

## **Introduction**

Search your Fuel System Specification for the word “Integration” and you are likely to come up with “No Results Found”. Without specified integration requirements, it will be a system that is obsolete before startup.

The fuel system should include integration requirements to make sure (a) that it all works together, and (b) that it integrates with the building management system, so that the facility may be operated with the greatest assurance and least effort.

Here is a useful specification for an integrated system:

### **1.0 Fuel Oil Delivery, Storage and Distribution**

#### **1.01 General**

The fuel oil specialist contractor shall undertake the detailed design and furnishing of the fuel oil delivery, storage and distribution system incorporating the requirements set out below.

The system is to be fault tolerant in design.

It is the supplier’s responsibility to ensure the final design complies with local norms, standards, codes of practice and statutory regulations current at the date of the installation; and achieves any necessary certification or approval.

#### **1.02 System Description**

Each fuel oil system includes the fuel delivery point, above ground storage tank and associated ancillaries, duplex packaged pump and filter sets, distribution pipework to the generator day tanks and other pipework shown in the Tender documentation including bulk storage tank fill and vent lines

The bulk fuel storage tanks and pumps shall be located above ground, external to the building. Fuel delivery trucks will drive alongside the building to gain access to the fill point. The fuel is pumped from here to the bulk storage tanks on the gantry. Vent lines return from the bulk storage tanks to the fill points. These may be connected to the diesel delivery truck during filling.

The fuel oil system C900 Master controller shall monitor the diesel generator run status. Under signal that one or more of the diesel generators is operational the fuel pumps shall turn on to pressurise the fuel oil supply line. Fuel shall be pumped from each bulk storage tank to the generator sets located internally.

Fuel polishing shall be provided for the bulk storage tanks

### 1.03 Fill Cabinets and Overfill Protection

A wall-mounted lockable fuel delivery cabinet shall be provided for each tank at the fuel delivery point. Each cabinet shall contain a C80 fill control panel with lamps indicating tank high and low level alarms, a weatherproof sounder with muting switch and an electronic calibrated tank contents gauge. The alarms shall be activated by tank level switches. The control panel shall connect to C900 Master Fuel System Controller using Ethernet.

Cabinets shall have a steel-framed wired glass door with metal parts painted red. The cabinets shall be clearly labelled 'OIL STORAGE INLET' in English.

Each tank shall have a fill line, with lockable end cap located within the fill cabinet. Fill pipe connections to BS 799-5, with non-ferrous screw-on captive caps with witness hole/groove as necessary. The tank fill lines shall each have a non return valve and drain towards the bulk tanks to prevent fuel draining back to the fill area.

The fill line will be fitted with an actuated ball valve to serve as an over-fill protection valve. An independent high level sensor shall be installed in the bulk storage tank This over fill prevention sensor shall signal to the mechanical control valve to shut when the tank has reached fill capacity, which in turn, signals back to the fuel oil fill point providing a visual and audible alarm.

If under any circumstance the tank continues to over-fill, the flow shall fill into the second skin of the tank, also triggering a leak detection alarm to the C900 Master Fuel System Controller.

The Fill Cabinet shall be an Earthsafe Model M400 or approved equal.

### 1.04 Diesel Fuel Pipework

Diesel fuel pipework shall be flexible double-walled pipe system with an annular leak monitoring space. Pipe consists of a corrugated stainless steel inner primary pipe and a corrugated outer containment pipe made of stainless steel. The annular gap between the inner and outer pipes is a surveillance space for leak monitoring. External corrosion protection shall provided by a polyethylene casing covering the outer pipe.

The pipe system shall include double-walled fittings to allow leak monitoring of the piping sections on either side of the fittings.

Tank vent lines shall be single wall flexible piping with a polyethylene casing covering the outer pipe.

Pipework shall be provided with hydrocarbon leak detection provided in the outer skin. Any alarm shall provide an addressable alarm signal to the C900 Master Controller.

The pipework shall be laid to fall and capable of being drained. Galvanized pipework shall not be used for fuel oil distribution.

The flexible double wall piping system shall be Brugg Flexwell Model FSR.

#### 1.05 Diesel Fuel Valves and Fittings

A drop type fire shut off valve complete with fusible link shall be provided on the connection to each generator day tank. The valve shall be linked to the fire alarm system.

Valves and fittings associated with the Diesel Pipework shall be meet the applicable BS standard for the application.

