



# Gasoline and Diesel Oil Systems

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CEU 231



Note: In determining your answers to the CE questions, use only the material presented in the corresponding continuing education article. Using information from other materials may result in a wrong answer.

A storage tank for liquid fuel is any stationary receptacle designed to contain an accumulation of regulated substances. Tanks can be constructed of materials such as steel, concrete, and fiberglass-reinforced plastic or of various combinations of materials that provide structural support.

A storage tank is considered underground if 10 percent or more of the total tank volume of single or multiple tanks, including all associated and interconnecting piping, is below grade or covered with earth.

A regulated substance is any designated chemical that includes hydrocarbons derived from crude oil, such as motor fuels, distillate fuel oils, residual fuels, lubricants, used oils, and petroleum solvents.

Occupational Safety and Health Administration (OSHA) 29 CFR 1926: *Safety and Health Regulations for Construction* further defines storage tanks according to their operating pressure ratings as follows:

- Atmospheric tank: Atmospheric pressure to 0.5 pound per square inch gauge (psig) (3.45 kPa)
- Low-pressure tank: Atmospheric pressure from 0.51 to 15 psig (3.451 to 103.42 kPa)
- Pressure tank: Atmospheric pressure greater than 15 psig (103.42 kPa)

National Fire Protection Association (NFPA) 30: *Flammable and Combustible Liquids Code* governs liquid fuel requirements. This code classifies liquids as either flammable or combustible based on their flash point, which is the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air at or near the surface. In short, the flash point is the minimum temperature at which a fire or explosion could occur.

In addition to classifying liquids as either flammable or combustible, NFPA divides them into Class IA, IB, and IC; Class II; and Class IIIA and IIIB. (Note: The following definitions are only for the purpose of fire protection.)

Flammable liquids are only Class I. They have a flash point below 100°F (37.8°C) and a vapor pressure no higher than 40 pounds per square inch absolute (psia) (2,086 millimeters of mercury [mm Hg]) at 100°F (37.8°C). Class IA liquids (which include gasoline and gasoline blends) have a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C).

Combustible liquids are only Class II or III. They have a flash point at or above 100°F (37.8°C). Diesel fuel, light heating oil, and kerosene are Class II combustible liquids with a flash point at or above 100°F (37.8°C) but below 140°F (60°C). Class III liquids include motor lubrication and waste oil.

Liquid petroleum and petroleum products are defined as hydrocarbons that are liquid at atmospheric pressure and at temperatures between 20 and 120°F (-29 and 49°C) or are discharged as liquid at temperatures in excess of 120°F (49°C). For the purposes of this discussion, these products include gasoline, gasoline blends, and diesel oil used as fuel for motor vehicles and internal combustion engines. These fuels are classified as hydrocarbons. They are also considered flammable liquids.

Specific gravity is the direct ratio of a liquid's density to a reference density, typically water at 62°F (16.7°C).

The viscosity of a liquid is a measure of a liquid's resistance to flow. As the viscosity increases, the liquid's flow decreases under gravity conditions. Viscosity is obtained by measuring the amount of time a given quantity of liquid at a specified temperature takes to flow through an orifice. Viscosity is expressed in Saybolt universal seconds, used primarily for pump work, as well as kinematic viscosity centistokes or centipoises, Saybolt Furol seconds, and Redwood seconds.

The vapor produced by the evaporation of hydrocarbons is in a category known as volatile organic compounds (VOCs), which are environmentally controlled emissions. Vapor produced by gasoline and gasoline blends is required by code to be recovered. Phase I systems refer only to storage tanks where vapor is displaced when the tank is filled with product. The recovered vapor is returned to the delivery truck or rail tanker car. Phase II systems refer only to vapor recovery from automobiles when their tanks are filled with product. The recovered vapor is returned to the storage tanks. Kerosene and diesel oil storage and dispensing systems do not require vapor recovery at this time. Codes concerning environmentally controlled substances are changed and improved frequently, so it is essential to stay abreast of current code requirements.

## CODES AND STANDARDS

The U.S. Environmental Protection Agency (EPA) provides basic minimum regulations to protect the environment and people's health from the leakage of hydrocarbons and VOCs from underground storage tanks (USTs), aboveground storage tanks (ASTs), and associated piping. The basic purpose of these regulations is to ensure the proper installation of the various system components, to prevent leaks or spills from occurring, and should a leak or spill occur, to ensure that the leak is quickly found, corrected, and reported.

