Your Questions Answered (47)
Fuel Transfer Systems

earth safe
Fuel Systems for Critical Power

.

5.1 What types of pumps are used for fuel transfer?

Fuel transfer pumps are of 3 primary types:

Positive Displacement / Gear Pumps:

- Best Application: Fuel transfer from bulk tanks to generator, filtration polishing systems, generator tank return flow pumps, boiler feed pumps.
- Common Brands are Viking, Blackmer, and Tuthill.
- Benefits: excellent suction characteristics up to about 20 vertical feet, high pressure output capability to several hundred PSI, very low to high flow capacities from 0.25 to several hundred GPM, relatively constant output through range of pressures. Available in full range of voltages and horsepower.
- Limitations: Suction piping characteristics can make starting and keeping prime a problem. Higher flow rate pumps can be relatively higher in cost. Noise and vibration can be relatively higher than alternatives.
- Most Common Problems: Loss of prime in suction piping. Overpressure of discharge piping if improper setting of pressure regulating valves. Debris in pump head if improper strainer.

Centrifugal Pumps:

- Best Application: Transfer to and from delivery vehicles to bulk tanks with flooded suction condition.
- Common Brands are Gorman Rupp and Gould.
- Benefits: High flow rates at relatively low costs.
- Limitations: Limited suction capabilities. Capacity decreases at higher pressures.
- Most Common Problem: Difficulty in self-prime

Submersible Turbine Pumps:

- Best Application: Fuel transfer from underground or aboveground tanks to generator day tanks and boiler feed at limited pressure.
- Common Brands are Red Jacket and FE Petro.
- Benefits: No suction or priming issues. Relatively high flow rates. Relatively low costs.
- Limitations: Pressure limitation of 50 PSI. Not available as 120 VAC. Not available for low flow applications. Not applicable for shallow tanks such as generator base tanks. Headroom required above tank for installation in buildings.

Most Common Problems: Excessive flow rate. Siphon through pump if missing or incorrect anti-siphon

5.2 What accessories are needed for fuel transfer pumps?

- Isolation Valves: Typically manual ball valves to isolate the pump for service.
- Gauges: Typically liquid filled gauges 2.5" to 4" dials both vacuum for pump inlet and pressure for pump outlet.
- Strainers: Inlet strainers to prevent debris in piping system from damaging pump.
- Check Valves: at pump discharge to prevent backflow through pump, or on pump inlet to maintain prime on suction pumps.
- Flex Connectors – Vibration Isolators: to isolate the pump vibration from the piping system.

Pressure Relief / Regulating Valves: To allow flow through pump when downstream valves are closed and prevent overheating of pump body, and for thermal expansion relief in piping.

5.3 How do I determine the required flow rate and pressure?

Here are some quick rules of thumb for determining flow rates and pressures. More precise calculations are often warranted by the requirements of the application, but this is a start.

Flow Rate for Boilers: Take the consumption of all of the boilers at full load. Then multiply by 2 to get the desired flow rate. This will make sure that the pump is fully capable, and helps assure that the last boiler in a series will not be starved for flow.

Pressure at Pump for Boilers: Take the required pressure at the boiler inlet. Add 25% for safety factor. Add 10 PSI for flow loss in piping (and size the piping for a max 10 PSI loss). Add the vertical head from pump to boilers and the suction head from tank to pump. The sum of these will be a good estimate for the required pressure at the pump.

Notes for Boilers: Some boilers and heaters require very low pressure inlets and the challenge to to provide that low pressure. Pressure regulators at the boilers is often a solution, as are head tanks with a continual overflow back to the bulk storage tank.

Flow Rate for Generators: Take the consumption of all generators at full load. Then multiply by 2 to get the desired flow rate. This will make sure that the pump is fully capable, and helps assure that the last generator in a series will not be starved for flow. If the potential for starving day tanks further along in the series is apparent, then flow regulating valves should be used at the day tank inlets to be precise. Also do not oversize the inlet valves.

5.4 How do I determine the pump motor horsepower and voltage?

The required pump horsepower is determined by the requirements for flow rate and pressure (at the pump) by the following equation. Round up to the next standard motor. For non-submersible pumps these would typically be 0.33, 0.50 0.75. 1.00, 1.50, 2.00, 2.50, 3.00, 5.00. For submersible pumps they would be 0.33, 0.75, 1.50, 2.00, 3.00, 5.00.

