovery system before repair. For guidance on degassing refer to TTMA RP No. 54 – 97.

6.1.2.2 Dry-disconnect Adapter

If local authorities require the substitution of a dry-disconnect vapor-recovery adapter for the standard adapter, a dry-disconnect version, incorporating an internal poppet valve and conforming to the external dimensions specified in CID-A-A-59326, should be used. The pressure drop through the dry-disconnect adapter should be checked for compatibility with the intended product loading rate.

6.1.2.3 Location of Vapor-recovery Adapter (Unloading)

The length of vapor-recovery hoses should be kept to a minimum during unloading. If the vapor-recovery adapter used for loading is not adjacent to the unloading adapter, the vapor-recovery adapter may require a tee and a connecting line on the tank vehicle to provide an outlet or outlets adjacent to the tank unloading outlet.

CAUTION: If more than one connection is installed, all the connections that are not being used must be closed when vapors are recovered during loading and unloading. On straight tank trucks, the location of the tank vehicle vapor-recovery adapter will be determined by the vehicle's piping design and the location of the bottom-loading adapter. Whenever possible, the adapter should be located as described in 6.1.1.3.

6.1.2.4 Vapor Collection Vents (Valves)

The vents and vapor valves provided to protect the tank during loading (see 4.2.1.5) should have sufficient capacity to protect the tank during unloading.

6.2 WHEN VEHICLES EQUIPPED FOR VAPOR RECOVERY ARE BOTTOM LOADED AND VAPOR RECOVERY IS NOT REQUIRED

6.2.1 Required Features

To prevent pressurization of the tank and vapor-recovery system, the vapor-recovery system must be open to the atmosphere during loading.

6.2.2 Avoiding Vapor Discharge

Bottom-loading facilities located in areas that do not require recovery of the truck vapors displaced during loading shall provide a discharge standpipe or other method to remove vapors from the loading area. Precautions shall be taken to avoid any vapor discharges that could cause human health, fire or environmental hazards.

6.3 WHEN VEHICLES ARE TOP LOADED AND VAPOR RECOVERY IS REQUIRED

6.3.1 Required Features

6.3.1.1 Vapor Connection

The vapor connection to the tank must be made by one of the following methods:

a. Through the dome opening without modification of the tank.
b. Through an adapter in the top of the tank.
c. Through an adapter installed in accordance with 6.1.1.3.

6.3.1.2 Vapor-recovery Adapter

If an adapter is used, it must be a 4-in. (101.6 mm) cam-and-groove, quick coupling type conforming to CID-A-A-59326. To avoid the possibility of connecting a product loading line to the vapor system, a bottom-loading adapter must not be used for recovery of vapors.

6.3.2 Recommended Features

6.3.2.1 Dry-Disconnect Adapter

If local authorities require the substitution of a dry-disconnect vapor-recovery adapter for the standard adapter, a dry-disconnect version, incorporating an internal poppet valve and conforming with the external dimensions specified in CID-A-A-59326, should be used. The pressure drop through the dry-disconnect adapter should be checked for compatibility with the intended product loading rate.

6.3.2.2 Location of Vapor-recovery Adapter

If the vapor-recovery adapter is not installed in accordance with 6.1.1.3 and is installed in the top of the tank, it should be located adjacent to the dome of the compartment being filled. The cover should not protrude above the rollover device.

6.4 WHEN VEHICLES ARE UNLOADED AND VAPOR RECOVERY IS REQUIRED

6.4.1 General

The system installed on the vehicle for recovery of vapors during bottom loading (see 6.1) can also be used to recover vapors at the unloading point when such recovery is required. (See Figures 10, 11, and 12 for typical examples of vapor recovery during unloading.)

6.4.2 Required Feature

To recover vapors during gravity unloading, all liquid and vapor hose connections must be vapor tight.