In almost all jurisdictions where these systems are installed, specific requirements are mandated by local and state agencies concerning permits, registration, fees, and recordkeeping, as well as specific technical rules and regulations

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regarding system installation, maintenance, materials, and leak detection. A thorough code search is necessary to ensure complete compliance with all applicable federal, state, and local regulations.

Other organizations regulate component testing and provide general provisions for system components and installation with regard to fire prevention. Following is a list of commonly used codes, regulations, and guidelines. This list is not complete and must be verified in the locality where the project is constructed.

- NFPA 30
- NFPA 30A: *Code for Motor Fuel Dispensing Facilities and Repair Garages*
- NFPA 385: *Standard for Tank Vehicles for Flammable and Combustible Liquids*
- NFPA 329: *Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases*
- 40 CFR 112: *Oil Pollution Prevention*
- International Code Council (ICC) *International Building Code (IBC)*
- State building and fire codes
- State fire marshal regulations, as applicable
- UL 142: *Steel Aboveground Tanks for Flammable and Combustible Liquids*
- UL 2085: *Protected Aboveground Tanks for Flammable and Combustible Liquids*
- Resource Conservation and Recovery Act (RCRA), Subtitle C
- STI/SPFA (Steel Tank Institute/Steel Plate Fabricators Association) regulations
- Public Law 98-616: *Hazardous and Solid Waste Amendments of 1984*
- Clean Air Act
- Superfund Amendments and Reauthorization Act of 1986 (SARA), Title III, Section 305(a): *Emergency Planning and Community Right-to-Know Act (EPCRA)*

## SYSTEM COMPONENTS

Liquid fuel storage and dispensing, whether in an AST or UST, require many interrelated subsystems and components for proper operation and for compliance with the applicable codes and standards. They are:

- Storage tanks, including tank filling and accidental spill containment, atmospheric tank venting, overfill protection, and a vapor recovery system
- Leak detection and system monitoring
- Motor vehicle vapor recovery system, if applicable
- Pump and piping systems for dispensing and distributing product from the storage tank into motor vehicles or directly to engines

Due to the significant differences between USTs and ASTs in terms of materials, installation, and operation, these systems are discussed separately.

## UNDERGROUND STORAGE TANKS

Storage tanks are designed and fabricated to prevent product releases due to structural failure and/or corrosion of the tank from the time of installation to the end of the expected useful life of the system. This requires the tank manufacturer to fabricate the tank in conformance with the applicable codes and nationally recognized standards for structural strength and corrosion resistance. Since the tank must be installed in a manner that prevents distortion and stress, the installation must be done by contractors trained and approved by the manufacturer of the specific tank. The tank foundation, bedding, and backfill must be done only with materials and methods approved by the manufacturer, local code authorities, and nationally recognized standards.

Prior to tank installation, groundwater conditions, soil composition, and the potential for corrosive action should be determined. When deemed necessary, tests should be performed to determine the allowable soil pressure. The excavation for the storage tank should be sufficient to allow safe installation and proper backfilling on all sides of the tank with a minimum of 18 inches (0.46 m) of noncorrosive inert materials, such as clean sand or gravel. The suggested backfill material should be a naturally rounded aggregate such as pea gravel, with clean and free-flowing particles ranging from 0.13 to 0.37 inch (3.2 to 9.5 mm) in diameter. An illustration of a typical UST installation is shown in Figure 7-1.

Other conditions that should be considered when installing underground storage tanks include the following:

- High water table levels: Proper tank strapping, pads, or deadman anchors should be installed to counteract tank buoyancy and to keep the tank from popping out of the ground. Deadman anchors are strip footings located under the tank that are engineered to counteract empty tank buoyancy.
- Possible flooding from an adjacent water body or source: Again, installation on an anti-floatation pad and strapping should be used.
- Established flood plains for the local area
- Seismic conditions
- Corrosion protection (soil conditions)

Since tank dimensions for the same size tank differ among manufacturers, consult the manufacturer of the proposed tank for the exact dimensions.



A convenient and leakproof method of connecting directly into the primary tank must be provided to allow for filling, venting, product dispensing, gauging, and leak detection. Where only piping connections are provided, an enclosure connected to all pipes and including an extension to grade should be installed to allow leakage monitoring and access to the connections for maintenance. This arrangement is commonly called a containment sump because the sump is not directly connected to the wall of the tank.

