
An Introduction to Petroleum Fuel Facilities: *Bulk Fuel Storage*

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An Introduction to Petroleum Fuel Facilities: Bulk Fuel Storage



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1. INTRODUCTION. This discussion provides guidance for the design of bulk fuel storage facilities, including bulk storage tanks and those components normally located within a typical bulk storage compound. These components include pipeline receiving facilities, tank truck and tank car receiving facilities, pipeline dispensing (pumping) facilities, tank truck and tank car loading facilities, and all related piping and equipment. Note: If aviation fuel can be pumped directly from a tank into an aircraft, aircraft direct fueling system or a refueler, treat the tank as an operating storage tank regardless of size and location and must meet the applicable requirements for aviation turbine fuel operating tanks. The exception is bulk storage tanks that are configured to fill refuelers on an emergency basis only.

2. GENERAL REQUIREMENTS. General design information on fueling facilities is provided elsewhere. Do not begin the design of any fueling system without first becoming completely familiar with the General Design Information.

3. RECEIVING FACILITIES. Fuel is normally received at bulk fuel storage facilities by pipeline, tank truck, tank car, barge, or ship. In many cases, the fuel is pumped by pipeline from the marine receiving facility to the bulk storage facility.

3.1 PIPELINE RECEIVING FACILITIES.

3.1.1 GENERAL CRITERIA. Petroleum fuels may be supplied to bulk fuel storage tanks by interterminal pipelines which may be dedicated to serving the particular facility or may be commercial pipelines handling a number of types or grades of fuel for more than one user. In some cases, the pipeline will be an installation pipeline. If different fuel types are used, separate each type within the receiving facility. Exercise extreme care to avoid designing a system that could create damaging surges in the pipeline created by quick closing valves.

3.1.2 EQUIPMENT REQUIRED.

a) Provide pressure-regulating diaphragm control valves to reduce pipeline pressures to the design pressure of the facility's piping and equipment. Provide a manual isolation valve at both the upstream and downstream side of each diaphragm control valve. Prior to designing any features into the system which might affect the flow from a pipeline, contact the operator of the pipeline to ascertain the current operating conditions, evaluate the use of diaphragm control valves, conduct a surge analysis of the pipeline, and determine whether the use of diaphragm control valves is appropriate.

b) Provide a meter at the receiving end of the line to measure quantities of fuel received. Turbine-type meters are commonly used for pipeline receipt. However, positive displacement meters are acceptable if available at the required flow rate. Consider also the use of alternative meter technologies such as ultrasonic meters. Compensate for fuel temperature at the point of custody transfer. Provide a basket strainer on the upstream side of the meter and connections for proving the meter with a portable prover. A meter prover connection consists of a manual isolation valve in the main pipeline with a tee on both the upstream and downstream sides of the valve. The branch of each of the tees has a manual isolation valve and a hose connection. The master meter can be attached to the hose connections.

c) Provide a means for sampling each pipeline product at a breakout manifold.

d) Provide provisions for a contractor to bolt pig launchers and receivers to the system for pigging. Arrange pig receiving connections to avoid introducing pipeline sludge and sediment into the tanks. Pig launching and receiving provisions are required for interterminal (cross-country) and installation (as described in Chapter 6 of this course underground pipelines.

e) Provide an interface tank to receive mixed fuels at the beginning and end of a shipment unless the commercial pipeline company can provide this service satisfactorily.

f) Provide a breakout tank only if pipeline flow cannot be stopped due to pipeline operational requirements. Provide valves to divert the flow of fuel from the pipeline to the breakout tank in the event fuel transfer is blocked by a manual or automatic valve within the fuel facility system such that the fuel facility system would be overpressurized from transient surge or high pressure from deadheading a pipeline supply pump. Provide appropriate breakout tank overfill alarms and alarm breakout operation so fuel facility operators can take the necessary steps to stop pipeline flow. Provide means of transferring fuel out of a breakout tank back to fuel systems after a breakout event. Conduct a thorough review with the pipeline operator and perform a transient surge analysis to determine if surge pressure reduction methods are required to avoid damage to the pipeline.

g) Provide means of inbound filtration for all products. The selection of filtration depends on anticipated impurities, the source of fuel, and the shipping methods. Consider the use of micronic filters, cyclonic filters, and haypack coalescers as possible filtration devices. Avoid the use of water slug shutoff diaphragm control valves or other rapid-closing valves on pipeline receipt facilities.

h) Provide manual isolation valves to isolate equipment for service.

i) Provide basket strainers upstream of pumps, meters and receipt filtration.

j) Provide thermal relief valves around isolation and check valves to relieve excessive pressures caused by thermal expansion of liquid trapped between shutoff points. See Figures 1, 2, 3 and 4.

k) Provide a concrete housekeeping pad and, unless otherwise directed, a canopy to protect fixed facility assets and equipment from the elements.

3.2 TANK TRUCK AND TANK CAR OFF-LOADING FACILITIES.

3.2.1 GENERAL CRITERIA. Bulk fuel storage facilities may be supplied with fuel by tank truck or tank car or both. At facilities with pipeline or water transport as their principal supply source, provide tank truck or tank car deliveries as a secondary supply source. Tank truck deliveries are the most common method. However, special transportation considerations or changing circumstances may make the use of rail facilities desirable. Therefore, at an activity with railroad service, arrange a tank truck receiving facility so that the system can be easily and economically extended to the existing rail spur. See Figure 5.

a) The preferred off-loading method is into a drop tank off-loading system. See Figure 6.

b) Provide a packaged off-loading system when a drop tank type off-loading is not practical for off-loading tank trucks or tank cars due to environmental concerns, site limitations, or cost considerations, and/or as directed by the Owner. See Figure 7.

c) Provide a direct off-loading system when only an occasional tank truck requires off-loading and when directed by the Owner. See Figure 8.

d) Do not locate tank truck or tank car receiving facilities closer than 50 feet (15 m) from buildings, roads, overhead power lines, pad-mounted transformers, and property lines, or 25 feet (7.6 m) from the fuel farm fence.

e) Provide an adequate number (minimum two) of positions to off-load the daily fuel requirements of the facility in an eight-hour period without causing detention or demurrage of delivery conveyances.

f) Provide separate off-loading connections for each type of fuel to be handled. To facilitate the use of tank trucks with multiple independent compartments, provide a hose manifold with a minimum of two connections per tank truck. A manifold with hose

connections equal to the number of truck compartments is recommended for quick turnaround. If less than five connections are provided, provide a blind flange on the end of the manifold to accommodate additional connections.

g) Provide a containment area at each truck off-loading position consisting of an impermeable retention and controlled drainage system leading to a concrete remote spill containment system. Pave the containment area consisting of the islands, the spaces between islands and on each side of the outer islands, with concrete pitched a minimum of one percent toward catch basins or trench drains. Design the containment area in accordance with federal, state, and local regulations. Do not use asphalt within a spill containment area. The maximum slope of any paving within a truck movement or parking area shall not exceed 2 percent excepting rollover curbs. If a rollover curb is provided, the sum of the vertical entrance and exit grades shall not exceed 8 percent, and the rollover curb shall be aligned perpendicular with the direction of truck movement. The designer shall assure that adequate ground clearance is achieved for all vehicles utilizing the containment areas.

h) At tank car off-loading areas, pave the containment area with concrete (or otherwise provide containment) for an area extending from 5 feet (1.5 m) outside of each outer rail and extending longitudinally 15 feet (4.6 m) each way from the center of each loading position. Slope the paved area to a spill containment system as described previously.

i) Provide a concrete remote spill containment system for each containment area. Design the remote spill containment system in accordance with federal, state, and local regulations. Provide the remote spill containment system with capacity greater than the volume of the largest tank truck or tank car compartment to be off-loaded. A curbed truck position may be provided in addition to a remote system. Twenty-five percent or more of the total required containment volume must be directed to, and stored at, the remote system before any of the shared containment volume will pond at the truck stand area. Provide a lockable eccentric plug valve with an indicator post located outside the containment area at a location that will be safely accessible during a fire. The valve shall

be lockable and normally closed to allow for containment during fueling operations and which can be opened to drain the area when necessary. Tank trucks can be as large as 10,000 gallons (38,000 L) in capacity and tank cars as large as 40,000 gallons (150,000 L). If a canopy is installed, reduce the sizing for rainfall, accounting for wind-blown rain. Consider combining the remote spill containment system with other spill containment systems on site, except with tank containment systems. However, take the level of contamination in each containment area into consideration.

j) Construct the drain piping between the containment area and the concrete remote spill containment system, and between the remote spill containment system and the lockable plug valve, of petroleum-resistant, fire-resistant, impermeable materials. Do not use clay, concrete, fiberglass, or plastic piping materials.

k) For off-loading tank trucks, arrange the flow of traffic to permit continuous forward movement of tank trucks at all times. Commercial tank trucks off-load on the passenger side.

l) To determine the number of connections needed for off-loading tank cars, consult with the Owner and consider minimizing tank car movements, tank car shipping schedules, conveyance turn-around times, local rail switching capabilities, and quantity of fuel needed for one day's fuel supply.

m) Provide an electrical design that meets the minimum requirements of NFPA 70, NFPA 77, and NFPA 780. Treat combustible liquids under pressure as a flammable liquid.

n) Provide a canopy for protection from the elements of fixed facility assets and equipment.

o) Provide a canopy to preclude rain from the containment area when the requirements of this discussion are met.

p) Provide for egress and entrance of emergency response vehicles. The egress and entrance routes need to be large enough to allow both, trucks and emergency vehicles, leaving and entering the facility.

q) Provide a means of inbound filtration for all products. The selection of filtration depends on anticipated impurities, the source of fuel, and the shipping methods. Consider the use of micronic filters, cyclonic filters, and haypack coalescers as possible filtration devices.

3.2.2 TANK TRUCK AND TANK CAR DROP TANK OFF-LOADING SYSTEM. The introduction of air into a fuel receiving system poses extreme hazards which can result in fire and/or explosion. Hazards are compounded when an air/fuel mixture is passed through receipt filter/separators where static electricity is generated and ignition can occur. Design off-loading facilities so air is not introduced into the system. For facilities with the capability to off-load several tank trucks at once or where newer tank trucks with multiple hoses are connected to multiple isolated compartments, consider providing an underground, gravity-type, receiving tank with submersible transfer pumps and level controls. For smaller systems of one or two tank trucks, consider a low profile, aboveground, receiving tank with a centrifugal transfer pump. For either case, provide level sensors to control the flow. Provide a temperature compensated meter on the receipt line to the tank at points of transfer and custody. For materials of construction for off-loading drop tanks, refer to Chapter 8. See figure 6.