6.4.3 Recommended Feature

When vapor recovery is required at the unloading point the vehicle should be equipped with vapor-recovery fittings of the conventional cam-and-groove type, at least 2 in. (50.8 mm) in size. If a hose with a diameter smaller than 3 in. (76.2 mm) is used, state regulations may require the owner/operator to demonstrate that the hose will achieve the required vapor recovery. The vehicle equipment should include one vapor-recovery adapter for each delivery hose to be used, unless one adequately sized adapter is used for recovery of vapors during multiple-hose delivery.

6.5 WHEN VEHICLES EQUIPPED FOR VAPOR RECOVERY ARE UNLOADED AND VAPOR RECOVERY IS NOT REQUIRED

6.5.1 General

The tank vehicle will normally inbreathe through the 4-in. (101.6 mm) cam-and-groove adapter or adapters on the vapor-recovery system.

CAUTION: Any closure or restriction may create a vacuum sufficient to collapse the tank. (The small capacity pressure/vacuum vent in each compartment may be inadequate for vacuum relief during unloading.)

6.6 REQUIRED FEATURE

When a dry-disconnect vapor-recovery adapter is required, provision must be made to ensure that the vapor-recovery system is fully vented before unloading is started to prevent collapse of the tank.

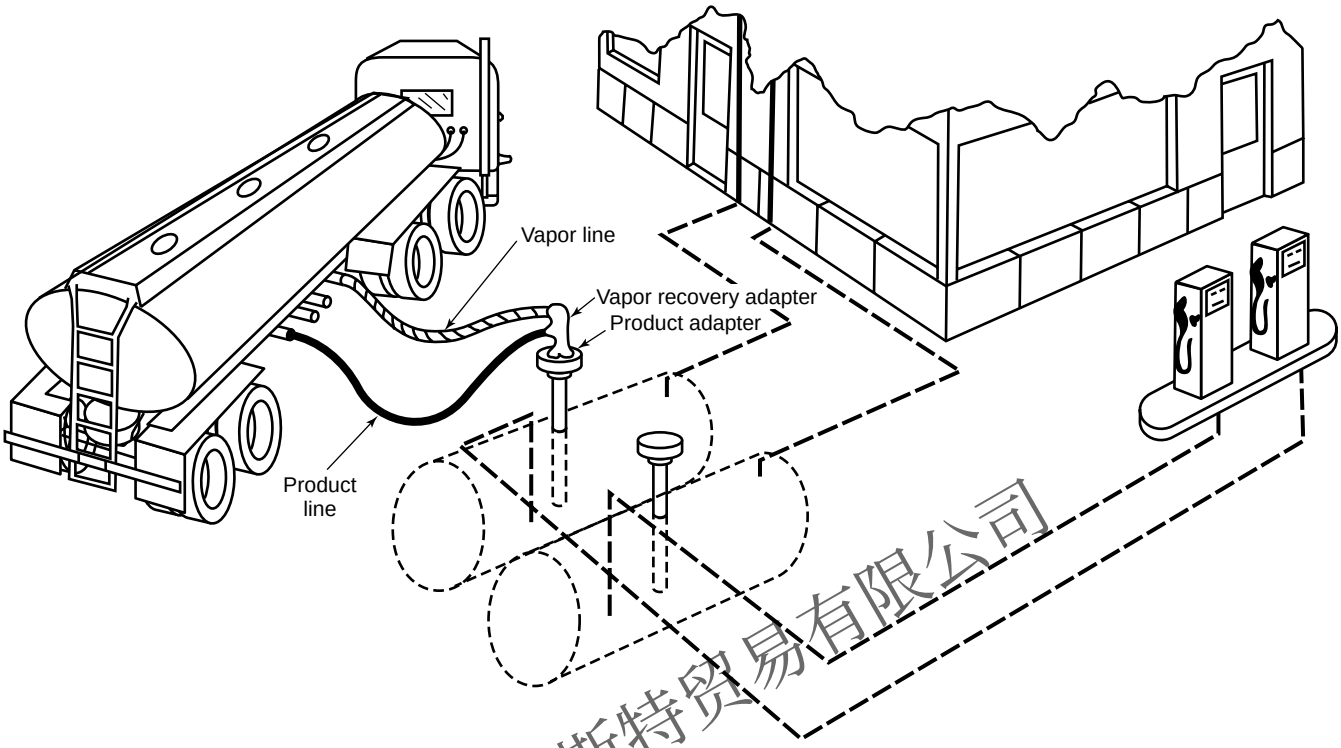


Figure 10—Coaxial Product Vapor Hose Connections

7 Loading Islands Equipped for Bottom Loading

7.1 REQUIRED FEATURES

7.1.1 Liquid Flow Control (See Section 5)

The minimum requirements for liquid flow control are a preset loading-island meter and a PSC valve that provides a positive means of loading a predetermined quantity. To prevent overfills, an independent automatic SSC system is required. The maximum volume for shutdown of the loading rack is 60 gallons (0.227 m^3).

7.1.2 Electrical Connection to Tank Vehicles (See 5.4)

The electrical connection to the tank vehicle must meet the following requirements:

a. The electrical system used for secondary shutoff control must comply with 5.4.1.

b. Vehicles and loading islands equipped for thermistor overfill control systems must use a green color coded plug on the loading island, and connect to a green color coded receptacle (socket) on the vehicle, both featuring eight electrical contacts and four attachment j-slots/locking pins respectively. See 5.4.3.1 for wiring standards and 5.4.4.1 for construction standards.

c. Vehicles and loading islands equipped for optical overfill control systems must use a blue color coded plug on the loading island, and connect to a blue color coded receptacle (socket) on the vehicle, both featuring six electrical contacts and three attachment j-slots/locking pins, respectively. See 5.4.3.2 for wiring standards and 5.4.4.2 for construction standards.

d. Loading islands equipped with a secondary overfill control system that will accept both thermistor type (green color coded) vehicle systems and optic type (blue color coded) vehicle systems and will automatically configure itself for proper operation of either type system (automatic-switching) shall be equipped with black color coded plug on the loading island, featuring eight electrical contacts and four attachment locking pins. See 5.4.3 for the wiring standards and 5.4.4.2. for construction standards.