For large tanks, access directly into the tank for personnel also may be desired. Allowance for this may be made by providing a manway (see Figure 7-2), which is formed at the factory during manufacturing. (It should be noted that a tank is considered a confined space, and entrance is specifically regulated by OSHA standards, which require, minimally, specific markings, the use of self-contained breathing apparatus, and an outside assistant or observer.)

The manway often is used for installing equipment and several piping connections. A manway cover on the tank with multiple piping connections in a variety of sizes can be provided. This is done to eliminate the need for secondary containment, and, if the pipes are installed inside the manway, to allow for easier maintenance. Standard fittings are 3- and 4-inch (80- and 100-mm) national pipe thread (NPT). Standard inside diameters (IDs) of manway openings are generally 22, 30, and 36 inches (0.56, 0.76, and 0.91 m), with the size depending on the size of the tank and code or OSHA requirements. These connections can be arranged in a straight line or in a circular configuration.

In addition to the manway, individual half-couplings are usually provided to directly connect piping to the tank.

**Tank Filling**

Underground storage tanks are filled from delivery trucks or, in rare cases, rail tanker cars. When done by gravity, this is commonly called a gravity drop or simply a drop. When gravity filling is not possible, truck-mounted pumps or remote pump fill stations are used. If the fill port is located directly over the UST, the assembly is called a direct fill port. If horizontal piping runs from the fill port to the tank, it is considered a remote fill port. The surrounding grade should be sloped away from the fill port.

The fill port cover must be watertight. Where multiple tanks containing different products are installed, the fill port covers should be color-coded to distinguish among the various product ports and the vapor recovery ports. The cover plates should be installed a minimum of 1 inch (25 mm) above ground level to minimize the possibility of stormwater entering the port.

Another integral part of the filling system is the drop tube or piping inside the tank. The drop tube provides a submerged inlet for the product during filling. This reduces the fluid's turbulence inside the tank, which can cause the product to foam. Some drop tubes include overflow protection valves that restrict tank filling. One example is a float valve that closes when the tank reaches capacity. Overflow protection must be provided.

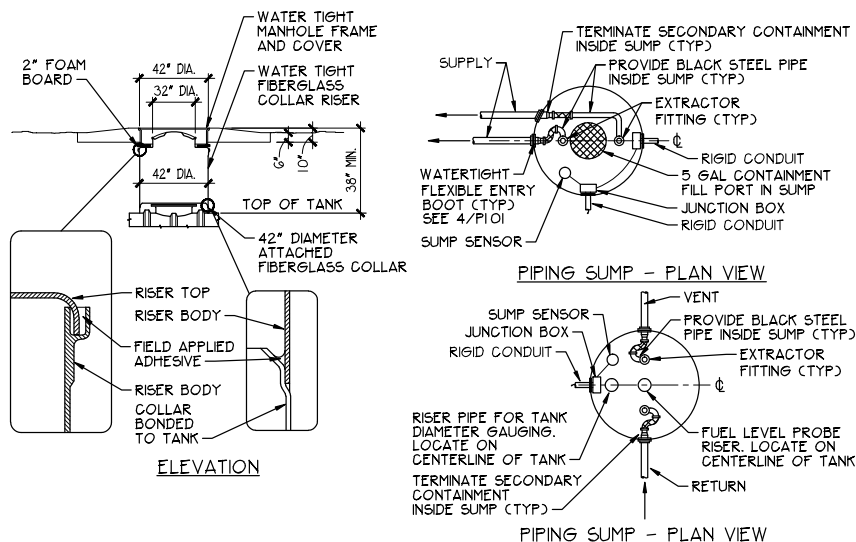
The fill port assembly is designed to accomplish the following:

- It provides a watertight grade cover allowing access to the fill hose connection.
- It provides a fill hose connection for the tanker truck delivery hose. The hose end has a standard end connection, so an adapter might be required on the fill pipe leading to the tank. The gravity drop delivers approximately 200 gallons per minute (gpm) (756 L/min). The flow rate of a truck-mounted pump is generally 50 gpm (189 L/min).
- It allows any fuel spillage from the fill hose to be contained and returned to the tank.
- It allows any stormwater to be removed.

Another fill method involves the use of a coaxial (pipe within a pipe) truck delivery hose to both fill the tank and recover vapor. This requires only one connection from the truck to the tank fill port and a different type of adapter than is used for a fill connection alone.