Pump voltage selection is usually a function of what is readily available in the building. Motors are typically 120 or 208 VAC Single Phase, or 230 or 460 VAC Three Phase. Submersible pumps in the lower HP range are commonly 208 VAC Single Phase, and in higher HP are available either as 208 VAC Single Phase or 480 VAC Three Phase. Many facilities as a rule of thumb will have all motors under 1 HP to be Single Phase and all motors over 1 HP to be Three Phase.

5.5 What maintenance and inspection is required for fuel transfer pumps?

The primary maintenance and inspection requirements for fuel transfer pumps are regular (weekly) inspections for leaks. An annual check of wire terminal tightness is also a recommended practice.

Other than that, the pumps operation is continually checked by the control system for proper operation.

5.6 Are motor starters needed for pumps?

Complete protection and monitoring of pumps requires motor starter characteristics as follows:

- Lockable disconnect switch
- Hand – Off – Auto switch
- Motor starter / contactor
- Motor overload protection and monitoring contact
- Current sensor
- Design to start in Manual mode on line power – independent of control power.

Submersible pumps used in service stations typically have a control box that incorporates Items 3 and 4, with Item 1 covered by the circuit breaker within the building power distribution panel. These are typically not considered to be appropriate for emergency power fuel systems.

5.7 Why are duplex pumps used and how do they operate?

Duplex pumps are used to provide a secondary means of fuel transfer in the event of a failure of the primary pump. Each pump in a duplex set is sized to meet the full flow requirements of the system. Pump controllers can be set for any of the following common operating modes:

- Lead / Lag (Primary / Secondary): The lead (primary) pump is selected by the user and the lag (secondary pump operates when a failure of the primary pump is detected.

- Alternating: Operates per Lead / Lag (Primary / Secondary) except that the operating pump and lead / lag status alternate on consecutive starts. A variation is to alternate the pumps based on the operating time (hour meter) of the lead pump.

Twin: Both pumps start when there is a fuel requirement.

5.8 Why are triplex pumps used and how do they operate?

Triplex pumps are often used where there is a wide variation in flow requirements, so that a single pump is activated initially, a second brought on-line at higher flow rate requirements and the third pump being a reserve backup. Triplex pumps are designed so that 2 pumps will serve the full flow requirements with a third pump as a backup to either of the operating pumps failing.

5.9 What is a line leak detector for a submersible pump?

Many State and local regulations require a line leak detector for pressurized underground piping. Line leak detectors for underground piping are used to detect a loss of integrity in the piping with a consequential shut down of the pump. There are 2 types of line leak detectors – mechanical and electrical.

Mechanical line leak detectors install on the submersible pump body. The pump must start against a closed valve to allow pressure to build in the line sufficiently to allow the line leak detector to open and flow. If pressure does not build in the line properly, then the mechanical line leak detector trips and restricts the pump flow.

Electronic line leak detectors operate in conjunction with a tank monitor such as a Veeder Root panel. After each pump run cycle, the panel turns on the pump automatically and measures the pressure in the line using a pressure transducer. The panel displays a pass / fail test result and may be required to be configured to disable th submersible pump.

Line leak detectors are designed to work reliably with motor fuel dispensing operations where dispensers include solenoid valves to work in conjunction with the submersible pumps. In emergency generator applications, especially mission critical applications, the devices can be problematic where test failures can shutdown the fuel supply system. Control systems need to include appropriate valve / pump timing controls to allow successful tests, and also detect failure and switch to a secondary pumps.

6.1 How are underground tanks typically filled?

Undergound tanks are typically filled by gravity drop from delivery trucks. Delivery hoses are connected to the tank fill pipe with a tight-fill connection at an in-ground spill containment sump. The underground tank fill pipe includes an overfill prevention valve that closes at 90% of tank capacity.

6.2 Can remote fill point be used for underground tanks?

Remote fill pipes can be used for underground tanks and are typically used where (a) the underground tank location does not allow for delivery truck access, and (b) where underground tanks are located in secure fenced areas where delivery trucks are not allowed for safety and security reasons.

Remote fill pipes need to slope toward the tank, and for longer piping runs the tank burial depth needs to be evaluated to accommodate the slope.

6.3 How are aboveground tanks filled?

Aboveground tanks are filled by several methods:

(a) delivery tuck is pump equipped and the delivery nozzle is directly attached to a top of tank fitting. Access stairs and platforms are typically provided for safe personnel access to the top of the tank. This system has the benefit of simplicity and the drawback of safety issues associated with moving heavy fuel hoses up stairs or ladders.