3.2.3 TANK TRUCK AND TANK CAR PACKAGED OFF-LOADING SYSTEM. For tank truck or tank car off-loading, an off-loading drop tank may not be practical due to environmental concerns, site limitations, or cost considerations. In these instances, provide a 600 gpm (38 L/s) packaged off-loading system. Provide one packaged system, including vertical inline centrifugal pump, diaphragm control valves to control flow, meter, and multiple hose connections (one for each tank truck compartment), for each tank truck or tank car receiving station. Provide an air eliminator tank to remove air from the system, reducing the risk of an air/fuel mixture passing through receipt filter/separators and preventing the metering of air. Level sensors in the air eliminator tank control the pump

discharge diaphragm control valves, modulating the flow rate based on the level in the air eliminator tank. Refer to and figure 7.

3.2.4 TANK TRUCK AND TANK CAR DIRECT OFF-LOADING SYSTEM. Use when only an occasional tank truck requires off-loading and when directed by the owner. Refer to figure 8.

3.2.5 EQUIPMENT REQUIRED.

a) When tank trucks or tank cars are off-loaded with a drop tank off-loading system, do not provide an off-loading pump. Provide at least two pumps in the drop tank to transfer fuel to the storage tank.

b) When tank trucks or tank cars are off-loaded with packaged off-loading systems, provide one system for each tank truck or tank car that is to be off-loaded simultaneously, at an average capacity of 600 gpm (38 L/s) each. The number of systems shall be determined by the Owner but shall be a minimum of two. The capacity of the systems may be reduced to 300 gpm (19 L/s) each only when directed by the Owner.

c) When tank trucks or tank cars are off-loaded with direct off-loading systems, provide centrifugal pumps configured to provide automatic air elimination as shown on figure 8. Provide at least two pumps to allow continued operation if one is out of service. The capacity of the pumps may be increased to 600 gpm (38 L/s) each only when directed by the Owner. The centerline height of suction line from manifold to pump should not exceed 23.25 inches (591 mm) above truck unloading, parked position. Locate the pump as close as possible to the off-load point to prevent suction problems.

d) Provide 4-inch (100 mm) diameter by 10-foot (3 m) long lightweight reinforced vacuum rated off-loading hoses and covered hose storage racks for each hose connection at each off-loading position. Eliminate covered hose storage rack if off-load rack is to be covered by a canopy. Ensure that all swivels are non-lubricated aluminum or stainless steel in-line

repairable type. Consult with Activity to verify the need for hoses, since at some locations, the fuel hauling contractor provides the hoses.

e) Equip each tank truck off-loading position with an electronic, intrinsically safe, automatic, self-monitoring ground verification unit with a lockable bypass. If grounding is not verified and there is an off-loading pump dedicated to that position, ensure the unit prevents the pump from starting. If the pump is not dedicated, ensure an alarm sounds if the off-loading valve is opened prior to grounding verification. Include a separate grounding reel to accommodate vehicles without grounding equipment.

f) Provide emergency fuel shutoff (EFSO) pushbutton stations. For truck off-loading with multiple positions, an EFSO pushbutton station is required for each position and along routes of personnel ingress and egress between 100 and 200 feet (30 m and 60 m) from the off-loading position. Design in such a manner that activation of the emergency stop will shut off all fueling in the off-loading area and/or the associated pumphouse or pump pad.

g) Provide fuel sampling connections at each position for each product line for collecting test samples.

h) Provide pressure gauges on both sides of each strainer or a differential type gauge across each strainer. Where a strainer is upstream of a pump, the pump suction gauge may function as the strainer downstream gauge.

i) Provide a compound (pressure/vacuum) gauge on the inlet side of pumps and a pressure gauge on the outlet side of pumps.

j) If the system is for JP-5 or other fuel that does not have a static dissipater additive which provides a conductivity level greater than 50 conductivity units (50 picosiemens per meter), and a 30-second retention time is not provided between filter/separator and

receiving tank, provide a relaxation tank downstream of filter/separator to ensure a combined 30-second retention time (time in the relaxation tank and time in the piping).

k) Provide basket strainers upstream of pumps, meters, and receipt filtration.

l) Provide a combination flow control and non-surge check diaphragm control valve on all off-load pumps except positive displacement types. If a bulk air eliminator with automatic air release head is included, provide a means of closing the diaphragm control valve with a solenoid pilot.

m) Provide a positive displacement or turbine meter and meter proving connections. Provide meter with temperature compensation capability wherever custody transfer occurs. Provide a basket strainer on the upstream side of the meter.

n) On each off-loading connection or on the off-loading riser, install a visual fuel flow indicator (maximum pressure 275 psi (1900 kPa) at 100 degrees F (38 degrees C), with Viton Seals with a maximum temperature rating of 350 degrees F (177 degrees C)). This will allow visual quality assurance and provide the operator with a backup system to shut off the pumps when off-loading is complete to prevent air build-up in the receipt lines.

o) Provide manual isolation valves to isolate equipment for service.

p) Provide thermal relief valves around isolation and check valves to relieve excessive pressures caused by thermal expansion of liquid trapped between shutoff points. See figures 1, 2, 3 and 4.

4. DISPENSING FACILITIES. Fuel is normally dispensed from a bulk facility via an installation pipeline, interterminal pipeline, tank truck, or tank car.

4.1 PIPELINE PUMPING FACILITIES.

4.1.1 GENERAL CRITERIA. As discussed elsewhere, pipelines are either interterminal pipelines or installation pipelines. Installation pipelines are commonly used to transfer fuel to an aircraft fueling facility or a marine dispensing facility. Interterminal pipelines are cross-country between installations. However, since pipeline pumping facilities are typically at a bulk fuel storage facility, they are covered in this discussion.

4.1.2 EQUIPMENT REQUIRED.

- a) Centrifugal pumps complying with API Std 610 with adequate head and capacity. Always provide one additional pump as back-up.
- b) Turbine or positive displacement meter with proving connections. Consideration can also be given to alternative meter technologies such as ultrasonic meters. Compensate for fuel temperature at custody transfer point.
- c) Provide fuel sampling connections for collecting test sample.
- d) Pig launching and receiving capability for interterminal and installation pipelines.
- e) Strainer on the upstream side of meters and pumps.
- f) Manual double block and bleed isolation valves where total isolation is required.
- g) Pressure gauges on both sides of the strainer or a differential pressure type gauge across the strainer.

h) Compound (pressure/vacuum) gauges on the inlet side of pumps and pressure gauges on the outlet side of pumps.

i) Provide a combination flow control and non-surge check diaphragm control valve on all pumps except positive displacement types. If a bulk air eliminator with automatic air release head is included, provide a means of closing the diaphragm control valve with a solenoid pilot.

j) Provide manual isolation valves to isolate equipment for service.

k) Provide thermal relief valves around isolation and check valves to relieve excessive pressures caused by thermal expansion of liquid trapped between shutoff points. See figures 1, 2, 3 and 4.

l) Provide a concrete housekeeping pad and, unless otherwise directed by the Owner, a canopy to protect fixed facilities assets and equipment from the elements.

4.2 TANK TRUCK AND TANK CAR LOADING FACILITIES.

4.2.1 GENERAL CRITERIA. This discussion applies to facilities required for loading over-the-road tank truck transports or rail tank cars used for the bulk transfer of fuel. A typical application is the transfer by tank truck from a storage terminal to secondary storage, such as a filling station or a heating plant. In many cases, the receiving and loading facilities are combined. In these cases, both receiving and loading facility requirements must be addressed. This chapter does not include facilities for loading aviation refuelers for direct issue to aircraft. This process requires special design considerations. See figures 5, 6 and 8.

a) Determine the volume of fuel and number of tank trucks or tank cars to be handled by an operational analysis with assistance from the Owner.

b) Do not locate tank truck or tank car loading facilities closer than a minimum of 50 feet (15 m) from buildings, roads, overhead power lines, pad-mounted transformers, and property lines, or 25 feet (7.6 m) from the fuel farm fence. Do not locate a tank truck loading facility closer than 100 feet (30 m) from a railroad track (or spur) or rail siding for loading/offloading. See Chapter 8 of this UFC for clearance requirements from tanks.

c) Bottom loading is the only acceptable method of loading tank trucks. Bottom loading results in increased safety, manpower savings, quality control of product, and area cleanliness. At non-U.S. locations where only contracted top loading tank trucks are available, install a top loading rack with permission of the Owner. In this event, provide future bottom loading capabilities.

d) Provide a containment area at each truck loading position consisting of an impermeable retention and controlled drainage system leading to a concrete remote spill containment system. Pave the containment area consisting of the islands, the spaces between islands and on each side of the outer islands, with concrete pitched a minimum of one percent toward catch basins or trench drains. Design the containment area in accordance with federal, state, and local regulations. Do not use asphalt within a spill containment area. The maximum slope of any paving within a truck movement or parking area shall not exceed 2 percent excepting rollover curbs. If a rollover curb is provided, the sum of the vertical entrance and exit grades shall not exceed 8 percent and the rollover curb shall be aligned perpendicular with direction of truck movement. The designer shall assure that adequate ground clearance is achieved for all vehicles utilizing the containment areas.

e) At tank car loading areas, pave the containment area with concrete (or otherwise provide containment) for an area extending from 5 feet (1.5 m) outside of each outer rail and extending longitudinally 15 feet (4.6 m) each way from the center of each loading position. Slope the paved area to a spill containment system as described previously in Item (d).

f) Provide a concrete remote spill containment system for each containment area. Design the remote spill containment system in accordance with federal, state, and local regulations. Provide the remote spill containment system with capacity greater than the volume of the largest tank truck or tank car compartment to be off-loaded. A curbed truck position may be provided in addition to a remote system. Twenty-five percent or more of the total required containment volume must be directed to, and stored at, the remote system before any of the shared containment volume will pond at the truck stand area. Provide a lockable eccentric plug valve with indicator post located outside the containment area at a location /1/ that will be safely accessible during a fire. The valve shall be lockable and normally closed to allow for containment during fueling operations and which can be opened to drain the area when necessary. Tank trucks can be as large as 10,000 gallons (38,000 L) in capacity and tanks cars as large as 40,000 gallons (150,000 L). If a canopy is installed, reduce the sizing for rainfall, accounting for wind-blown rain. Consider combining the remote spill containment system with other spill containment systems on site, except with tank containment systems. However, take the level of contamination in each containment area into consideration.

g) Construct the drain piping between the containment area and the concrete remote spill containment system, and between the remote spill containment system and lockable eccentric plug valve of petroleum-resistant, fire-resistant, impermeable materials. Do not use clay, concrete, fiberglass, or plastic piping materials.

h) Provide a canopy for protection from the elements of fixed facility assets and equipment.

i) Provide a canopy to preclude rain from the containment area when directed by the Owner.

j) Provide separate piping, pumps, loading connections, and controls for each different type and grade of fuel.

k) Arrange loading rack with a row of islands with sufficient clearance between to allow easy access to all parts of the tank trucks when parked. Arrange islands and approaches in a manner that allows forward motion for all tank trucks at all times with ample room for turning. Space and arrange bottom loading islands to accommodate one tank truck only on the side adjacent to the tank truck's liquid connections, usually the passenger side of the tank truck.

l) Provide for entrance and egress of emergency vehicles.

m) If top loading is required for tank cars (normally only when commercial contract leaves no other choice) and approved by the Owner, provide a typical tank car loading rack with an elevated steel platform, consisting of a walkway, 4 feet (1.2 m) wide, 10.5 feet (3.2 m) above the top of the rails, and the full length of six tank cars. Ensure that the centerline of the structure is 10.5 feet (3.2 m) above the centerline of the tracks. Equip the platform with a counterweighted or spring-loaded tilting bridge to connect to the tank car dome at each loading station. Design so that when released from the horizontal position, the bridge will automatically move and lock in an upright position away from any part of the tank car under all weather conditions. Ensure conformance with appropriate requirements.