**Spill Prevention**

The purpose of spill prevention is to provide a safe filling method that is capable of catching spills from delivery hose disconnections. A typical 20-foot (6.1-m) length of 4-inch (100-mm) delivery hose holds 15 gallons (56.8 L). Spilled product must be prevented from entering the soil adjacent to the fill port through the provision of safeguards that are code mandated and recommended as good practice. This is accomplished by installing a below-grade catchment basin with a capacity of 3.5 to 15 gallons (13.2 to 56.8 L) to catch spillage of product from truck delivery hoses. An optional device that could be part of the basin is a drain valve that, when opened, empties the product into the tank fill line.



**Figure 7-2 Manway**

Any water accumulating in the sump must be removed manually and properly treated elsewhere. Catchment basins should be watertight to prevent surface water from entering the tank.

A dry disconnect coupling on the delivery truck hose also could be used to prevent spills.

**Overfill Prevention**

All UST systems must be provided with overfill protection by the installation of one or more of the following devices. The method must be approved by the local authority.

- A device that alerts the operator when the tank is no more than 90 percent full by restricting the flow of product into the tank or by sounding an audible alarm, which is activated by a high-level alarm probe, and sometimes a visible alarm, which must be located in clear sight of the fill port and the operator
- A mechanical device (see Figure 7-3), typically located on the fill tube, that automatically reduces flow into the tank when the tank is 90 percent full and stops flow entirely when the tank is 95 percent full

The best method of overfill protection is the second, and many approved mechanical devices from different manufacturers are available. This is the method most often required by local authorities.

In addition, tanks that do not require a vapor recovery system can have a floating ball device (see Figure 7-4) installed on the atmospheric vent line that closes the vent when the product reaches a predetermined point (usually 90 percent full) at which additional filling may cause a spill. When the vent is closed, the air pressure increases inside the tank and restricts the inflow, alerting the operator that the tank is approaching the full level. If such a device is used, an extractor fitting is required to allow access into the line for maintenance or removal of the float assembly.



**Figure 7-3 Overfill Protection Valve**

**Figure 7-4 Ball Float Overfill Protection Valve**

**Atmospheric Tank Venting**

Underground storage tanks are at atmospheric pressure and require continuous tank venting to ensure that no pressure or vacuum builds up inside the tank when it is filled or emptied. These vents are not to be confused with vapor recovery vents, which serve a different purpose.

Since all of the vapors produced from products are heavier than air, the vapors typically do not escape, but a release of vapor can occur as the tank is filled (vapor is displaced by the product added), as product is removed, or as a result of vapor pressure buildup caused by the evaporation of product at times of high temperature.

Each tank is vented by means of a dedicated vent pipe, typically 2 inches (50.8 mm) in diameter for tanks 10,000 gallons (37,854.12 L) or less. The vent pipe is directly connected to the top of each primary tank and should be extended to a safe location above the highest level of any adjacent building or to a minimum of 12 feet (3.66 m) above grade. The vent discharge must be directed either vertically or horizontally away from buildings and other tanks.

When not in conflict with other regulations, the general practice is to terminate the vent in a pressure/vacuum cap that prevents the entrance of rain and birds and only opens when the pressure exceeds 2 to 15 ounces per square foot (0.86 to 6.46 kPa) or when a vacuum pressure of 1 ounce per square foot (0.43 kPa) is exceeded. If a cap is not provided, a flame arrestor should be installed, if permitted by regulations.

**ABOVEGROUND STORAGE TANKS**

The most often-used aboveground storage tank is factory constructed of steel and intended for atmospheric pressure conditions. Such tanks must conform to UL 142, UL 2080: *Fire Resistant Tanks for Flammable and Combustible Liquids*, or UL 2085. Materials such as FRP, reinforced concrete, and FRP-clad steel are seldom used for small tanks. If used, code requires the outside of a concrete vault to be protected against corrosion, weather, and sunlight.

**Tank Construction**

Aboveground storage tanks are factory fabricated in both rectangular and cylindrical configurations. Concrete-encased tanks can be obtained in either round or rectangular forms. Primary tanks are often manufactured with compartments capable of storing different products. NFPA 30 limits motor fuel AST capacity to 6,000 gallons (22,710 L). All ASTs must be provided with some form of product leakage and overfill containment conforming to 40 CFR 112 regulations. This containment can be achieved by including a dike or an impoundment capable of holding 110 percent of the tank's contents or by providing integral secondary containment of the primary tank.