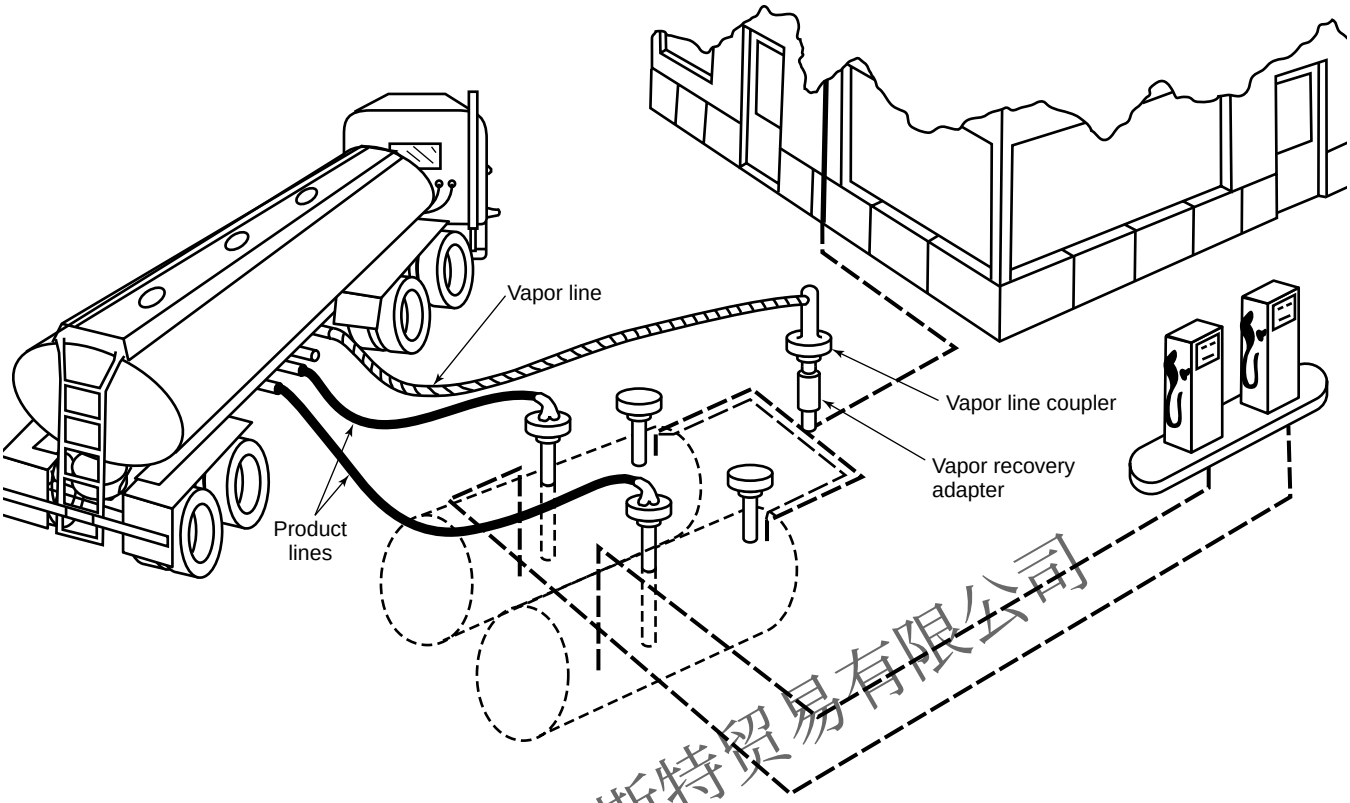


Figure 11—Separate Product and Vapor Hose Connections with Manifold Vents

7.1.3 Design of Terminal Bottom-loading Systems

7.1.3.1 The design of terminal bottom-loading systems must meet the following requirements:

a. The rated pressure of terminal bottom-loading systems shall be a minimum 75 psi (86 kilopascals) and shall not leak at 1.5 times the rated pressure.
b. Due to thermal expansion, adequate pressure relief shall be provided to ensure a maximum pressure in the loading arm system does not exceed 75 psi.
c. The design of the loading-arm assembly must provide for vertical displacement of vehicle springs, snow and ice on the pavement, and vertical spacing variations of the bottom-loading adapters (see 4.2.1.3).
d. Loading islands equipped with thermistor or optic overfill control systems require (1) tank vehicles with compatible systems (see note to 5.4.3.3), (2) a loading-island bottom-loading coupler to connect the loading island to the tank vehicle, or (3) an adapter on the tank vehicle to match it to the loading island.

7.1.4 Loading-island Couplers

Loading-island couplers must be designed to connect to the bottom-loading adapters and vapor-recovery adapters specified in this RP.

7.1.5 Vapor-recovery System

The entire vapor-recovery system must be designed and operated to remain in compliance with 40 CFR 60 Subpart XX, which requires vapor backpressure to not exceed 18 in. water column (4500 pascals) under any loading conditions, as measured as close as possible to the vapor connection on the truck (see Figure 13).

7.2 RECOMMENDED FEATURES

7.2.1 Procedures for Loading

The terminal operator should establish and display clear, specific written procedures to be followed during loading of tank vehicles (see API RP 1007). If two or more different types of electrical plugs are used on the loading island, they should be clearly labeled to ensure proper application.