4.2.2 TANK TRUCK FILLSTAND EQUIPMENT REQUIRED.

a) Provide a positive displacement or turbine meter for each tank truck fill connection. Protect each meter with an upstream basket strainer. Include temperature compensation if rack is to be point of custody transfer.

b) Provide fuel sampling connections for collecting test samples.

c) Provide pressure gauges on both sides of the strainer or a differential pressure type across the strainer.

d) Provide fusible link butterfly isolation valves as the first piece of equipment (in the direction of the flow) on the loading position.

e) Make provisions to start and stop the pumps with start and stop pump controls at each position. Include pump status indicator light on control box.

f) Provide a solenoid operated truck loading diaphragm control valve with opening/closing speed control, pressure regulating, check and solenoid shut-off features. Interlock the solenoid with the electronic high-level shutoff, and ground verification control system.

g) Provide each fill position with an electronic high-level shutoff, \1\ electronic ground verification, and electronic or hydraulic /1/ deadman control system. The system shall be intrinsically safe and self-checking. Interlock the system with either the solenoid operated truck loading diaphragm control valve or the pump such that the valve cannot remain open or the pump cannot operate if the tank truck compartment is full, the tank truck is not grounded, or the deadman is released. Ensure the system is compatible with both electronic and fiber optic sensors with manual-keyed bypass. (May require a parallel effort beyond the project scope to ensure that all trucks using the facility have compatible connections. If facility has trucks that do not have fixed probes, use cane probes instead.)

h) Provide emergency fuel shutoff (EFSO) pushbutton stations. For fillstands with multiple positions, an EFSO pushbutton station is required for each position and along routes of personnel ingress and egress between 100 and 200 feet (30 m and 60 m) from the fillstand. Design in such a manner that activation of the emergency stop will shutoff all fueling at that pump house or pump pad.

i) Equip liquid connections to tank trucks for bottom loading with drybreak couplers in accordance with API RP 1004.

j) Refer to appropriate guidelines on vapor collection and recovery or disposal systems.

- k) Provide heaters and insulated, heated pipelines, as required, where viscous fuels are to be loaded to maintain the temperature of the fuel at its minimum pumping temperature.
- l) Provide stainless steel loading arms (pantograph, without hoses) equipped with non-lubricated swivels may be used instead of hoses, if approved by The Owner. Ensure all swivels are non-lubricated, stainless steel in-line repairable type.
- m) Provide meter proving connections as described unless local procedure provides an alternative.
- n) Provide relaxation tank or piping configuration with sufficient capacity to retain the maximum flow of the loading station for 30 seconds from the time the fuel leaves the last piece of filtration equipment to the fuel reaching the loading nozzle. Applies only to JP-5 or other fuels which do not have a static dissipation additive that provides a conductivity level greater than 50 picosiemens.
- o) Provide basket strainer upstream of meters and pumps.
- p) Provide manual isolation valves to isolate equipment for service.
- q) Provide thermal relief valves around isolation and check valves to relieve excessive pressures caused by thermal expansion of liquid trapped between shutoff points. See figures 1, 2, 3 and 4.
- r) Grounding/bonding reel (provided as an integral part of the high level shutoff system).
- s) Provide hydraulic shock surge suppressors (if required).

4.2.3 TANK CAR LOADING STATION EQUIPMENT REQUIRED.

- a) Provide a positive displacement or turbine meter for each tank car fill connection. Protect each meter with an upstream basket strainer. Include temperature compensation if rack is to be point of custody transfer.

- b) Provide meter proving connections, unless local procedure provides an alternative.

- c) Provide fuel sampling connections for collecting test samples.

- d) Provide pressure gauges on both sides of the strainer or a differential pressure type across the strainer.

- e) Provide fusible link butterfly isolation valves as the first piece of equipment (in the direction of the flow) on the loading position.

- f) Provide loading connections, controls, valves, etc., on one or both sides of the loading platform as specified by The Owner. Load tank cars from the bottom using counterbalanced, articulated tank car loading assemblies.

- g) Provide an electronic, intrinsically safe, portable liquid high level sensor with adjustable height at each loading rack. To prevent an overflow, interlock the sensor with the electronic high-level shutoff and ground verification control system.

- h) Provide an electronic high-level shutoff, electronic ground verification, and electronic or hydraulic deadman control systems. The system shall be intrinsically safe and self-checking. Interlock the system with either the solenoid operated tank car loading diaphragm control valve or the pump such that the valve cannot remain open or the pump cannot operate if: the tank car is full, the tank car is not grounded, or the deadman is released. Provide the capability to connect the ground verification rack to the rail tank car frame.

i) Provide emergency fuel shutoff (EFSO) pushbutton stations. For fillstands with multiple positions, an EFSO pushbutton station is required for each position and along routes of personnel ingress and egress between 100 and 200 feet (30 m and 60 m) from the fillstand. Design in such a manner that activation of the emergency stop will shutoff all fueling at that pump house or pump pad.

j) Provide solenoid operated tank car loading diaphragm control valve with opening/closing speed control, pressure regulating, check, and solenoid shut-off features. Interlock the solenoid with the electronic high-level shutoff, and ground verification control system.

k) Provide a basket strainer upstream of meters and pumps.

l) Provide manual isolation valves to isolate equipment for service.

m) Provide thermal relief valves around isolation and check valves to relieve excessive pressures caused by thermal expansion of liquid trapped between shutoff points. See figures 1, 2, 3 and 4.

n) Provide relaxation tank or piping configuration with sufficient capacity to retain the maximum flow of the loading station for 30 seconds from the time the fuel leaves the last piece of filtration equipment to the fuel reaching the loading nozzle. Applies only to JP-5 or other fuels which do not have a static dissipation additive that provides a conductivity level greater than 50 picosiemens.

o) Provide hydraulic shock surge suppressors (if required).

5. PIPING SYSTEMS.

5.1 PRODUCT SEGREGATION. Except as otherwise approved by the Owner, provide separate receiving, storage, and distribution systems for each product. Except as otherwise approved by The Owner, prevent misfueling (transferring a type of fuel other than the type intended) by using different size piping, valves, adaptors, nozzles, etc.

6. EQUIPMENT DESCRIPTIONS. The appropriate guide specification and/or standard design provides specific information for equipment selection. Make provisions to drain equipment for maintenance. Provide hardpiped drains when the equipment holds more than 5 gallons (19 L) of fuel or when a pipe which drains to the product recovery tank is within 12 ft (3.7 m) of the equipment.

6.1 BULK AIR ELIMINATORS. Use flange-connected, steel bodied bulk air eliminator of the desired pressure and flow rating for the applicable service requirement. Include an automatic air release head and interlock the equipment with a float or solenoid-operated hydraulically operated diaphragm control valve. Provide discharge piping to the product recovery tank or other safe means of containment.

6.2 METERS. Provide meters with swivel mounted counter heads at truck fillstands to accommodate varying truck and operator positions.

6.2.1 METERS - POSITIVE DISPLACEMENT. Use flange-connected, cast steel bodied positive displacement meters of the appropriate pressure and flow rating to meet applicable service requirements. Ensure meter has case drain and register. Provide meters with temperature compensation and adjustable calibration where there is custody transfer. Ensure meter accessories are compatible with either the mechanical or electronic support equipment selected. Provide an accuracy of plus or minus 0.5 percent when used for custody transfer. Consult the Owner for requirements for the meter to communicate to a remote location or equipment. Consider the use of a card-operated or key-operated data acquisition system.

6.2.2 METERS – TURBINE. Use flange-connected steel bodied turbine meters of the appropriate pressure and flow rating to meet applicable service requirements. Provide a flow straightener before turbine meters or provide a straight length of pipe at a minimum of ten pipe diameters upstream and five pipe diameters downstream of all turbine meters, or as required by manufacturer. Ensure meter has case drain and register. Provide meters with temperature compensation and adjustable calibration where there is custody

transfer. Provide an accuracy of plus or minus 0.5 percent when used for custody transfer. Ensure all supporting equipment for meter is compatible with the turbine meter selected. Consult the Owner for requirements for the meter to communicate to a remote location or equipment. Consider the use of a card-operated or key-operated data acquisition system.

6.2.3 METERS – ORIFICE. Use this type of meter only where custody transfer or accounting/inventory control is not required. Provide with flange connections. Provide a flow straightener before orifice meters or provide a straight length of pipe at a minimum of ten pipe diameters upstream and five pipe diameters downstream of all orifice meters, or as required by manufacturer.

6.3 PRESSURE OR PRESSURE/VACUUM GAUGES. Use liquid-filled gauges of range and dial size, as necessary, but not less than 0 to 160 psig (0 to 1100 kPa) pressure range and 4-inch (100 mm) diameter dial. Gauges shall be all stainless steel construction, with black graduations on a white face. For extreme temperature environments, consult the Owner for direction on the possible use of air-filled gauges. For locations where the temperature is less than -40 degrees F (-40 degrees C), use appropriate gauge liquid that will not freeze to prevent damaging the gauge.

a) Consider the location, year-round weather conditions, and service requirements for the type of liquid filling to be used.

b) Gauge liquids and service ranges as indicated in Table 1 below:

Liquid	Range
Glycerin	0 °F to 400 °F (-18 °C to 204 °C)
Silicone	-40 °F to 600 °F (-40 °C to 316 °C)

Table 1
Liquids and service ranges

c) Provide a lever handle gauge cock and pressure snubber in each pressure gauge connection.

d) Provide indicating and recording pressure gauges on suction and discharge lines for interterminal pipeline pumping stations and on the incoming line at the delivery terminal of each such pipeline, if required by the Owner.

e) Pressure gauges shall be installed so that they are testable without removing them from the piping.