Many small tanks are provided with integral secondary containment and an interstitial space. The width of the space varies among manufacturers. Several proprietary methods are used to construct the secondary containment vault around the primary tank. An often-used material is plastic-lined concrete. These tank constructions, if sufficiently thick, provide a two-hour fire rating in accordance with UL 2085. Another material used for external secondary containment vaults

is steel. Insulation between the primary and secondary tank is provided by some manufacturers to protect the primary tank from temperature extremes and to meet fire safety requirements for a two-hour fire rating.

Stairs or ladders are generally provided to allow inspection and for delivery truck operators to reach connections located on top of the tank.

**Corrosion Protection**

Since the tank is aboveground, the only corrosion protection required is weather resistance on the tank exterior. This is a code requirement, and each manufacturer has a proprietary method of protecting the outside of the AST.

The exposed piping must be a corrosion-resistant material such as FRP (which also must be impervious to UV light), stainless steel, or protected (painted or coated) black steel.

**Tank Connections and Access**

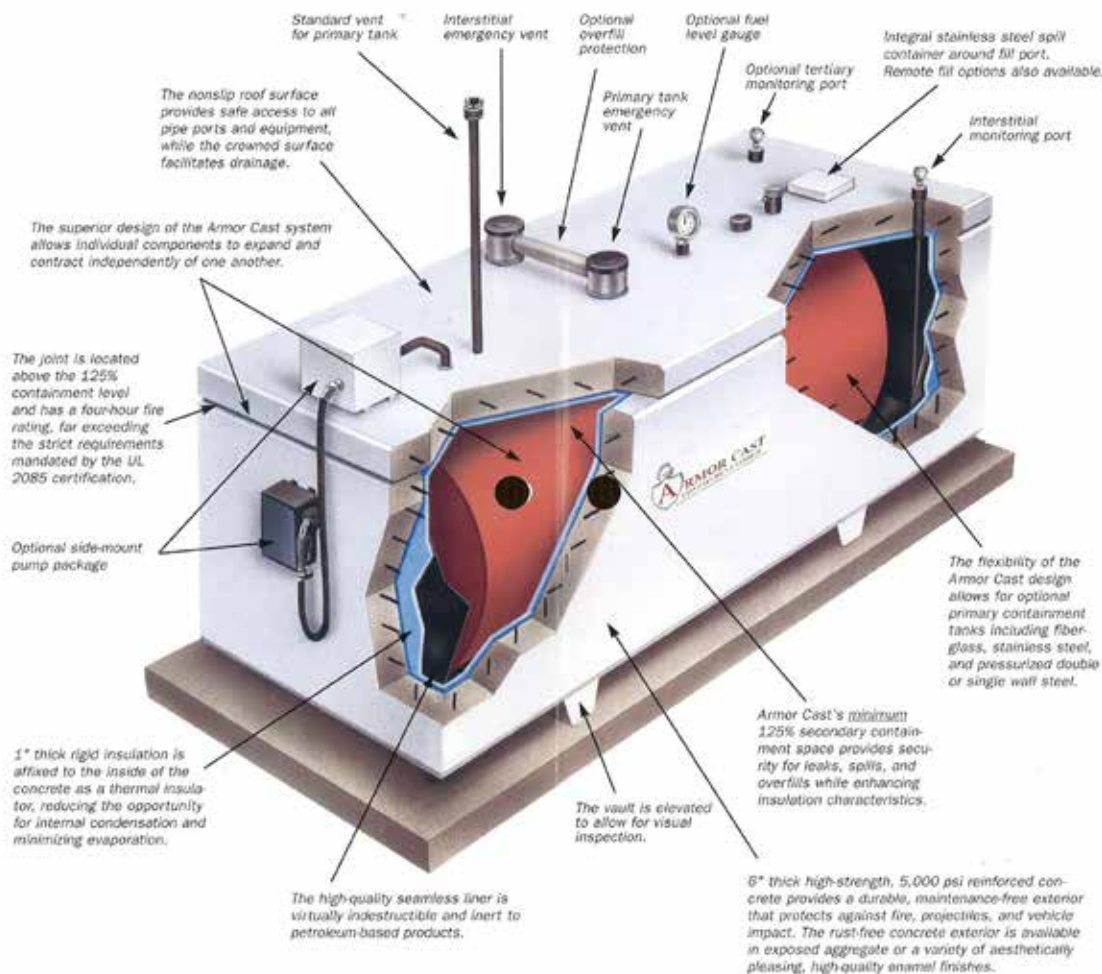
Connections are located only on top of the tank and extend through the vault or secondary containment into the primary tank. Except for large tanks, direct access for personnel entry into the primary tank typically is not provided. Standard connections include:

- Tank vent
- Emergency vent for fire and the elevated pressures created by liquid boiling in the tank
- Product dispenser outlet
- Product fill (either coaxial or single as required)
- Phase 1 vapor recovery
- Tank gauging
- Leak detection

A typical aboveground tank installation is illustrated in Figure 7-5.

