Your Questions Answered (15)
Special Fuel Design Topics

earth safe
Fuel Systems for Critical Power

25.1 Where are tanks located in buildings?

Tanks are required by code to be located in buildings at the lowest level in the building, with limited volumes allowed for day tanks in upper levels.

This means that tanks are often located several level below ground in urbn high rise construction, while generators may be locate at grade, upper floors , or the roof..

The tanks are filled by delivery trucks located at grade. So between fill piping, fuel supply and return piping to generators, and tank vent piping, routing of fuel piping within buildings is an important consideration.

25.2 What are day tank restrictions on upper floors?

Day tank restrictions on upper floors vary with local building codes. Common limits are 240 gallons limit for a floor or room, or sometimes the much more restrictive 60 gallons.

25.3 How is piping designed for building risers?

Between fill piping, fuel supply and return piping to generators, and tank vent piping, routing of fuel piping within buildings is an important consideration. Most of the piping is routed vertically through risers, and layout and coordination with other building systems is an important consideration.

Fuel oil supply, return, and vent piping is typically double wall steel pipe with welded connections. Tank vent pipe is typically single wall piping.

Tank vent piping is an important consideration for fuel systems in buildings. In some locations emergency vents are required to be routed to the exterior of the building. For a double wall tank, this would be 2 pipes from 4” to 10” diameter. Added to fuel oil supply, return, and normal vent piping, this can be a considerable installation cost, and also take up a lot of space within the building.

25.4 What is a fuel header system?

A fuel header system is designed to provide fuel to multiple generators, where there are severe regulatory restrictions to the volume of fuel that can be stored in the generator room. The header is an 8” to 12” diameter pipe which runs the length of the room to serve all generators. The pipe is sized to be less than the regulatory limit for fuel storage quantities in the room.

The generators draw fuel from the header pipe, and return fuel to the header pipe.

The fuel supply pumps draw fuel from a bulk tank and pump to the header inlet. The header outlet is a gravity overflow back to the bulk storage tank.

26.1 What are the regulatory and code requirements for underground tanks?

All states regulate underground fuel tank installation and operation. The regulations have their basis in the federal underground tank rules that were first established in 1988 and phased in through 1998. The regulations include technical requirements for fuel tanks and piping as well as financial responsibility requirements. Technical requirements include: leak detection, corrosion priotection, and spill and overfill protection.

Many states have special technical requirements that are in addition to the standard regulations. California rules would be inclusive of most of the special requirements that can be encountered. Their regulations include:

1. Pre-qualification approval of all equipment and materials used in underground fuel tank systems.
2. Full secondary containment of all tanks and piping.
3. Fill pipes and spill container located within secondary containment sumps. All tank openings including tank gauging within secondary containment sumps.
4. Periodic testing of secondary containment piping, sumps, tanks, and tank monitors.
5. Double wall construction for tank sumps and piping transition sumps.
6. Double containment of vent piping.
7. Continuous positive monitoring of tank, pipe, and sump secondary containment by vacuum, pressure, or hydrostatic method.
8. Precision leak detection testing after installation and backfill using tracer gas method.

26.2 What are the regulatory and code requirements for aboveground tanks?

Tank Volumes State and local regulations will limit the capacity of aboveground tanks. Some local ordinances may severely limit aboveground tank capacity or even prohibit them. Special rules for fuel dispensing into motor vehicles will also limit capacities for these applications.

Tank Construction Typically regulations will require that tanks be built to UL 142 or UL 2085 standards.

Tank Location Regulations will specify distances of separation for aboveground tanks from buildings and property lines.

Tank Equipment Regulations will typically require proper vent devices for aboveground tanks, overfill prevention valves, Anti-siphon and emergency valves.

Fire Protection / Suppression Fire Protection / Suppression measures may be required by local regulations. Typical requirements may include a piping system to allow for the remote dispensing of foam by fire fighters into the tank containment area.

Leak, Spill, and Overfill Protection Regulations leak monitoring procedures and devices. These may be visual with recordkeeping or continuous electronic monitors. Spill protection is provided by curbs and diking. Overfill protection is usually required as redundant methods such as a high level alarm device and a fill pipe overfill prevention valve.

Spill Prevention Control and Countermeasure Plans (SPCC) SPCC Rules are US Federal and State regulations that apply to certain aboveground tanks. They were originally enacted to prevent problems at large marine oil terminals, which had the experience in several instances of discharging large volumes of oil into adjacent rivers. The regulations apply to tanks over 500 gallons where a discharge could impact a navigable waterway. Since the concept of navigable waterway is broadly interpreted, the regulations will apply to most tanks. The standards require a written plan for the facility with the plan reviewed by a professional engineer, and periodically updated.

26.3 What are the regulatory and code requirements for tanks in buildings?

National Building and Fire Codes address the use of fuel tanks in buildings. These codes are often modified for the particular requirements of individual States or Local authorities.

NFPA Standards include requirements for storage tank buildings. These are separate structures for the special purpose of fuel storage. These rules are not in general applicable to fuel storage and use within commercial buildings.

The principals addressed are:

- Tank Design Standards
- Tank Venting
- Overfill Prevention
- Secondary Containment
- Quantity Restrictions
- Location within Buildings
- Piping Systems in Buildings
- Fire Protection

26.4 What are the special requirements for underground tanks in California?

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27.1 When is ant-siphon protection needed and how is it done?