6.4 STRAINERS. Require a strainer to protect centrifugal pumps, unless it precludes meeting the net positive suction head of the pump. Whether or not strainers are installed on the suction side of centrifugal pumps, require a spool piece so that temporary strainers can be installed during startup of the system. Strainers are required on the suction side of all pumps, meters, and receipt filtration. Also:

a) Use flanged basket strainers constructed of steel and fitted with removable baskets of fine Monel metal or stainless steel mesh with large mesh reinforcements. Provide quick opening, single screw type with drain connection in bottom.

b) Provide a fine screen mesh as indicated in Table 2 below::

	Mesh	Size of Opening
Pump suctions (Centrifugal)	7	0.108 inch (2.74 mm)
Pump suctions (Positive Displacement)	40	0.016 inch (0.40 mm)
Receipt Filtration	40	0.016 inch (0.40 mm)
Meter inlets (unless downstream of a filter/separator)	40	0.16 ch (0.40 mm)

Table 2

Recommended mesh screen sizes for pumps and accessories

c) In all cases, ensure the effective screen area is not less than three times the cross sectional area of the pipe.

d) Provide pressure gauges on both sides of the strainer or a differential type gauge across the strainer.

6.5 SURGE SUPPRESSORS. Every effort should be made to control hydraulic surge or shock to acceptable limits by the design of the piping system rather than by the use of surge suppressors. Where this is not possible or becomes extremely impractical, surge suppressor(s) may be incorporated. Use the diaphragm or bladder type equipped with a top-mounted liquid-filled pressure gauge, wafer-style check valve at the bottom, drain above the check valve, and isolation valve. Provide a needle valve around the check valve to permit controlled bleed back of the surge suppresser without rebounding. Locate surge suppressors as close as possible to the point of shutoff that is expected to cause the shock. Surge suppressors can reduce shock pressure but will not eliminate it entirely. The preferred solution to hydraulic shock is conservative piping design, use of loops, and slow-closing valves. Surge suppressors are strictly a last resort solution and require the approval of The Owner prior to designing into a system.

6.6 PUMPS.

6.6.1 DESIGN REQUIREMENTS. Design pumps to deliver the full range of operating conditions anticipated at any facility with flow rates required. Ensure pumps develop sufficient head to overcome the friction and static head losses in the system at the rated flow. Consider the specific gravity, temperature, viscosity, vapor pressure, corrosive, and solvent properties of the fuel. If a range is given for the specific gravity, etc., use the larger value for the purpose of calculations. For any single grade of fuel, connect pumps in parallel. Select according to the type most suitable for the particular application. Do not use positive displacement or reciprocating pumps for product issue or pipeline transfer. Provide enough pumps to allow the system to operate at full capacity with the largest pump out-of-service.

6.6.2 CENTRIFUGAL PUMPS. Use API Std 610 centrifugal pumps to pump from aboveground tanks with continuously flooded suctions.

6.6.3 VERTICAL TURBINE PUMPS. Use API Std 610 vertical turbine pumps to pump from underground tanks. Do not use horizontal transfer pumps in a pit alongside the underground tank as an alternative.

6.6.4 ROTARY PUMPS. Use sliding vane positive displacement pumps or self-priming centrifugal pumps for applications such as stripping pipelines or similar service where the pump may frequently lose its prime. For these pumps, provide a pressure relief valve located on the discharge side of the pumps. A variable speed motor can be used on positive displacement pumps to gradually bring the pump to normal operating speed. Note: On positive displacement pumps the pressure relief valves shall be considered safety relief valves, not operating valves (valves that modulate on a normal basis to maintain a set pressure). Use of the relief valve to modulate the pump discharge pressure voids the pump warranty.

6.6.5 DRIVERS. Drive permanently installed pumps by an electric motor which is properly classified in accordance with NFPA 70. Size drivers to be non-overloading at any point on the curve. Provide anti-reversing ratchets on all vertical turbine pump motors.

6.6.6 MATERIALS OF CONSTRUCTION. Use carbon steel or nodular iron casings and components.

6.6.7 INSTALLATION. Mount permanently installed pumps on substantial foundations of reinforced concrete designed in accordance with Hydraulic Institute Standards.

6.7 VALVES.

6.7.1 MATERIALS OF CONSTRUCTION – GENERAL SERVICE. Require valves to have carbon steel bodies and bonnets except for aviation turbine fuels (see below).

Valves in general service may be internal nickel plated, or internal epoxy coated. Do not allow valves with aluminum, cast iron, or bronze materials. Use only API fire-safe valves.

6.7.2 MATERIALS OF CONSTRUCTION – AVIATION TURBINE FUEL SERVICE. Valve materials in contact with aviation turbine fuel shall either be stainless steel, chrome plated carbon steel, or electroless nickel plated carbon steel. Do not allow zinc, zinc-coated, copper, or copper bearing materials in contact with the fuel. Do not allow internally epoxy-coated valves. Require manual valves in aviation turbine fuel systems to have stainless steel bodies and bonnets. Carbon steel bodied valves are permitted provided they are internally plated with nickel plating. Do not allow aluminum, cast iron, or bronze bodied valves. Use only API fire-safe valves.

6.7.3 ISOLATION VALVE TYPES.

a) Double Block and Bleed Isolation Valves:

- Use these for separation of product services, on tank shell connections, when piping goes above or below ground, between pier and tank storage, and other locations critical to pressure-testing of piping.
- Plug Valves (Double Block and Bleed): Use double-seated, tapered lift, lockable, plug type valves with a body bleed between the seats (double block and bleed). Valves shall be designed so that if the synthetic seating material is burned out in a fire, a metal-to-metal seat will remain to effect closure and comply with API Std 607. Lubricated plug valves are not allowed. Include integral body cavity thermal relief valve.
- Ball Valves (Double Block and Bleed): Use double-seated, trunion mounted, lockable, ball type valves with a body bleed between the seats (double block and bleed). These will be very rarely used but are acceptable as an alternative to double block and bleed plug valves in applications where the valve is operated very infrequently. An example is isolation valve pits where they are only closed to perform pressure testing of piping. Valves shall be designed so that if the synthetic seating material is burned out in a fire, a metal-to-metal seat will remain to affect

closure and comply with API Std 607. Include integral body cavity thermal relief valve.

- Gate Valves (Double Block and Bleed): Use double-seated, lockable, gate type valves with a body bleed between the seats (double block and bleed). These will be very rarely used but are acceptable as an alternative to double block and bleed plug valves and double block and bleed ball valves only when other double block and bleed valves will not physically fit. Valves shall be designed so that if the synthetic seating material is burned out in a fire, a metal-to-metal seat will remain to affect closure and comply with API Std 607. Single seated gate valves are not allowed. Include integral body cavity thermal relief valve.

b) Quick Opening/Frequent Opening Isolation Valves:

- Use these for less critical applications where double block and bleed shutoff is not required.
- Ball Valves: Ball type, lockable, valves designed so that if the synthetic seating material is burned out in a fire, a metal-to-metal seat will remain to affect closure and comply with API Std 607. Use Teflon or Viton synthetic seals or seating material. Use full port ball valves where line pigging is required or if within ten pipe diameters upstream and/or five pipe diameters downstream of a flow or pressure control valve, or a flow-sensing device such as a venturi. Valves should comply with API Std 608.
- Butterfly Valves: High-performance wafer trunion butterfly type valves designed so that if the synthetic seating material is burned out in a fire, a metal-to-metal seat will remain to affect closure and comply with API Std 607. Use Teflon or Viton synthetic seals or seating material. Use valves of high-performance type with eccentric disc shaft and clamping action for bubble-tight shutoff. Provide only at inlet to truck fillstand and on supply and return risers at aircraft direct fueling stations with fusible link set to release at 165 degrees F (74 degrees C). These valves are not required nor permitted on Air Force projects.

c) Use full port valves with exact same diameter of the pipe when line pigging is required.

6.7.4 ISOLATION VALVE OPERATORS. Manually operate valves not specified for remote, automatic, or emergency operation. Use geared operators for ball and double block and bleed plug valves larger than 6 inches (150 mm). Double block and bleed gate, ball, and double block and bleed valves specified for remote, automatic, or emergency service may have electric motor operators, if approved by The Owner. Provide locking tabs on isolation valves to allow padlock to be used to lock out the valves during maintenance. Provide chain operators on valves which are located 72 inches (1800 mm) or higher above grade.

6.7.5 ISOLATION VALVE LOCATIONS. Provide isolation valves in piping systems to control flow and to permit isolation of equipment for maintenance or repair. Provide additional valves at locations necessary to conduct a valid hydrostatic test. Require manually operated valves, except where motor operators are specifically authorized by applicable standard drawings or technical specifications. Use double block and bleed type isolation valves for separation of product services, on tank shell connections (ASTs over 12,000 gallons (45 800 L) only), when piping goes above or below ground, between pier and tank storage, and other locations critical to periodic pressure-testing of piping. Quick opening/frequent opening type isolation valves may be used for less critical applications where double block and bleed shutoff is not required. As a minimum requirement, provide isolation valves at the following locations:

- a) Where piping goes underground or comes aboveground and requires periodic pressure testing.
- b) At all subsurface and aboveground piping connections to storage tanks.
- c) On each branch line at the point of connection to the main product pipeline or header.
- d) On the product pipeline or header just before the line leaves a pumping station.

e) On the suction side and discharge side of each pumping unit, except the suction side of vertical centrifugal pumps installed in underground tanks.

f) On the upstream and downstream side of each line blind at connections to cross country pipelines.

g) On the inlet and outlet connection of each line strainer, filter/separator, meter, diaphragm control valve, and other equipment that requires periodic servicing. One inlet valve and one outlet valve may be used to isolate more than one piece of adjacent equipment which are connected in series.

h) On each main distribution pipeline immediately downstream of the branch connection to each existing or future operating storage facility served by the pipeline.

i) On the aboveground piping at each tank car or tank truck off-loading connection, and at each inlet to the gravity drop tank.

j) On the aboveground piping at each tank car and tank truck loading connection.

k) At critical roadway, runway and taxiway crossings, consider isolation valves on both sides of runway/taxiway to facilitate hydrostatic testing and isolation.

6.7.6 ISOLATION VALVE PITS. Provide fiberglass or concrete pits with a rolling or hinged cover for all isolation valves installed in non-traffic areas on underground fuel systems. Design valve pits and valve operators so that the valves can be operated by personnel, without confined space entry.

6.8 OTHER VALVES (EXCEPT DIAPHRAGM CONTROL VALVES).

6.8.1 CHECK VALVES. Use check valves to prevent backflow through pumps, branch lines, meters, or other locations where runback or reverse flow must be avoided. Check

valves may be of the swing disk, globe, dual plate hinged disk, spring-loaded poppet, ball, or diaphragm-actuated types. Use checks of soft-seated non-slamming type with renewable seats and disks. Ensure check valves conform to API Spec 6D. Use non-surge check diaphragm control valves with flow control feature on the discharge of all pumps. When using non-surge check diaphragm control valves on pump discharge, consider the use of a spring type wafer check before the diaphragm valve to prevent sudden flow reversals during shutdown from passing back thru the pump before the diaphragm control valve diaphragm chamber is filled and reacts by closing the valve.