(b) delivery truck is pump equipped and the delivery hose is connected to a fill pipe at a ground mounted spill container. This system provides for personnel safety while increasing the complexity of the fill system.

(c) delivery truck is gravity drop and a stationary transfer pump mounted at grade moves fuel from the truck to the aboveground fuel tank through the fill pipe. This system has the benefit of being able to utilize the broader availability, and sometimes lower cost, of gravity drop fuel trucks. The drawback is the capital cost of providing the stationary pump system.

6.4 How is a tank within a building filled?

Tanks in buildings have the challenge typically of being remote and blind from the fill point, increasing the importance of safety controls. Tanks in buildings are required to be located on the lowest level, usually in basement level or at grade. Gravity flow to lower level tanks may be used where appropriate, however typically fuel is pumped from outside fuel receipt points to the tanks.

Fuel piping systems from outside fill stations to tanks in buildings are typically double contained for safety.

6.5 What accessories are needed for tank fill systems?

Required accessories for tank fill systems are as follows:

(a) tight fill connection for delivery hoses which are usually camlock type connections to minimize spills.

(b) spill containment devices surrounding the fill pipe connection to the delivery hose.

(c) overfill prevention valve in the fill pipe. This would be either a mechanically actuated float type valve, or an electrically actuated valve that closes at 90% fill level.

(d) high level sensors in the fuel tank for high level alarm activation.

(e) a high level alarm device providing visual and audible indication.

(f) a means of determining the fuel level in the tank such as an electronic level gauge.

(g) a secondary means of determining the fuel level in the tank such as a manual gauge port.

(h) safety equipment including spill cleanup kits and fire extinguishers.

(i) manual shutoff valves and check valves for aboveground tank systems.

6.6 How do you fill multiple tanks from a common fill station?

There are 2 methods of filling multiple tanks from a common fill point:

(a) individual fill pipes are run from each tank and they terminate within an enlarged fill station. This method has the benefit of simplicity but the drawback of increased costs for multiple fill points. Also within buildings the space requirements fro multiple fill points may not be practical.

(b) a common fill pipe with electrically actuated valves to allow tank selection and a control panel at the fill station to allow tank selection and high level alarm and shutoff.

6.7 What are the regulatory requirements for filling tanks?

Regulations for filling tanks are designed to prevent spills and overfills. Tanks required to have redundant protection for overfills such as a high level alarm plus a mechanical shutoff device. Tank fill limits are typically 90% maximum, although some locations may allow up to 95% for aboveground tank systems.

6.8 How do I size the fill pipe?

Fill piping for gravity fill systems is typically either 3” or 4” diameter.

Fill piping for pumped fill systems (either delivery truck pumps or stationary pumps) is generally sized as follows:

- 2” pipe for flow rates to 100 GPM
- 3” pipe for flow rates to 200 GPM
- 4” pipe for flow rates to 300 GPM

7.1 Should day tanks be single wall or double wall?

Day tanks should always include a containment structure for at least 125% of the tank capacity, and in some locations by regulation 150%. Day tanks are built to a UL 142 standard for Steel Tanks for Flammable and Combustible liquid storage. This standard covers both single wall and double wall tanks.

Common constructions for day tanks are:

(a) single wall UL 142 steel tank within an open-top steel containment basin. This system has the benefit of the open top construction actining also to serve the containment for all of the pipe, valves, and fittings installed on the top of the tank. The drawbacks are problems of excluding rainwater in exterior locations, and the inability to pressure test the containment.

(b) double wall UL 142 steel tanks with the secondary top sealed to the primary tank. This system has the benefit of pressure testing capability for the secondary containment, and exterior installation capability that excludes rainwater. The drawback is that this type of construction may need a means of containment for the pipe, valves, and fittings mounted on the tank.

7.2 How big should a day tank be?

Day tank sizes are restricted by regulation to a maximum capacity that may be allowed within a room of a given occupancy. Within that restriction, there is not a standard for day tank sizing.

The recommended approach is to take the maximum generator consumption per hour, which can range up to 200 gallons per hour for larger generators, and consider the day tank size for 1, 2, 4, and 8 hours.

Here is an example: If the building code requires 4 hours of run time on a life safety generator that consumes 50 gallons per hour, then you would have 200 gallon of consumption. Since the tank is not always full, NFPA requires a 1.33 factor adjustment (to compensate based on a 75% full tank) which would be 266 gallons. Then round up to a 300 gallon day tank and check to see if the volume is within the regulatory restrictions for the room.