#### 1.06 Diesel Fuel Tanks

Diesel fuel tanks shall be cylindrical horizontal double skinned steel fabrications. Tanks shall have tank turrets for access for sampling and inspection.

Each tank shall include for dip-stick level measurement at each end of the tank. All diesel pipework, ventilation pipework, power and BMS cabling connections shall be located through the top of each tank into the tank turrets.

Suitable safe systems for personnel access/maintenance for of the diesel fuel tanks and ancillary systems located in tank turrets will be provided.

The internal surface of storage tanks shall be protected by closure of all openings to prevent ingress of foreign matter, and surface deterioration.

Before dispatch from works, tanks shall be cleaned internally and externally, tested, witnessed and certified by the Contractor

#### 1.07 Leak Detection and Other Interfaces

Tank leak detection shall be provided within the outer skin of each tank and raise an alarm to the C900 Master Controller in the event of activation. The system must be testable in line with all local requirements for fuel oil systems. A fuel level sight gauge within a turret of each bulk tank shall be provided to give a clear indication of the level and quantity of fuel contained within individual tanks.

Fuel level switches and alarms shall be provided with each tank for 95% critical high, 90% high level, 85% high warning, 25% low warning, and 10% low alarm. All alarms will be connected to the C900 Master Controller. A fuel level transmitter shall also be provided and connected to the C900 Master to provide tank level and volume information.

#### 1.08 Diesel Fuel Pumping

Each bulk storage tank shall be supplied with a duplex pump set (N+N) to deliver fuel oil to the generator day tanks upon demand. The pumping system shall be supplied as a duplex packaged pump set with duplex fuel oil filters.

The pumps shall run in a duty/standby configuration with an auto change over on a pump fault with manual override function. Each pump shall include an independent motor starter

with a MAN-OFF-AUTO selector switch, control transformer, current sensor, motor overload protection and safety disconnect switch. In the manual mode the pump shall start independent of external control power.

Each pump shall be sized to supply fuel at not less than 125% of the total maximum fuel demand for the system.

The pump assembly shall include a duplex oil metal screen filter shall fun in duty/standby configuration with manual changeover and pressure differential switch to alarm when dirty/blocked.

The pump system shall include a C80 controller to provide local pump control and monitoring. The controller shall have a tough screen interface for status display and alarm logging for functionality, leak detection, filter pressure drop alarm and fault alarms. The controller shall have an Ethernet connection for network integration with the C900 Master Controller.

#### 1.09 Diesel Fuel Polishing

Each bulk tank shall be equipped with a filter polishing system. The filter polisher shall consist of a fuel circulation pump dual stage filter and accessories to assure the quality of the fuel during long term storage. The system shall be sized to provide as a minimum a full circulation of the tank contents within a 24 hour time period.

The fuel pump shall be an iron body positive displacement pump. The pump and filter assembly shall include pressure and vacuum gauges to monitor system performance, and manual ball valves for component isolation. The system shall include a pressure relief valve for thermal expansion protection.

The filter polisher shall be located within a weatherproof enclosure with integral leak containment of minimum 25 liters. The enclosure shall include a fan and vent to protect against condensation. Where located outdoors the enclosure shall include a heater for freeze protection.

The filtration shall include a 10 micron particulate filter and 2 micron coalescing filter to remove water. The filters shall yield a fuel cleanliness of 12/9/6 per ISO Standard 4406.

The system shall include a differential pressure sensor to indicate a filter change requirement, and a high water sensor to indicate filter drain, and a leak sensor.

The filter – polisher shall include a C80 controller to operate the filter polisher on a timed cycle. The system shall start at a day and time selected by the operator to repeat on a weekly basis. The controller shall monitor sensors for differential pressure, water level, and leak and shall provide an audible and visual alarm upon activation. The controller shall have an Ethernet connection for networking with the C900 Master Controller.

#### 1.10 Generator Day Tanks

Day tanks shall be rectangular welded steel fuel tanks. Tanks shall be banded to provide a minimum 150% containment capacity. Tanks shall include an exterior epoxy or polyurethane finish coating.

Day Tank accessories shall include normal and emergency vent devices, a direct reading fuel gauge, and an inspection / manual gauging port.

**Engine Fuel Oil Supply Connection:** Provide a 25 minimum suction pipe for the engine fuel oil supply connection. A manual valve shall be provided at the top of the tank. Where required by local code for anti-siphon protection, provide an electric actuated solenoid valve at the day tank connection for the engine fuel oil supply. The valve shall be a minimum of 1", normally closed, electric actuated, 24 VDC, bronze body with viton soft goods. The valve shall have an integral manual bypass. The valve shall be controlled directly by the engine generator to open upon generator start

**Engine Fuel Oil Return Connection:** Provide a 25 minimum pipe connection for the engine return fuel flow. The connection shall include a drop pipe to the 50% tank level to minimize turbulence within the tank.