Anti-siphon valves are used at aboveground tanks where fluid levels would be above the point of use with the potential for inadvertent siphoning of fuel out of the tank. The valve is installed in the fuel supply piping from the tank at the top of tank elevation.

Anti-siphon valves are also required for submersible pumps in aboveground tanks, since fuel can flow through the pump under siphon conditions.

There are 2 common valves used for anti-siphon protection: (a) spring loaded valves, or (b) normally closed electric solenoid valves or actuated valves. The electric actuated valves are sometimes preferred where there is a concern over the capability of a suction pump in reliably overcoming the spring force resistance of a spring loaded valve.

The spring loaded valve is a spring loaded angle check valve with a spring force sized to resist the static fuel head. They are selected as 0-5, 5-10, 10-15, 15-20 feet of head resistance and are typically adjustable within that range. The fuel transfer pump must overcome the spring force to allow the pump to open and flow.

Electric actuated valves are normally closed valves that open and allow flow when energized. Solenoid valves for submersible pumps are sometimes energized with the same electrical circuit as the pump to simplify control.

27.2 What is fluid hammer and how is it avoided?

Fluid Hammer is a pressure wave within a piping system that can cause excessive vibration of the piping and other system components. Fluid hammer occurs when the fluid in a piping system is rapidly pressurized, most commonly from a pump starting or a valve closing, particularly when refilling generator day tanks.

The easiest way to avoid water hammer in fluid systems is through the control programming that (a) allows a pump to start only after a valve is day tank inlet valve is opened, and (b) allowing a day tank inlet valve (or the last open valve in a multi-day tank system) to close only after the pump has stopped.

An alternative is to slow the start and stop of pumps using VFD drives, and to use actuated valves rather than fast closing solenoids at tank inlets.

Other alternatives are (a) the use of hydraulic actuated valves to slow the pressure builup in piping systems, (b) the use of accumulators or bladder tanks to absorb and dissipate pressure waves.

27.3 What is important about fuel meters?

Accurate fuel metering depends on (a) removal of entrained air in suction pump systems, (b) minimizing turbulence at meter inlet and outlet connections using minimum lengths of straight pip, (c) measurement of fluid temperature and compensation (other than for mass flow meters).

Meters used for custody transfer are commonly regulated by State and local agencies for accuracy, including periodic independent testing of accuracy.

Meters are used in generator fuel systems for a number of purposes:

- Measurement of fuel delivered to various generators when multiple tenants draw fuel from a common tank
- Filtration systems that operate based on the volume filtered in a particular cycle
- Measurement of generator or boiler fuel consumption for air quality regulation recordkeeping

27.4 How is fuel consumption measured?

Fuel consumption measurement for diesel engines ins complicated by the fact that the engine consumes only about 1 / 3 of the fuel flow. There are 2 common methods of determining consumption: (a) measure the fuel flow into a day tank or reservoir tank and compensate for start volume, end volume, and temperature, (b) use 2 meters one on the engine fuel supply plus one on the engine fuel return, compensate for temperature and net the difference.

The second method of measuring inflows and outflows can be subject to inaccuracy because a very small measurement error is multiplied by many times with repeated flow. Highly accurate mass flow meters are preferred for this method.

27.5 What are the causes of tank overfills and the appropriate protections?

Overfills are the most common cause of release from aboveground tanks. The key idea in prevention is redundancy. What several methods should be used to prevent overfills: (a) a method – such as an electronic tank gauge- of determining the fuel volume in the tank, and calculation of the available free space to the 90% fluid level, (b) a secondary method for levels / volumes such as a direct reading level gauge, (c) a third method for level / volume such as a manual gauge stick, (d) procedures for filling tanks only when facility personnel are present for observation and monitoring and lockable fill equipment to control access, (e) a high level audible and visual alarm to warn the fill operation personnel when the tank reaches 85% capacity, (f) an overfill prevention valve to close and stop flow when the tank level reaches 90%.

27.6 What are the causes of piping overpressure and the appropriate protections?

The most common cause of over-pressure in piping is caused by thermal expansion, an increase in temperature of a pipe section that is blocked between 2 closed valves. The situation occurs because relatively cool fuel may be drawn from a tank into a higher temperature piping system, or an exterior piping system may increase in temperature as the ambient temperature increases.

Thermal expansion of fluid will cause a pressure increase that exceeds the pressure rating of pipe and valves in the fuel system. It must be relieved through safety relief valves installed in the piping system. Relief valves should be installed in any piping section that could be blocked at both ends by closed valves. The safety relief valves should discharge to a return flow pipe or dedicated discharge pipe that is open to the fuel supply tank.

Some fuel system valves are available with internal pressure relief devices, however in general external relief devices are used.

27.7 What are the causes of suction pump problems?

Suction pump problems are caused by the following conditions:

- there is a leak in the suction piping allowing air to flow into the pipe,
- the vertical lift of the suction pump exceeds the maximum lift of the suction pump
- the pump inlet piping is under-sized causing a high line loss
- Valves or other devices, such as clogged strainers, cause high line losses
- The pump itself has poor suction characteristics