**Spill Prevention**

For tanks with integral secondary containment, a containment sump surrounds the fill pipe. The size of the sump ranges from 5 to 15 gallons (18.9 to 56.8 L). For tanks with external secondary containment, spills enter the containment and



**Figure 7-5 Aboveground Storage Tank Installation**

are manually removed. A remote fill station could be provided with an integral spill containment sump to catch any hose spills. A small hand or electric pump could be provided to empty the containment sump into the primary tank.

### Atmospheric Tank Venting

An AST requires two vents. One is the standard atmospheric vent used to keep the tank at atmospheric pressure. This is commonly a 2-inch (50-mm) vent that must extend to a point 12 feet (3.66 m) above grade. The end typically terminates in a pressure/vacuum cap.

The second is an emergency vent required to depressurize the tank if a fire near or under the tank raises the temperature to a point where product vapor is generated faster than the atmospheric vent can pass it. Such a vent is commonly 6 or 8 inches (150 or 200 mm) in size, based on the tank size and the volume stored. The tank manufacturer provides the required emergency vent, with the size based on American Petroleum Institute standards.

### Overfill Prevention

Overfilling is prevented by automatic or manual means installed directly on the tank. Automatic overfill prevention employs an overfill-preventing valve similar to that described previously in the discussion of underground storage tanks. Manual methods include a direct-reading level gauge installed in sight of the operator and/or an audible high-level alarm activated by a separate probe installed inside the tank. Alarms shall sound when the product level reaches 90 percent of capacity, and product delivery will be stopped when the level reaches 95 percent of capacity.

### Leakage from Tanks

The use of aboveground tanks requires a method of containing any possible product release and preventing contamination of the adjacent environment. Product releases can result from small leaks or the catastrophic failure of the tank. Containment methods that meet requirements include a dike completely surrounding the tank, remote secondary containment, and integral secondary containment.

For ASTs without secondary containment, a dike must be provided. Dikes are required to be capable of containing 110 percent of tank capacity and to be constructed of materials such as concrete, steel, or impermeable soil designed to resist the full head of liquid. Dikes must be constructed in conformance with NFPA 30. For discharge from the dikes, a separator must be provided along with the necessary control valves, which may need to be self-actuating to conform with local codes. For ASTs, dikes are seldom used because remote and integral secondary containment have far lower initial costs.

It is recommended that an additional impoundment basin be constructed at least 50 feet (15.2 m) from the AST and at a safe distance from other buildings, property lines, or tanks. The purpose is to capture and isolate any flammable liquids released during a fire or tank failure and to remove them a safe distance away from the AST.

Remote secondary enclosures are usually made of steel. They are totally enclosed and sealed in a manner that prevents the entrance of rainwater by the inclusion of rain shields. They are required by code to have a capacity that is 110 percent of the nominal capacity of the primary tank.

Tank integrity is achieved by enclosing the primary tank with an integral secondary containment, usually of steel or reinforced concrete. This type of tank has an interstitial space that is monitored for leakage in the same manner used for a UST, which was discussed previously.

### System Monitoring

System monitoring consists of product level gauging and leakage annunciating. AST systems can be monitored either manually or electronically; however, manual reading is no longer allowed in some states.

Product level gauging in the tank can be achieved by the use of a visual level gauge or an electronic gauge, either mounted on or immediately adjacent to the tank or at a remote location. Level gauges similar to those installed in USTs can be used. Remotely mounted electronic gauges using probes similar to those installed in USTs are commonly used. These are capable of many functions and of recording and placing data in memory.

Leak detection for ASTs is much easier than that for USTs because leakage from the tank can be easily observed. Automatic means of system monitoring include a stand-alone alarm panel and alarms that are integral to an electronic panel used for product level indication.