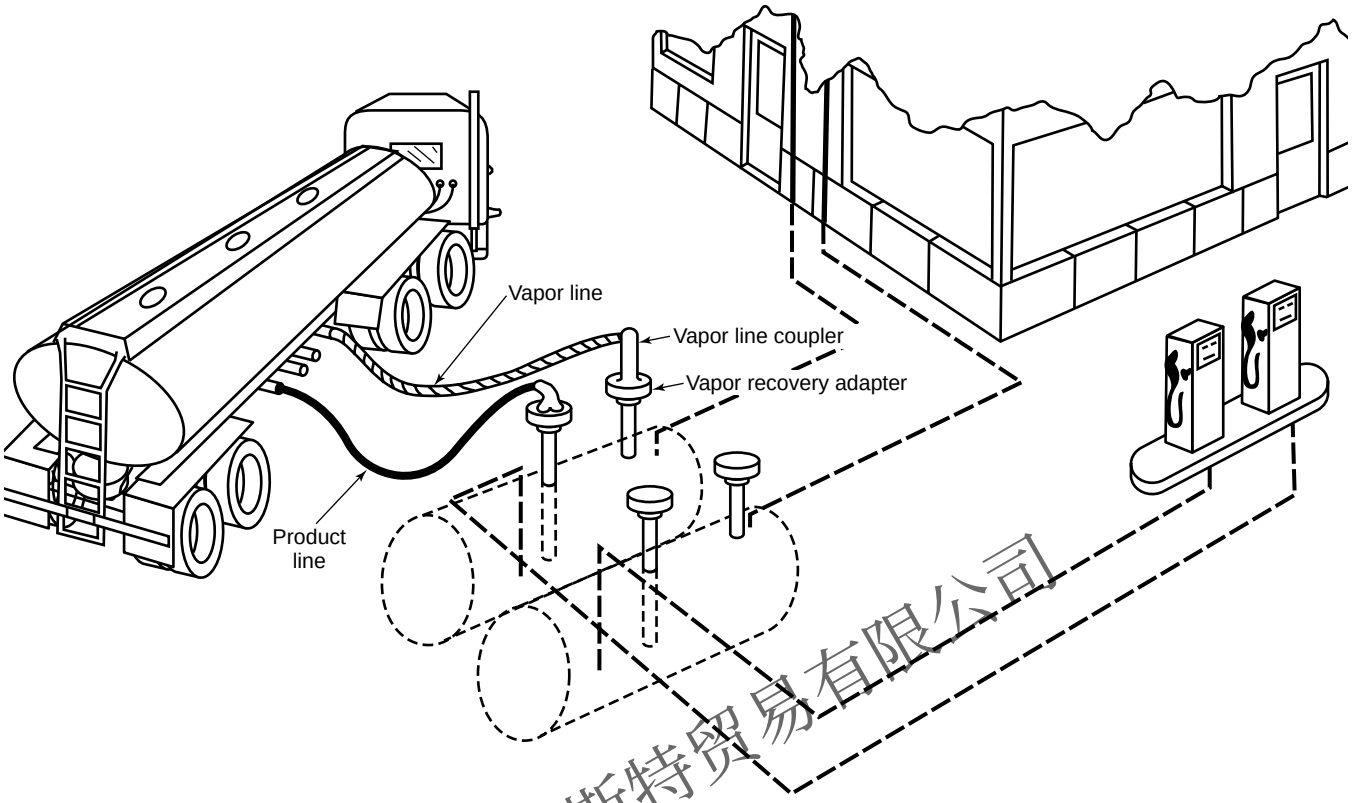


Figure 12—Separate Product and

7.2.2 Additional Safety Procedures

Individual shippers or terminal operators may require additional safety procedures or devices, either on the tank vehicle or on the loading island.

7.2.3 Loading-island Couplers

Loading-island couplers should be located in accordance with the spacing recommendations given in 4.2.1.1, 4.2.1.2, and 4.2.1.3.

The couplers should be installed to provide for an error of 1 ft (304.8 mm) in either direction in spotting the tank vehicle at the loading island.

7.2.4 Avoiding Discharge of Vapors into Loading Area

Bottom-loading facilities located in areas that do not require recovery of the truck vapors displaced during loading shall provide a discharge standpipe or other method to remove vapors from the loading area. Precautions shall be taken to avoid any vapor discharges that could cause human health, fire or environmental hazards.