6.8.2 THERMAL RELIEF. Provide thermal relief valves around isolation and check valves to relieve excessive pressures caused by thermal expansion of liquid trapped between shutoff points. See figures 1, 2, 3 and 4.

6.9 DIAPHRAGM CONTROL VALVES. Hydraulically operated, single-seated, globe type, diaphragm actuated control valves are used extensively in fueling systems as control valves. These valves consist of a main valve and a pilot control system. The main valve consists of a body, diaphragm, and cover and is operated by varying the amount of pressure above the diaphragm. Since the chamber above the diaphragm exposes a greater area of the diaphragm to chamber pressure than the area of the disc exposed to line pressure, an equal pressure in the chamber and pipeline results in a greater force being applied to the top of the disc. This forces the disc against the seat, thus closing the valve. By selecting the proper pilot control system, these valves can be used in numerous ways to control flow, pressure, and level within fueling systems.

6.9.1 OPEN/CLOSE OPERATION. This is the most basic function of hydraulically operated diaphragm control valves. The operation is accomplished by applying pressure above the diaphragm to close the valve and relieve that pressure to allow line pressure to open the valve. The pilot trim used to perform this operation is a three-way valve which can be controlled by a solenoid, hand, pressure, pressure differential, or a float.

6.9.2 THROTTLING OPERATION. This is the other main method of controlling the hydraulically operated diaphragm control valve. In this case, the valve modulates to any degree of opening, in response to changes in the throttling control. The throttling control reacts to a pressure or a pressure differential across the main valve or a pressure differential across an orifice plate to regulate the position of the disc in the main valve. For proper operation these valves should be installed with straight pipe on both sides of the valve. Ten pipe diameters on the upstream side and five diameters on the downstream side is sufficient; provide full port manual isolation valves if they are placed within these limits.

6.9.3 CHECK VALVE FUNCTION. This is a unique function of a control valve. In this case, the main valve outlet pressure is connected to the diaphragm cover. Therefore, if the downstream outlet pressure exceeds the inlet pressure, which normally holds the valve open, the valve will close and prevent backflow. Note: In order for the valve to close it must backflow, sometimes for a substantial amount of time. Consider putting a regular check valve in series with this valve in cases where this is a concern.

6.9.4 REMOTE OPERATIONS. Hydraulically operated diaphragm control valves can be operated remotely. This is accomplished by installing tubing from the point of pressure sensing to the valve or by using remote-controlled solenoids within the trim.

6.9.5 MATERIALS OF CONSTRUCTION. Use stainless steel pilot control valves and stainless steel tubing. Use bodies, bonnets, and covers made stainless steel, internally plated (chrome) steel, or internally plated (nickel) nodular iron. Provide Viton or Buna-N diaphragm and disc ring. Enclose all electrical apparatus according to classification of the area in which they are installed. Provide a means to wire seal all adjustable pilots. Do not use aluminum valves.

6.9.6 APPLICATIONS. For fueling systems, use hydraulically operated diaphragm control valves in the following applications (also refer to specific chapters for applications):

- a) Water slug shutoff.
- b) Rate of flow control.
- c) Pressure reduction.
- d) Pressure relief.
- e) Liquid level control.
- f) Non-surge check control.
- g) Deadman control
- h) Electrical block control.

6.9.7 COMBINATIONS. A combination of these controls is also possible. A typical use of these controls is on a filter/separator for water slug shutoff and rate of flow control.

6.10 THERMOMETERS. Provide thermometers in Burner Fuel No. 5 and No. 6 distribution piping systems at each loading and receiving point and on the inlet and outlet of each heater.

6.11 FUEL HOSES. Use sizes as required for design flow rates. For hose flanges and nipples, use carbon steel or brass, except at aviation turbine fuel issue points use brass, stainless steel, or aluminum where metal parts contact the fuel.

6.11.1 LOADING FUEL HOSES. Provide pressurized loading hoses and connections complying with EI Std 1529.

6.11.2 OFF-LOADING FUEL HOSES. Provide lightweight, flexible, non-pressurized off-loading hoses constructed of nitrile rubber, rigid polyvinyl chloride (PVC) helix, synthetic braiding, smooth bore, and corrugated outer diameter. Provide non-pressurized hoses with a 65 psi (450 kPa) rating at 72 degrees F (22 degrees C) and 27 in Hg (90 kPa) vacuum rating.

7. CONTROLS.

7.1 DESIGN REQUIREMENTS. Automatic controls at any facility may include temperature, pressure, fuel level and pump controls, automatic flow controls, alarm and limit switches, motor operated isolation valves, solenoid pilot actuated diaphragm control, and remote system condition indicators. Other forms of automatic controls are remote meter indication, electronic access control, data logging, and application of computer techniques. Base the selection of advanced automation and telemetry systems on a study of the particular application with consideration of possible economic justification, operational, and security requirements.

7.2 FLOW CONTROLS. Where it is possible to achieve flow rates which exceed equipment ratings, provide an adjustable flow control valve on the outlet connection of each meter or filter/separator. Use a diaphragm control valve controlled by the pressure differential across an orifice or a venturi in the main line. Where necessary, provide remote-operated valves on storage tank inlet and outlet lines, suction and discharge of transfer pumps, and transfer lines at fuel piers and other locations.

7.3 PUMP CONTROLS. Operation of pump suction and discharge valves may be a part of the automatic sequence for the starting of a centrifugal pump and for shutting it down, remotely, locally, or by a protective shutdown device. Remote-operated valves on the discharge side of the pump can be either motor-operated or the solenoid pilot-type, hydraulically operated diaphragm control valves. Remote control valves on the suction side of the pump can be motor-operated valves only. Equip these valves with green and red (open and closed) indicating lights at their pushbutton control locations. Consider the use of PLCs on more complicated systems.

7.3.1 ALL PUMPS. Provide the following controls:

a) A keyed hand/auto button at each pump and a keyed hand-off-auto switch at the motor starter for each remotely operated pump. Both devices will use the same key.

- b) Indicator lights at the control station to give positive indications both when a pump is operating and when it is not energized. Use the "push-to-test" type.
- c) A signal light or alarm to indicate pump failure when a pump is controlled automatically.
- d) Reduced voltage starting if required by electric utility supplier or in all cases for pump motors greater than 50 horsepower (37 kW) and all vertical pumps.
- e) Emergency fuel shut-off (EFSO) pushbutton stations, between 100 and 200 feet (30 m and 60 m) from the pump in the expected ingress and egress direction, with maintained contacts. Provide additional EFSO pushbutton stations at the point of fuel delivery or receipt (fillstands, piers, tanks, etc.) using the same spacing and location requirements.

7.3.2 MULTI-FUNCTION PUMPS. Multi-function pumps are typically used at small facilities and are designed and arranged to be able to perform different functions such as fuel loading, off-loading, or transfer depending on how valves are aligned. Provide each function with the control system requirements for each function described elsewhere in this chapter. For each multi-task pump provide a manual selector switch to choose which set of control and set points the pump is to "look at" when performing a particular function.

7.3.3 TRANSFER PUMPS. Transfer pumps are used to supply fuel to a tank truck loading facility, tank car loading facility, or transfer fuel from one place on the installation to another (e.g., bulk storage tank facility to operating storage tank). Provide transfer pumps exceeding 150 hp with push button start/stop stations. Where these pumps are used for truck and/or car loading, provide push button controls adjacent to the pumps and at each loading station. Use programmable logic controllers (PLC) where multiple pumps supply header loading multiple trucks or cars to obtain desired flow rate to each loading station.

7.3.4 PIPELINE PUMPS. For pumps over 150 horsepower (112 kW), provide protective shutdown devices with alarm at central supervisory control station in the event of the following:

- a) High pump case temperature due to blocked discharge.
- b) Excessive pump vibration.

- c) Mechanical seal or packing gland failure.
- d) High discharge pressure or loss of discharge pressure.
- e) Excessive motor vibration.
- f) High motor winding temperature.
- g) Electrical interlocks which will prevent starting a pump if certain key valve settings are not correct and which will cause a pump shutdown if a key valve setting is changed.
- h) Loss of pump suction pressure.
- i) High bearing temperature and/or loss of cooling water flow.

7.3.5 TEMPERATURE CONTROLS. Provide temperature controls at all fuel oil heaters to control the outlet oil temperature within safe limits. Provide a sensing element in the fuel outlet line which activates a thermostatic valve in the heating medium supply connection to the heater. Use a self-actuating control valve that requires no external power for closure. Use a manually adjustable set point for each temperature variable over the desired temperature range. Provide a bypass around the control valve with a V-port globe or ball valve for manual operation.

7.3.6 CARD AND KEY LOCKS. Consider the possible economic and operational advantages of using an electronic card or key system which permits 24-hour unmanned operation of the facility. These types of systems are comprised of a card/key reader which is located near the service pump. The reader is activated by a card or key and accumulates issues and customer data which is downloaded to a central computer on a periodic basis.

8. CANOPIES.

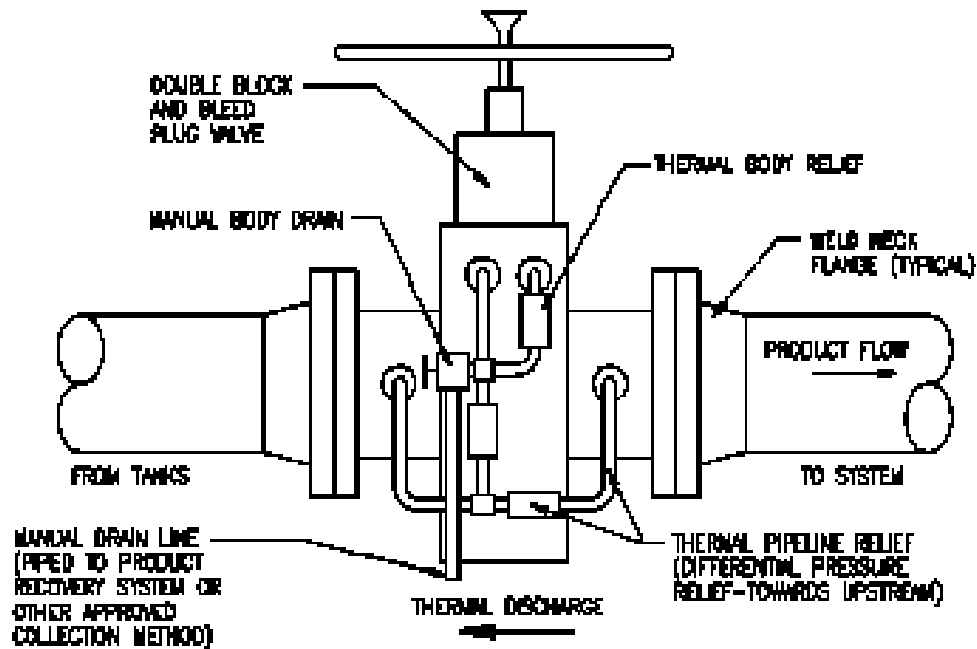
8.1 CANOPIES TO PROTECT FIXED ASSETS FROM EXTREME WEATHER CONDITIONS. Unless otherwise directed by the Owner, provide a canopy to protect fixed facility assets, operators, and equipment from the extreme weather conditions (I.E. re-occurring / sustained extreme icing/snow or desert like conditions). Fixed facilities and equipment include but are not limited to: pump pads, filtration pads, meter pads, isolation valve pads, tank truck and tank-car off-loading and loading equipment pads, control panels, electrical panels, and motor control centers (MCCs).