### Vapor Recovery

Phase 1 and phase 2 vapor recovery for gasoline and gasoline blends is required. For phase 1 recovery, similar to USTs, either coaxial or two connections from a delivery truck are necessary during the filling operation. Phase 2 vapor recovery for tank-mounted dispensers is usually integral. For remote dispensers, a separate vapor recovery line connecting the dispenser to the tank is required.

### Product Dispensing Systems

For ASTs, the dispenser is usually directly connected to the tank or located a very short distance from it. Some codes require a separation distance between the tank and the dispenser of upwards of 50 feet (15.24 m).



For remote dispensers, a vacuum system may offer a lower initial cost, and due to the short piping runs and single dispenser, most of the objections to vacuum systems discussed previously in the UST section do not apply. However, while they often operate acceptably for diesel fuel dispensing applications, vacuum systems may be plagued by chronic vapor lock in gasoline dispensing systems.

It is important to include an anti-siphon valve with all AST dispensing systems. This valve is used to automatically shut off the flow of product in case the line is broken.

For ASTs, the dispenser can be mounted either on the tank or as a separate, remote dispenser (similar to those used for a UST). Dispensers are available with vacuum or pressure systems.

The tank-mounted dispensing system consists of a submersible pump, the complete dispenser (nozzle, hose, integral phase 2 vapor recovery system, means of base mounting, and safety features), product pump, and interconnecting piping. This arrangement has the lowest initial cost.

### Tank Protection

All ASTs located adjacent to a road or subject to a possible automotive collision must be adequately protected. Acceptable means of protection are concrete barriers or bollards or a concrete encasement. Bollards similar to those used to protect fire hydrants are the means most often used. The entire assembly should be placed within fencing with a lockable gate to minimize vandalism.

## SYSTEM PIPING CONSIDERATIONS

For pressurized product, it is common practice to use a minimum 2-inch (50-mm) pipe, increasing it only if the system under design requires a larger size based on a higher flow rate or if the difference in friction loss allows the selection of a lower-horsepower submersible pump. Generally accepted practice is to not use pipe sizes smaller than 1¼ inch (32 mm). A larger-size product pipe is generally used to lower the head requirements of the pump selected.

### Piping Materials

Piping aboveground from an AST is for the vent and product delivery. The most common piping material is A53 steel with threaded joints, and the pipe must be coated at the factory with an accepted and proven corrosion paint or coating. Teflon tape should not be used on pipe joints as it is incompatible with hydrocarbons. A common practice is to use a baked-on powder.

Another material used where a high degree of corrosion protection and strength is required is stainless steel. FRP with ultraviolet protection added to the pipe is another often-used material. Galvanized steel pipe is not considered acceptable. Adapters are used to connect steel pipe to FRP if an underground run to a remote dispenser is necessary.

Because leakage is visible, double-contained piping is not required for ASTs if the tank is located within a dike or inside remote containment. If pipe is run underground or aboveground outside diked areas, it must be double contained and provided with leak detection.

For new and replacement USTs, interconnecting piping is almost exclusively plastic or FRP with plastic or FRP secondary containment. Requirements regarding the approval of the specific piping material, connections, and cathodic protection, if applicable, must be verified with the jurisdictional authority.

Plastic piping is commonly divided into two general types: flexible and rigid. Flexible pipe is generally manufactured from proprietary materials. If it is UL listed and/or FM Global approved, it is generally acceptable. In addition, the joints and connections should be selected to provide the greatest strength, ease of installation, and corrosion resistance. Flexible, plastic coaxial piping systems are a double-walled piping system installed as a single pipe.

Rigid FRP piping with an epoxy interior lining has been widely used and accepted and is considered the piping material of choice. The primary pipe is assembled with socket-type fittings and epoxy cement. The outer (secondary containment) pipe is the same material as the primary pipe and is manufactured in two half sections with a longitudinal flange. It is assembled after the primary pipe is tested using cement placed on the adjacent flanges with nuts and bolts installed to hold the two half sections together until the cement dries.

Drop tubes in tanks reduce the production of vapors as well as product foaming. Foot valves are used to maintain prime in suction piping.

Flexible pipe connectors are used to connect piping runs to sumps and manways to allow for settlement. In addition, because submersible pumps are screwed into a tank connection, the product discharge will not always face the direction of the piping run to the dispenser when tightened. Flexible connectors are necessary inside manways to connect the submersible pump discharge to the dispenser supply piping.

Gasket materials must be either Buna-N (nitrile butadiene) or NBR (acrylonitrile butadiene rubber).