**Overflow Pipe Connection:** Where a gravity flow return pipe to the bulk storage tank is used provide a 50 overflow connection for the day tank to allow gravity overflow back to the main storage tank. Where gravity overflow is not provided, the day tank shall include a return flow pump with a capacity greater than the maximum inlet flow rate.

**Level and Leak Sensors:** Provide a tank level sensor for 95% high level, 85% normal fill level, 75% refill start level, 50% low level, and 25% critical low level. Provide a leak sensor for the tank secondary containment. Provide a tank analog level transmitter for tank level and volume measurement.

**Inlet Valve Assembly:** Provide a normally closed solenoid valve and a normally open solenoid valve in series for normal tank filling and high stop. Provide a line strainer upstream of the solenoid valves. Provide manual valves to isolate the solenoid valves and to provide a manually operated bypass of the solenoid valves. Include an adjustable flow limiting valve in the inlet piping. The valve shall be set to 150% of the generator maximum consumption, and within 75% of the day tank overflow or return flow pump capacity.

The day tank shall include a C80 controller to provide local control and monitoring. The controller shall have a touch screen interface for status display and alarm logging. The controller shall have an Ethernet connection for network integration with the C900 Master Controller.

### 1.11 Tank Inventory Monitoring

Each fuel storage tank shall be provided with a fuel inventory monitoring system which shall report to the C900 Master Controller, the BMS and tank fill panel as appropriate.

The fuel inventory monitoring system shall provide real time inventory status. The fuel inventory monitoring system shall provide warning when fuel storage drop to a low level, and when fuel level is above normal level. The system shall provide indication and warning set- points for the presence of water.

These status and alarm indications should include at a minimum the following: Tank volume level, Fuel temperature sensor, Presence of water alarm, High fuel level alarm, High high level alarm, Low level alarm, Low low level alarm.

## 1.12 Master Fuel System Control

Provide a Master Fuel System Controller to integrate the individual fuel system elements and provide a point of interface to the BMS system.

Fuel system controls shall be UL 508 listed, PLC based controllers. Controls for all fuel system assemblies shall have a common PLC basis, and communication capability to be readily integrated with other fuel system equipment. The common control basis or integration capability shall include fuel transfer pumps, day tanks, fuel maintenance / polishing systems, and multi-tank selection systems.

The control enclosure shall be a welded steel enclosure. For exterior locations with heaters and fans as required to maintain controller operating environment.

Operator Interface: provide touch screen operator interface for system operating data and operator selected parameters. Provide selector switches, push buttons, and indicator lights from a common manufacturer.

Emergency Stop: Control panels shall include emergency stop devices to stop fuel transfer upon activation in compliance with OSHA requirements

Dual Power Input and Dual PLC: The Controller shall be based on dual parallel PLC, either of which performs the required system functions independently. The controller shall accept dual power sources and shall automatically switch to a secondary power source upon failure of the primary source. Dual 24VDC control power sources shall be included. PLC and power source status shall be indicated on the panel touch screen and communicated to the BMS.

Alarm Indication and Logging: The controllers shall provide alarm indication for conditions indicated in the operating description. The controller shall maintain a date-time log for the alarm conditions and for other operating events as indicated.

BMS Inetgration: The control system shall provide a standard communication capability for the BMS system. The communication protocol shall be BACnet, Modbus, or LON to match the project requirements.

Output Relays: the controller shall provide sufficient dry contact output relays for integrations with generator controls, switchgear, BMS, fire, and security systems.

Tank Level Gauging and Leak Detection System Integration: The fuel system master controller shall accept a data communication from the tank level gauging and leak detection system. The master controller shall provide the tank level and leak detection information to the BMS system in conjunction with all other fuel system information.

The Master Controller shall be Earthsafe Model C900 or approved equal.

### 1.13 Testing and Commissioning:

The fuel system specialist contractor shall submit a testing and commissioning plan for the fuel system in accordance with the contract specifications. The testing and commissioning shall include the services of a factory representative of the fuel control equipment.

The fuel system specialist shall coordinate all interface requirements of the BMS system. Testing and commissioning shall include demonstrating the activation of all BMS monitored status and alarm points.