Another example: If the day tank has a well designed re-fill system from a bulk tank, the codes are restrictive, and space is at a premium in the generator room, then a 100 gallon capacity day tank may be appropriate, even though this is only 30 minutes of run time on a large generator with 200 GPM consumption. If the facility has well trained operating personnel, and the fuel system is monitored by the BMS, then 30 minutes of time to react to a problem with the day tank, may be an appropriate measure.

7.3 Where should the day tank be located?

The day tank should be located as close to the generator engine as possible, and preferably on the side of the engine that includes the fuel supply and return connections.

In some cases, the day tanks are located along one wall of the generator room for convenience, which in some cases could be up to 100 feet away. The generator dealer should be contacted to confirm that a generator fuel pump will operate with a remotely located day tank.

Local restrictions on the volume of fuel in a room, may require that day tanks be located remotely in fire rated rooms, separated from the generator room.

7.4 How is the tank refilled?

Day tanks are re-filled by either (a) on-board fuel transfer pumps, or (b) remote pump systems with inlet control valves at the day tanks..

On-board fuel transfer pumps are simple configurations for single generator – single bulk tank operations. They may be configured as either single or duplex pump systems. Limitations include: (a) limited suction lift on pumps means the bulk tank must be in close proximity, (b) multiple day tanks typically need dedicated suction lines, rather than sharing a common fuel supply line, (c) potential for loss of prime in suction lines.

Remote pump systems can be either positive displacement pumps or submersible turbine pumps, and are usually configured as duplex systems. Advantages include: (a) wide range of flow capacities, (b) ability to serve multiple day tanks.

7.5 How do you safeguard against overfills?

The primary safeguard against overfills is a properly sized gravity overflow pipe from the day tank and returning to the bulk storage tank. A secondary safeguard is a high level switch in the day tank that disables and closes the inlet control valve.

The primary safeguard of gravity overflow cannot be used where the bulk tank is at a higher elevation than the day tank, or where pipe routing considerations do not allow for gravity flow back to the bulk tank. In these circumstances, a return flow / overflow pump is needed along with additional protection.

The return flow pump is configured as either (a) a separate overflow receiving tank with pump out, or (b) a return flow pump mounted on each day tank. In either case the return flow pump should be sized for 125-150% capacity of the fuel supply to the day tanks.

Additional protection can be provided by a high level stop valve in the day tank inlet piping. This is typically a normally open solenoid valve that closes when a high level sensor is activated.

7.6 What are common day tank problems?

The most common day tank problems are in re-filling: either high level or low level problems.

High level problems can be caused by: (a) leaking inlet solenoid valves, (b) inlet solenoid valve failed open, (c) inlet solenoid bypass valve is open, (d) failure of the fill stop level sensor, (e) loose wiring to the controller for fill stop level sensor.

Low level problems can be caused by: (a) failed solenoid valve, (b) closed manual valve in the day tank inlet piping, (c) failure of the fill start level sensor, (d) loose wiring to the controller for the fill start level sensor, (e) loss of signal from the controller to the pump start, (f) problem with duplex pump electrical motor starter, (g) closed valve in fuel supply piping, (h) loss of prime in pump suction piping, (i) low fuel level in bulk storage tank.

7.7 How is a day tank different for mission critical?

Mission Critical day tanks provide redundant functional elements for all of the potential failure mechanisms noted above. This type of design includes: (a) dual inlet solenoid or actuated valves, (b) high level sensor redundant to fill stop sensor, (c) low level sensor redundant to fill start sensor, (d) BMS monitoring of controller, (e) manual bypass of functional elements, (f) duplex pumping systems, (g) dual suction pipes from bulk tank to duplex suction pumps, (h) dual bulk storage tanks with auto-switch on low level.

7.8 What are common day tank accessories?

Common day tank accessories include the following: (a) level control panel, (b) inlet solenoid or actuated valves, (c) inlet strainers for solenoid valves, (d) inlet manual valves, (e) engine fuel supply connection with manual valve, (f) engine fuel return connection, (h) level sensor for high, fill stop, fill start, low, and critical low, (i) tank leak sensor, (j) direct read level gauge, (k) inspection port for manual gauging, (l) emergency vents, (m) normal breathing vent, (n) on-board fuel return / overflow pump.

7.9 Is a pump needed to transfer from the day tank to the generator?

The generator engine has an on-board fuel transfer pump that draws fuel from the day tank, and delivers the fuel to the engine at the proper flow rate and pressure. No supplementary pump is needed.