8.2 CANOPIES TO REDUCE STORMWATER. Do not provide a canopy to preclude rain from reaching the containment area unless it is required by federal, state, or local regulations; or it is economically justified by reducing the size of the concrete remote spill containment or spill treatment system; or if directed by the Owner. At a canopy over a tank truck or tank car loading and off-loading containment area, ensure that the underside of the canopy is high enough to provide operator head room when walking on top of the truck or car.

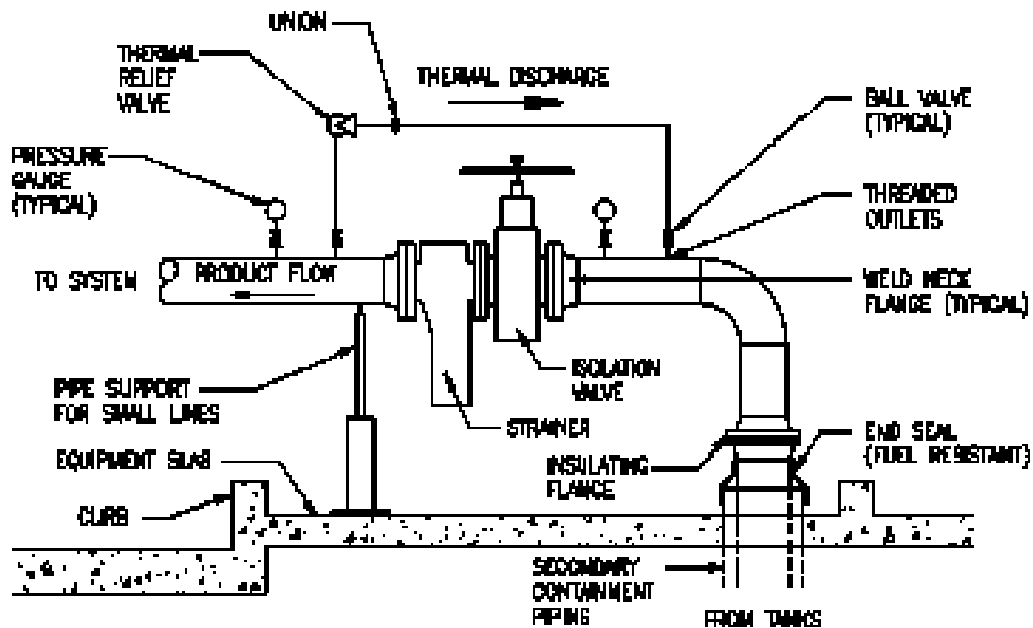
9. PRODUCT RECOVERY SYSTEMS. Provide a product recovery system to collect and store usable aviation turbine fuel that would otherwise become waste from operational or maintenance activities. Consider a product recovery system for other products.

10. FUEL ADDITIVES.

If directed by the Owner, provide bulk storage facilities which store aviation turbine fuels with the equipment to inject fuel additives. This will require proportional injectors, storage of additives, and capability of recirculating tanks through piping with injectors. If the additives have a corrosive characteristic, construct the system, including storage tanks, tank appurtenances, pumps, if required, piping and associated fittings, valves, and injector assemblies of stainless steel components.