7.2.5 A typical configuration for a loading rack arm is shown in Figure 14 and has the following recommended features.

a. A shear spool or breakaway coupling may be used to minimize damage and product spillage caused by driveaways.

b. If a valve is used to facilitate maintenance of the coupler without draining the entire arm it shall conform to the requirements of 7.1.3.1a.

c. If a sight glass is used in the loading rack system, it shall conform to the requirements of 7.1.3.1a.

d. To assure that the requirements of 7.1.3.1a are met the use of a pressure gauge equipped with a maximum indicator is recommended in the loading arm system (see Figure 14).

7.2.6 It is recommended to perform periodic visual inspection of the loading arm system.

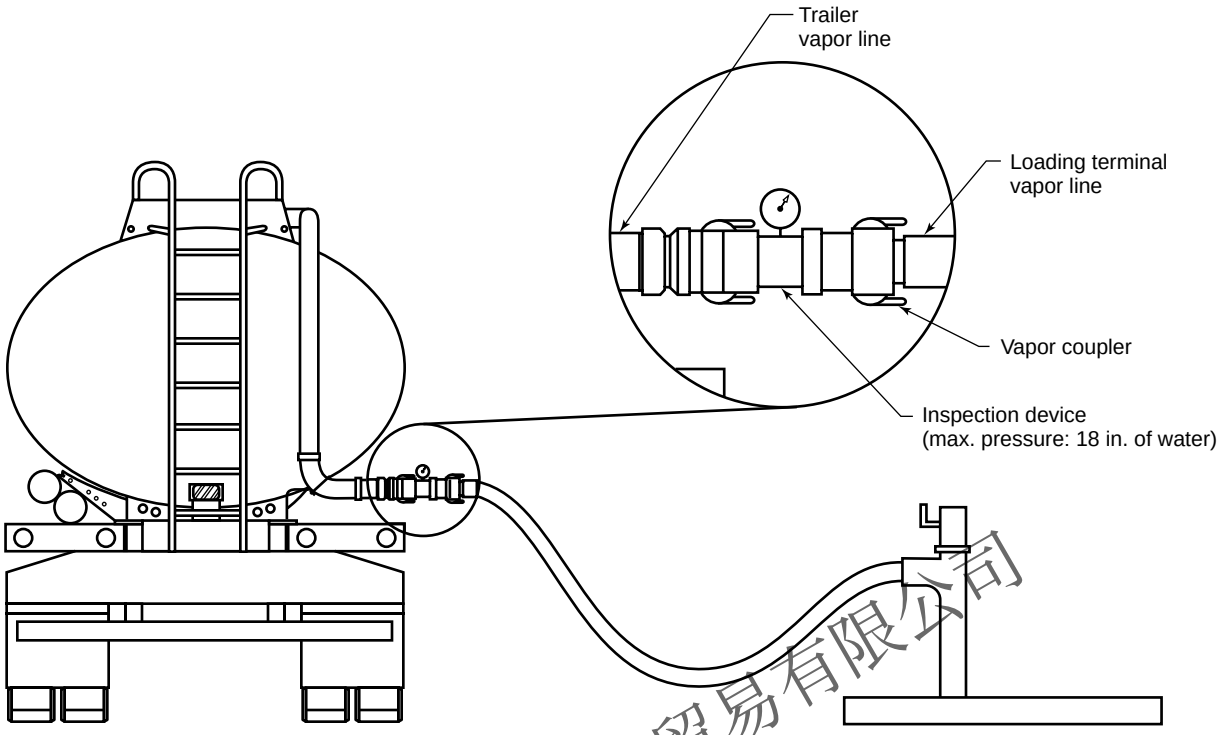


Figure 13—Location of Pressure Gauge

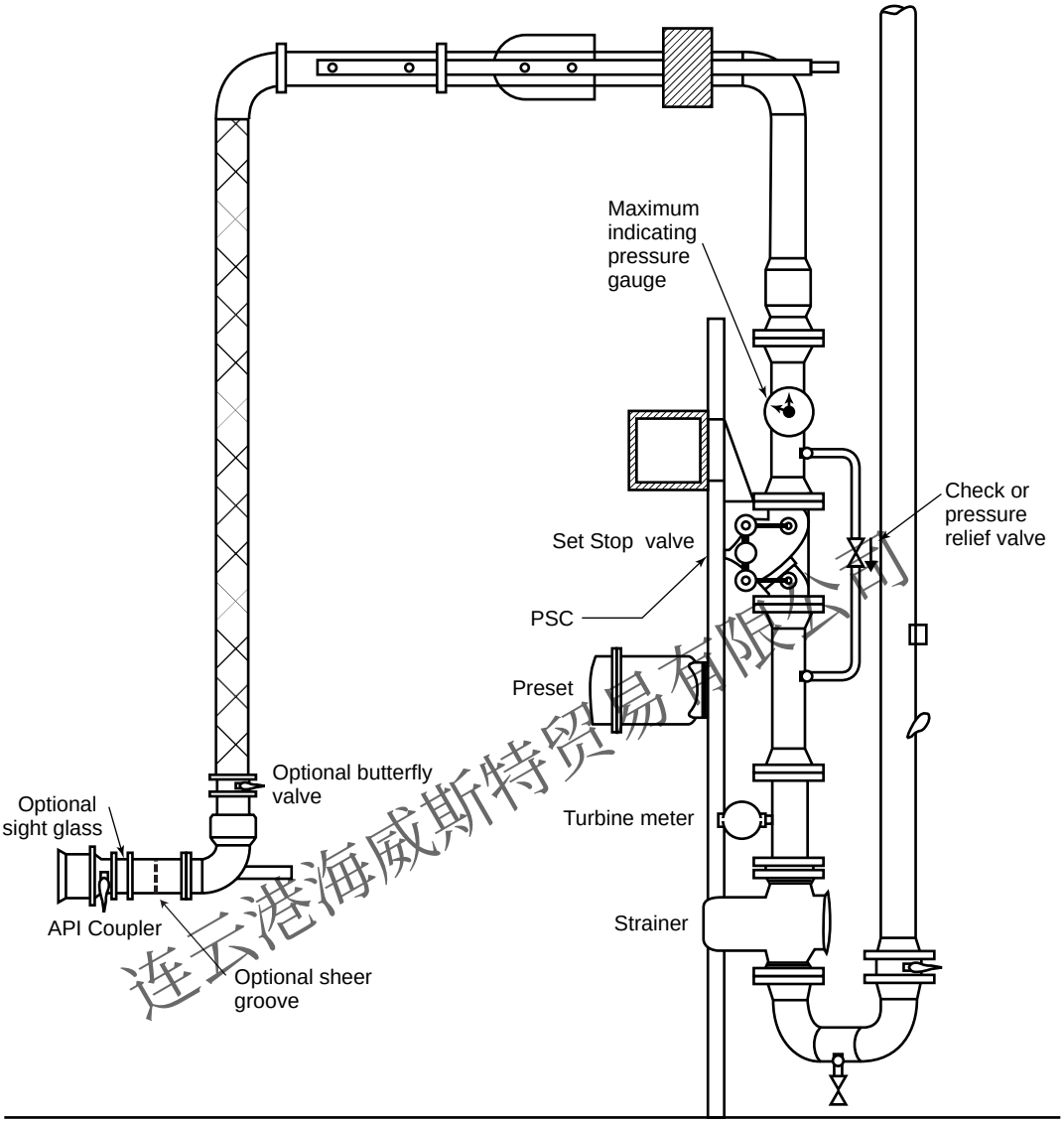


Figure 14—Typical Loading Rack Arm Configuration

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