7.10 When is high temperature a problem and how is it handled?

High temperatures for generator fuel occur because the engine returns 65-95% of the withdrawn fuel back to the day tank. This return fuel flow is at a temperature that is well over 100 degrees F, without cooling measures, and this can cause the temperature in the tank to rise to dangerous levels. The engines often require relatively cool fuel, usually less than 110 degrees F, as a means of cooling certain engine components. And heated fuel can become a safety concern if it is heated above its flash point temperature.

High temperature is not a common problem because most generators include a fuel cooling radiator to treat the return fuel before it is received by the day tank. The fuel cooling radiator is mounted as a slave to the generator engine coolant radiator, and utilizes the same engine fan.

The fuel cooling radiator on the engine may not be practical where the engine utilizes a remote radiator for its coolant system. In this case several methods of fuel cooling may be used:

- a dedicated fuel oil radiator and fan are installed at the day tank for return flow fuel from the engine.
- fuel return from the engine is directed to a gravity return flow pipe to a bulk storage tank. Since the engine consumption is only 1 / 3 of the engine fuel pump flow, the fule supply to the day tank should be increased by about 3 times to accommodate the higher flow.
- A temperature sensor in the day tank activates a return flow pump to pump fuel back to the bulk storage tank, allowing the day tank to be re-filled with fuel at a lower temperature.

7.11 How much fuel does a generator consume?

As a quick estimate we use 0.085 gallons per hour per generator KW at full load. So a 1000 KW generator consumes about 85 gallons per hour at full load, and a 2000 KW generator consumes about 170 gallons per hour at full load.

Generator specifications should be checked for exact calculations.

7.12 How do I size the inlet piping for the day tank?

For on-board day tank pump systems, the inlet piping should be at least the size of the pump inlet, and most likely will be increased to allow for calculated line losses on the suction side.

Remote pump systems should be sized for 2 considerations: (a) minimize line losses at full flow conditions to a maximum of about 10 PSI, and (b) size the piping sufficiently to make sure that the last generator in a series, is not starved for fuel.

7.13 Do I need an anti-siphon valve on the engine suction line at the day tank?

Anti-siphon valves may be required in the fuel supply piping from the day tank to the generator. The anti-siphon valve is considered a safety device if the fuel hose connections at the generator were to fail.

The preferred method of providing the anti-siphon protection is a DC powered normally closed solenoid valve that is activated directly by the generator controls. Spring loaded anti-siphon valves used for aboveground tanks are typically not used in this application because of the increased suction burden that they place on the engine fuel pump.

7.14 When is a return flow pump needed and how is it sized?

A return flow pump may be required for several reasons: (a) day tank overflow protection as discussed at Item 7.05 above, (b) day tank high temperature as discussed at Item 7.10 above, and (c) as a means of lowering the fuel level in the day tank for initial and periodic testing of the system. Sizing of the pump is usually governed by the overflow protection function.

7.15 Can the inlet flow to the day tank be precisely controlled?

There are 2 reasons to more precisely control day tank inlet flows: (a) to make sure that downstream day tanks are not starved for fuel flow, and (b) to make sure that the overflow protection mechanism, either gravity overflow or pumped overflow, is greater than the maximum inlet flow.

In general, a properly sized inlet control valve will allow for these functions without additional measures. A 1 / 2" solenoid valve at 25 PSI differential pressure will flow about 18 GPM. This allows for (a) a maximum normal engine consumption of about 3 GPM, (b) adequate capacity where the engine return flow goes directly back to the bulk tank requiring a maximum flow of about 9 GPM, and (c) adequate capacity for a 30 GPM rated return flow pump.

More precise flow control can be achieved by using a flow regulating valve, such as the one manufactured by Kates, that has been proven in fuel service. The device does have relatively small orifices which must be protected by a properly sized inlet strainer.

7.16 Do the day tank vents need to terminate outside?

NFPA requirements are that fuel tank vents must terminate outside of buildings. Emergency vents are often mounted directly on the day tank and these are typically acceptable since they are normally closed vents.

Some local regulations may require that emergency vents terminate outside the building as well. If the day tank is a UL 142 double wall tank with a closed secondary containment, then the tank will have a secondary emergency vent. In some cases both the primary and secondary emergency vents, as well as the normal breathing vent, must be terminated outside the building. The size and number of these vent pipe can be a routing challenge within the building, so it is an issue worth addressing with the local fire authorities early in the project.