INTEGRAL VALVE THERMAL RELIEF PIPING SYSTEM



CONVENTIONAL THERMAL RELIEF PIPING SYSTEM

NOT TO SCALE

Figure 1

Thermal relief piping systems. Integral valve and conventional

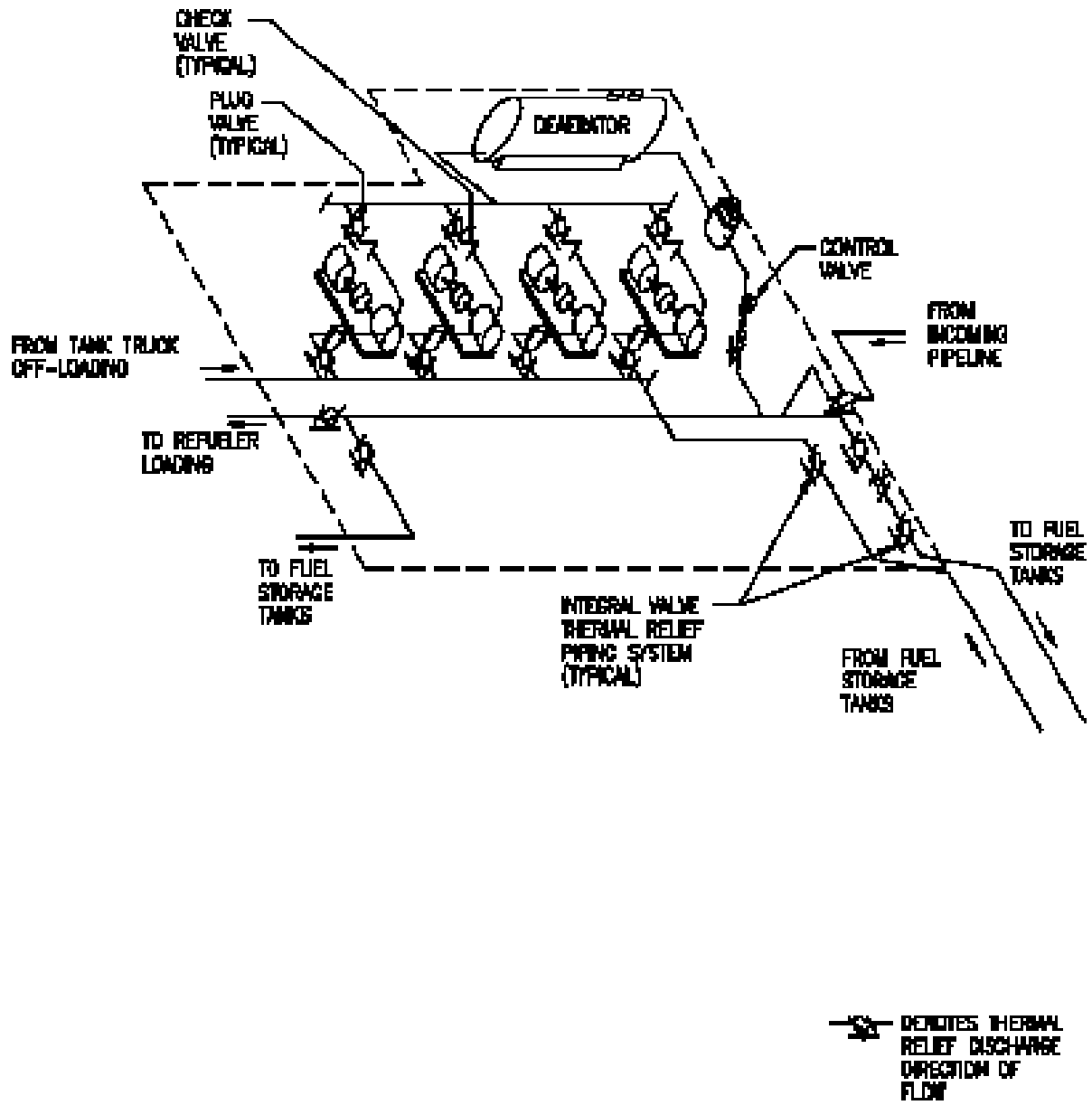


Figure 2
 Thermal Relief Piping Systems Equipment Pump House or Pads

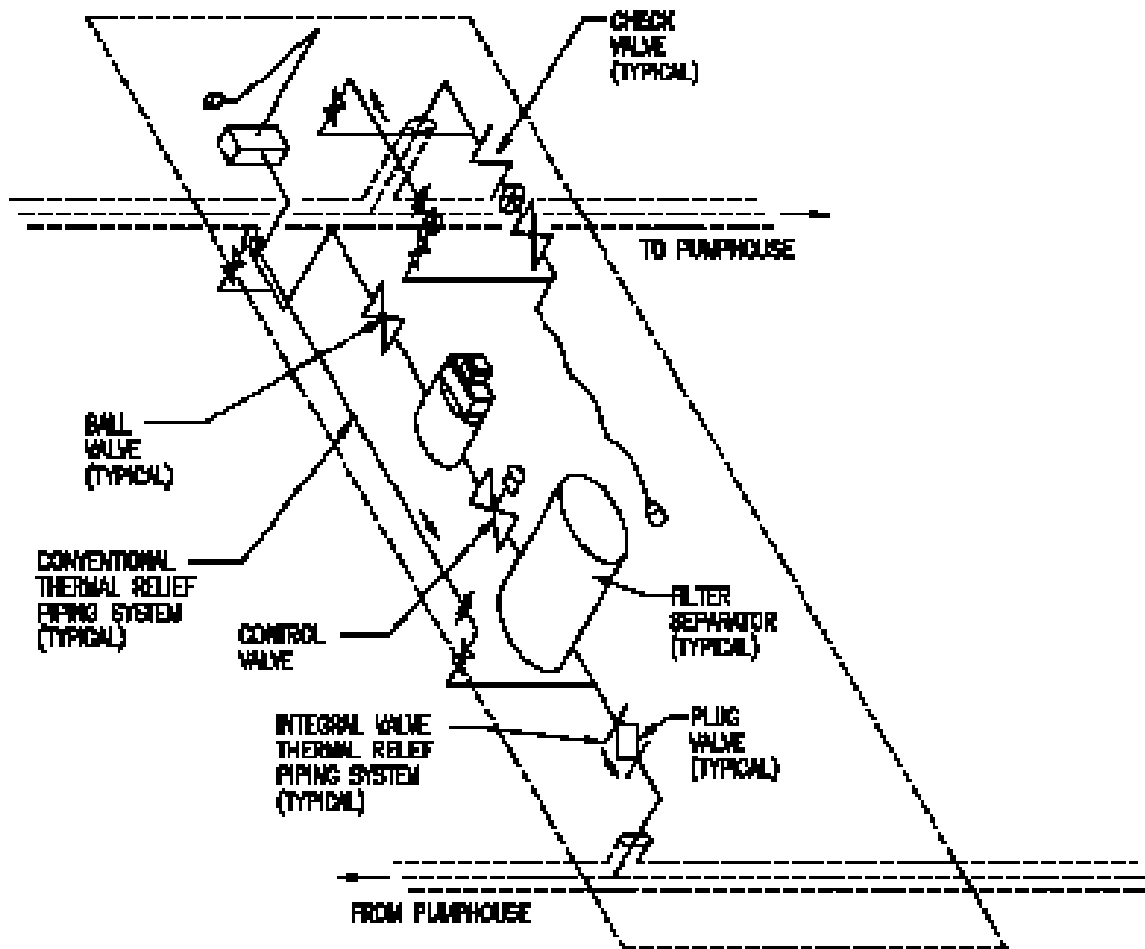


Figure 3

Thermal Relief Piping Systems Tank Truck and Refueler Racks

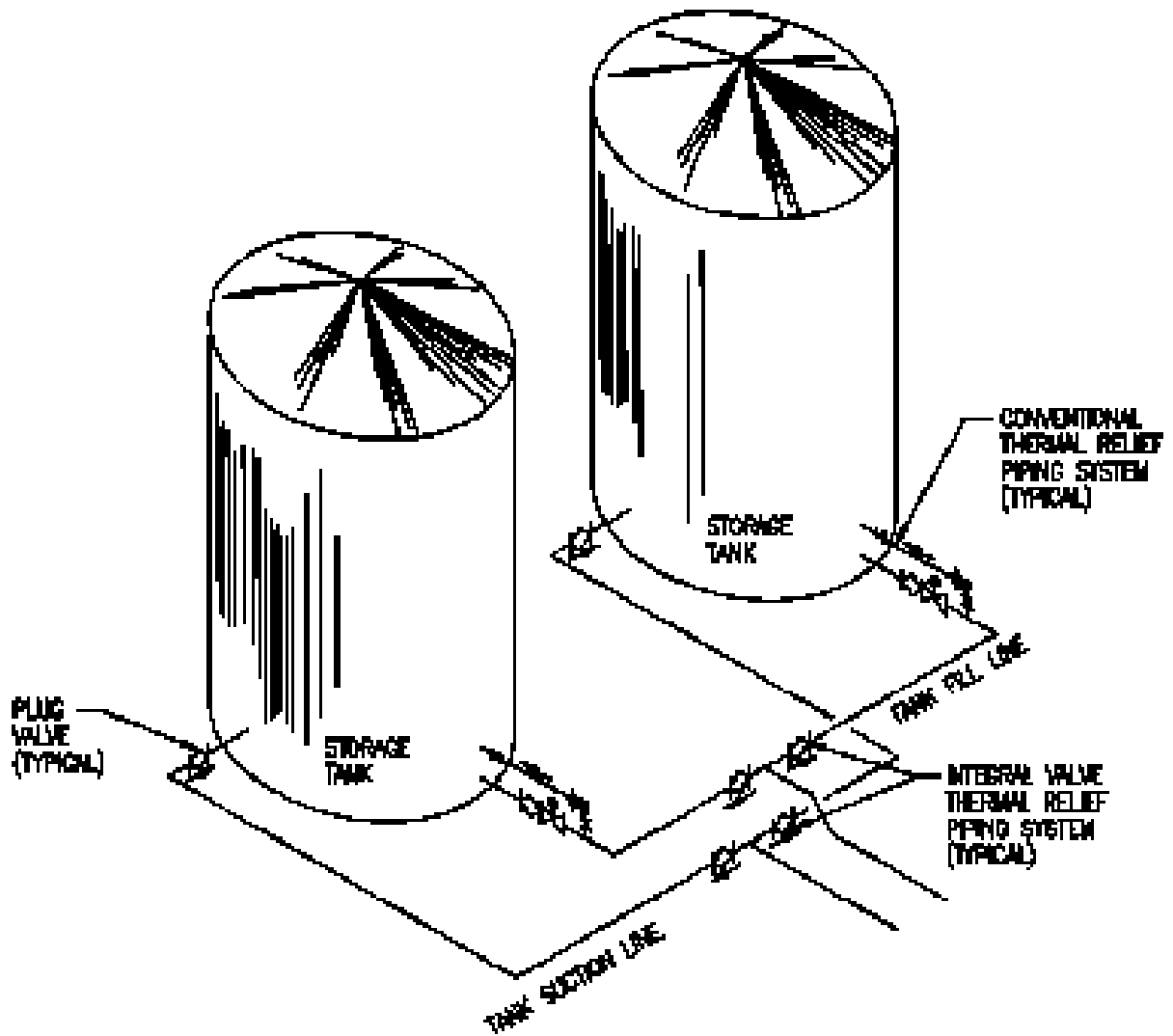
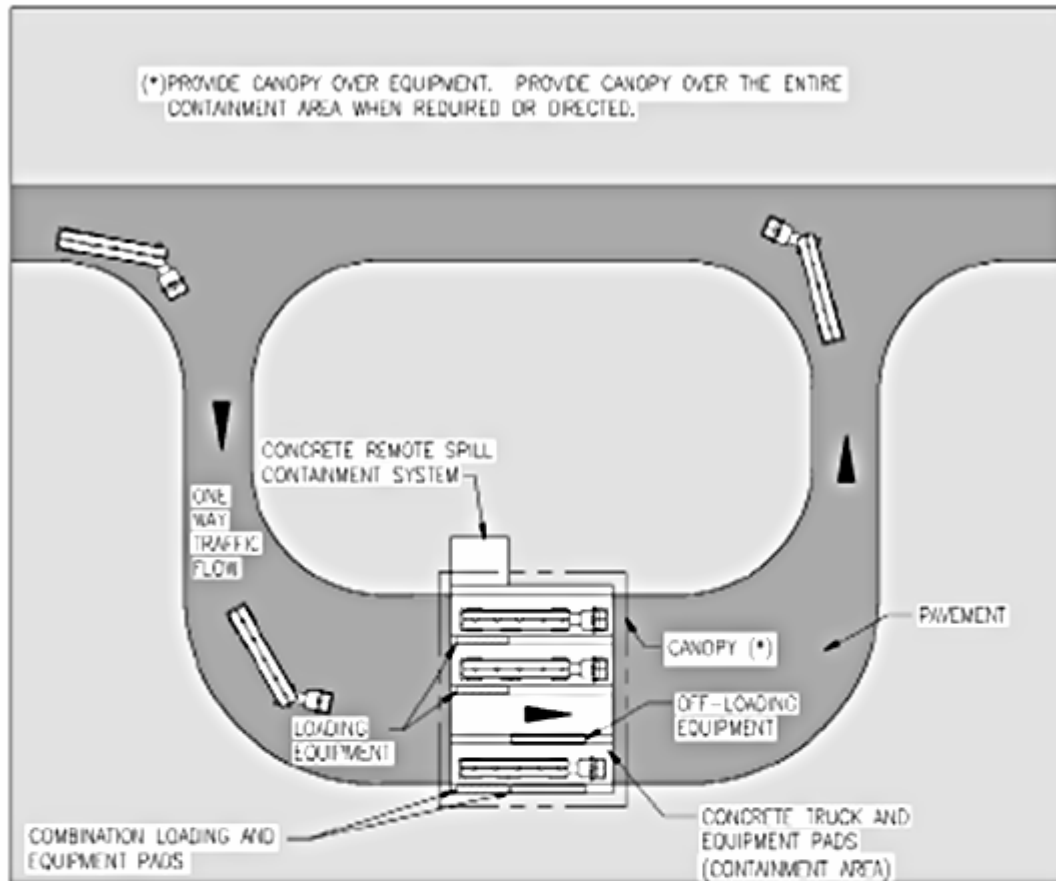
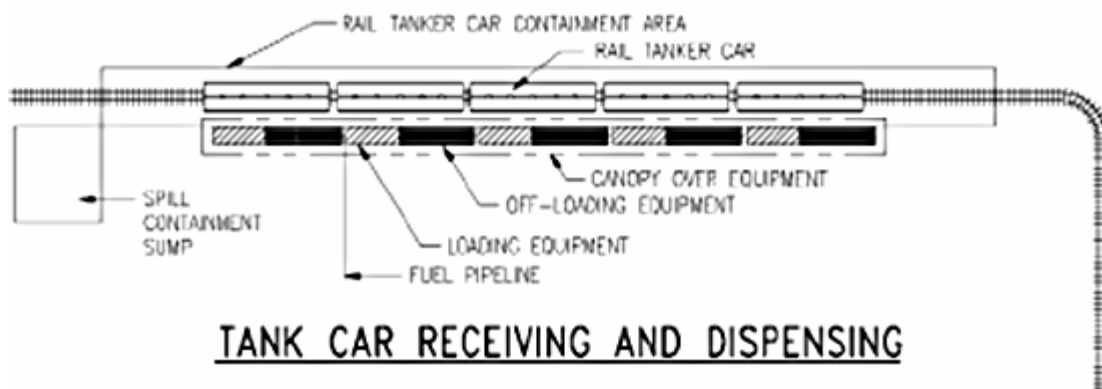