### Pipe Sizing

Pipe size is based on the flow rate of the product, the allowable friction loss of the fluid through the system, and fluid velocity. This is an iterative procedure done in conjunction with selecting the size of the product pump.

Before the pipe can be sized, the following procedure for sizing the dispensing system must be done:

1. Select the dispenser location, type, and ancillary devices.

2. Select the pipe material.
3. Lay out the piping system, including the length, fittings, and elevations in the layout.
4. Select the storage tank size and location.
5. Select a suction or pressure product pump system.

#### *Flow Rate*

For ordinary applications, the typical discharge flow rate to a motor vehicle from an average dispenser is 8 to 10 gpm (0.50 to 0.63 L/s). High-rate dispensers with discharge rates up to 45 gpm (2.84 L/s) are available for buses and trucks.

#### *Simultaneous Use Factor*

The number of dispensers likely to be used at once is usually determined by experience. Where this can't be determined by experience, the following rule of thumb may be used: For multiple dispensers up to four, use a 100 percent use factor; for more than four, use a 75 percent simultaneous use factor.

#### *Velocity*

For FRP piping, the recommended maximum velocity should be kept at or below 7.5 feet per second (fps) (2.3 m/s). This figure keeps the pressure rise from water hammer to a safe level of 150 percent of design pressure. This is necessary due to the quick closing of the dispenser valve. For steel pipe, a maximum velocity of 8 fps (2.44 m/s) has been found acceptable. Some coaxial piping systems can handle velocities of 20 fps (6.1 m/s) or lower.

#### *Piping Friction Loss*

Friction loss of product through piping is found by checking with the manufacturer of the submersible pump or dispenser. Using the established flow rate, the allowable friction loss can be selected based on the pipe size and selected product.

For preliminary sizing purposes only or if specific tables are not available, most products are close enough in viscosity to water that standard water charts can be used to obtain a friction loss figure that is sufficiently accurate. For FRP pipe, the friction loss should be decreased by 10 percent for a more accurate figure.

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Expiration date: Continuing education credit will be given for this examination through **January 31, 2016**.

### CE Questions — "Gasoline and Diesel Oil Systems" (CEU 231)

1. According to OSHA, a \_\_\_\_\_ storage tank has an operating atmospheric pressure greater than 15 psig.
  - a. atmospheric
  - b. high-pressure
  - c. pressure
  - d. low-pressure
2. \_\_\_\_\_ is an example of a Class II combustible liquid according to NFPA.
  - a. diesel fuel
  - b. gasoline
  - c. kerosene
  - d. both a and c
3. Which of the following contains requirements for steel aboveground tanks for flammable liquids?
  - a. NFPA 385
  - b. UL 142
  - c. 40 CFR 112
  - d. NFPA 329
4. Which of the following should be considered when installing an underground storage tank?
  - a. high water table levels
  - b. seismic conditions
  - c. corrosion protection
  - d. all of the above
5. Which of the following materials is used to manufacture underground storage tanks?
  - a. cast iron
  - b. clad steel
  - c. concrete
  - d. all of the above
6. While filling an underground storage tank, the \_\_\_\_\_ reduces the fluid's turbulence inside the tank.
  - a. drop tube
  - b. manway
  - c. fill port cover
  - d. dry disconnect coupling
7. The vent pipe for a 9,000-gallon underground storage tank is typically \_\_\_\_\_.
  - a. 1 inch
  - b. 1½ inches
  - c. 2 inches
  - d. 2½ inches
8. The most-often used material for a factory-constructed aboveground storage tank is \_\_\_\_\_.
  - a. FRP
  - b. steel
  - c. concrete
  - d. cast iron
9. The emergency vent for an aboveground storage tank is commonly \_\_\_\_\_ inches.
  - a. 2
  - b. 4
  - c. 6
  - d. none of the above
10. A \_\_\_\_\_ is used to capture and isolate any flammable liquids released due to failure of an aboveground storage tank and remove them a safe distance from the tank.
  - a. dike
  - b. manhole
  - c. catch basin
  - d. impoundment basin
11. Which of the following is not considered an acceptable material for tank piping?
  - a. FRP
  - b. stainless steel
  - c. galvanized steel
  - d. A53 steel
12. A rule of thumb when sizing piping is to use a \_\_\_\_\_ simultaneous use factor for a tank installation with 10 dispensers.
  - a. 100 percent
  - b. 75 percent
  - c. 50 percent
  - d. 25 percent