7.17 Can a common vent pipe be used for several day tanks?

NFPA requirements are that vent pipes be independent for each tank, except in special circumstances. The special circumstances are usually vapor recovery systems for gasoline underground tanks.

In some cases, the local regulators have allowed for the combining of day tank vents into a common vent header to the outside of the building.

Another basis for combining vents is to calculate the normal and emergency venting requirements of the day tank, and provide a single properly sized vent pipe to the exterior that is normally open, and fulfills the requirements of both functions.

7.18 Can a day tank be shared by more than one generator?

Day tanks can be used for more than one generator, when they are properly sized. Each generator should have an independent fuel supply line from the day tank, and preferably an independent fuel return to the day tank.

The reason that each generator usually has its own day tank is redundancy. A failure of a single day tank would disable all of its associated generators.

7.19 What day tanks levels are specified for high and low levels?

Typical day tank level switch activations are:

90% High Level
85% Fill Stop Level
75% Fill Start Level
50% Low Level
15% Critical Low Level

These can vary slightly based on the depth of the tank, because there is a minimum spacing between floats

7.20 How are day tank levels integrated with the generator?

Commonly generators use inputs from the day tank controller for high level, low level, critical low level, and leak. The critical low level input is often used as an engine shutdown condition.

In some instances these day tank signals are input to the generator control equipment, such as ASCO, RussElectric, GE Zenith, or others, rather than to the individual generator controls.

7.21 Do I need filters for the day tank?

Generators commonly have fuel filters at the inlet connection to the generator. For this reason, filters at the day tank inlets are not commonly used.

7.22 What are day tank size restrictions in building codes?

Local building code requirements will vary as to the limitations on day tank sizes, within varying types of room construction and occupancy ratings.

A common restriction is 240 gallons total per room, and 60 gallons per individual tank.

8.1 What is a generator base, sub-base, or belly tank?

Generator base, sub-base, or belly tank is a UL 142 fuel tank that is built into the frame of a generator support typically as part of a packaged unit that includes an enclosure. The tank acts as a substitute for a free-standing day tank.

Sub-base tanks can be classified as UL 142 double wall, L 142 single wall with containment dike, or UL 2085 fire rated.

8.2 What are the benefits of a base tank?

The benefits of a sub-base tank are: (a) saves floor space associated with a free-standing day tank, especially important for an outdoor fully enclosed generator package, (b) the engine draws directly form the tank minimizing piping costs and performance risks associated with suction piping.

For outdoor generators the sub-base tank can often be sized to allow for a 4, 8, or even 24 hour run time fuel storage requirement.

8.3 What are the problems with base tanks?

The problems with base tanks can include: (a) larger tanks raise the working level of the generator where steps and walkways can be required for routine inspection and maintenance, (b) the fuel tanks are subject to a higher level of vibration due to the construction within the generator frame, and (c) the large flat bottoms of the tanks with internal baffle construction, can promote biological growth within the tank.

8.4 How is the tank re-filled from a storage tank?

Base tanks are refilled in the same way as day tanks are re-filled with a couple of challenges: (a) limited room within the enclosure for mounting re-fill equipment, (b) shallow depth of tank may require special level sensors for refill control, and (c) shallow depth of tanks can make location of a properly sized overflow pipe difficult on the top sidewall of the tank.

9.1 What are the requirements for pump motor starters?

Complete protection and monitoring of pumps requires motor starter characteristics as follows:

1. Lockable disconnect switch
2. Hand – Off – Auto switch
3. Motor starter / contactor
4. Motor overload protection and monitoring contact
5. Current sensor
6. Design to start in Manual mode on line power – independent of control power.

9.2 What are the problems with standard submersible pump controllers?

Submersible pumps used in service stations typically have a control box that incorporates Items 3 and 4, with Item 1 covered by the circuit breaker within the building power distribution panel. These are typically not considered to be appropriate for emergency power fuel systems.

9.3 What conditions are monitored for pump motor starters?

Pump motor starters are typically monitored by the fuel system controller for the following conditions:

- Not-in-Auto
- Motor overload trip
- Pump current

9.4 What are the benefits of VFD controllers?

Variable Frequency Drive (VFD) controllers allow for variable flow output to accommodate a range of operating conditions. The controller is set to operate with a pressure transducer input to maintain a constant pressure in the fuel supply pipe. With multiple generators, the controller automatically adjusts to the increased flow requirement when more than one day tank needs fuel.

A secondary benefit of the VFD controller is for soft start and stop of the pump to minimize fluid hammer issues in longer piping runs.