Figure 4
Thermal Relief Piping Systems Storage Tanks



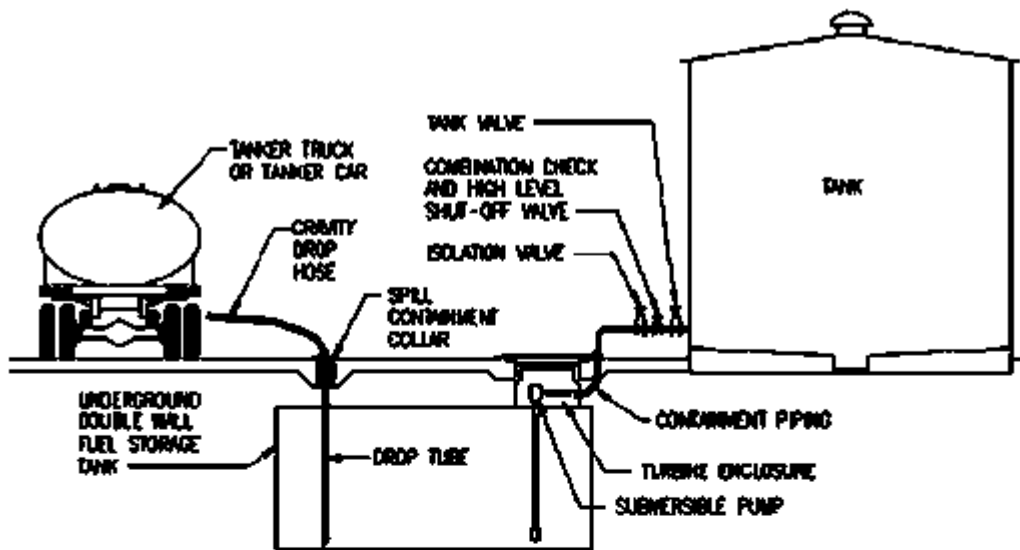
TANK TRUCK RECEIVING AND DISPENSING



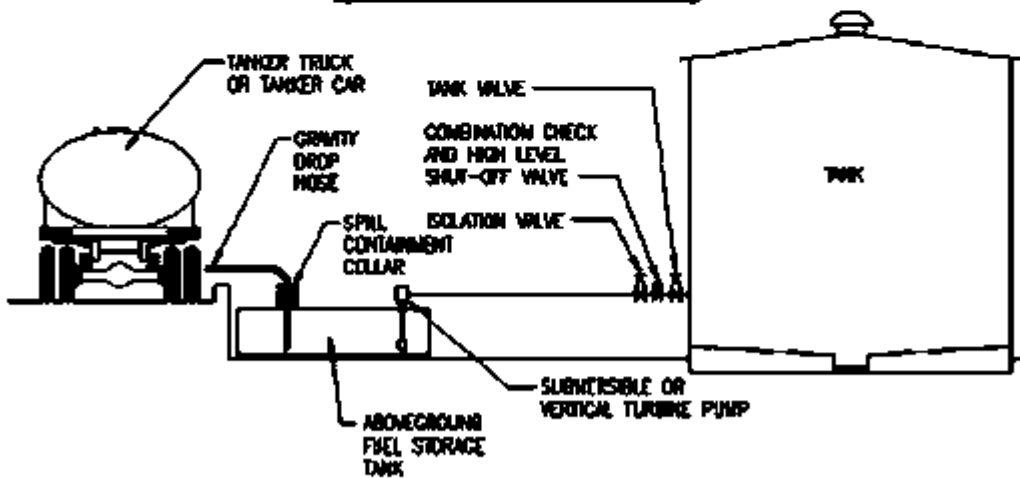
TANK CAR RECEIVING AND DISPENSING

Figure 5

Tank Truck and Tank Car Receiving and Dispensing Facilities



DROP TANK OFF-LOADING SYSTEM EQUIPMENT
(UNDERGROUND TANK)

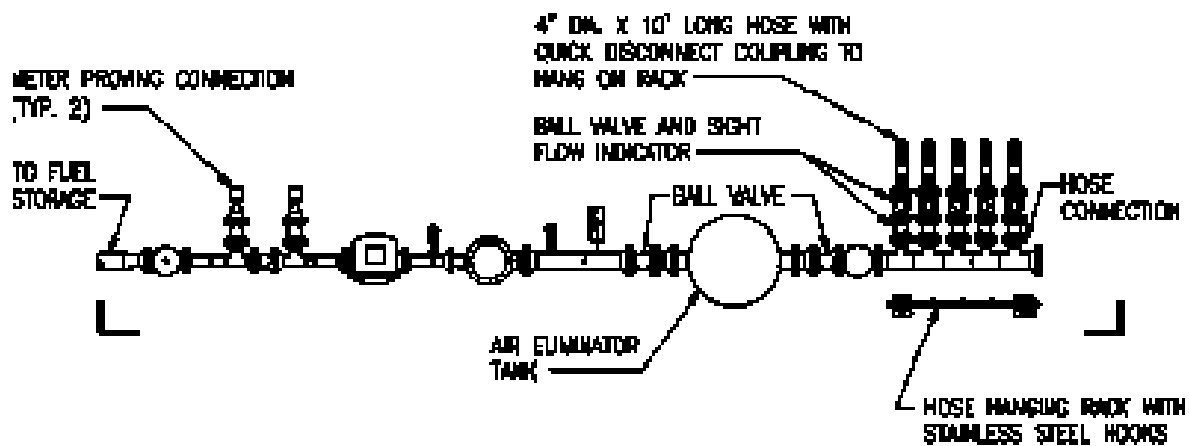


DROP TANK OFF-LOADING SYSTEM EQUIPMENT
(ABOVEGROUND TANK)

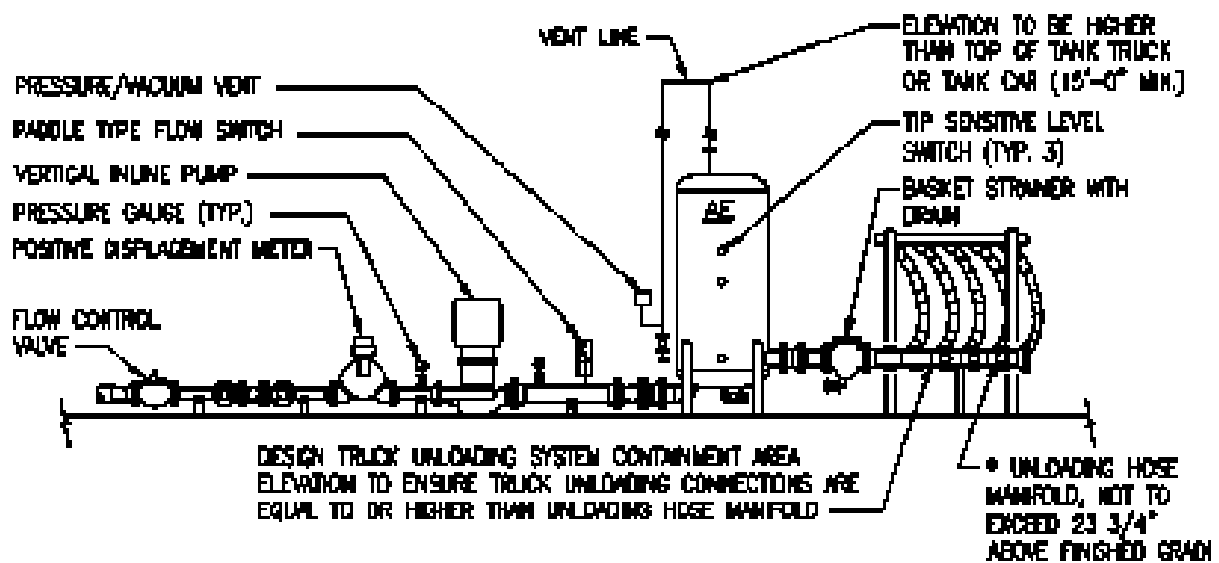
NOT TO SCALE

Figure 6

Tank Truck and Tank Car Off-Loading Drop Tank System



PLAN



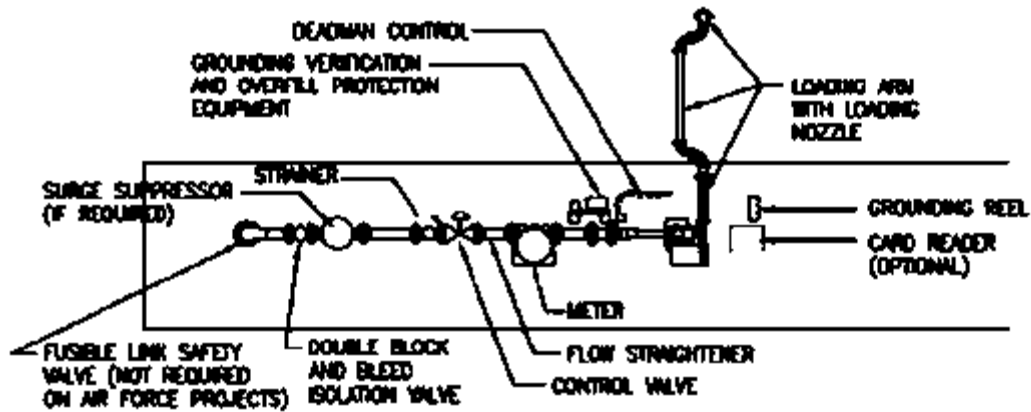
* PROVIDE OFF-LOAD HOSE MANIFOLD WITH 5 HOSE CONNECTIONS AND NUMBER OF HOSES TO MATCH TRUCK COMPARTMENTS (MINIMUM OF 2).

SECTION

PACKAGED OFF-LOADING SYSTEM EQUIPMENT

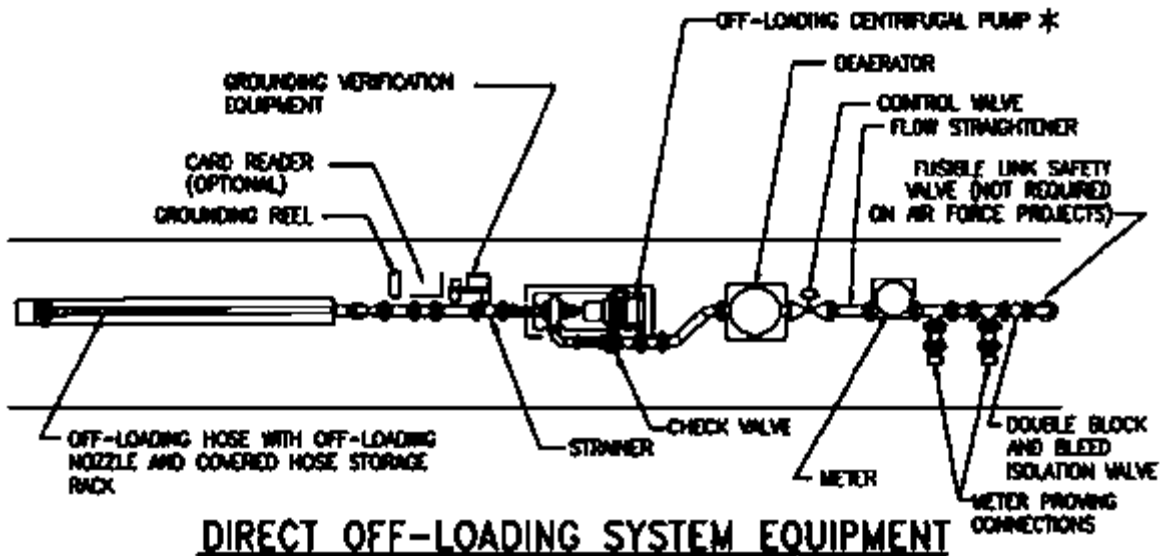
Figure 7

Tank Truck and Tank Car Packaged Off-Loading System



LOADING SYSTEM EQUIPMENT (*)

(*) NOT TO BE USED FOR LOADING REFUELER TRUCKS



* TWO PUMPS MAY BE PROVIDED TO ALLOW CONTINUED OPERATION IF ONE IS OUT OF SERVICE.

NOT TO SCALE

Figure 8

Tank Truck and Tank Car Loading System and Direct Off-Loading System