1. CONTROLS
2. Acceptable manufacturers, subject to compliance with the specifications:
3. Critical Fuel Systems
4. Allen Bradley Compact Logix
5. Siemens S7

Due to the wide range of control capabilities and functions that are involved with these systems a different set of paragraphs are provided below, please select the ones that are appropriate for your application and design. For help please consult the factory.

When considering PLC/HMI based controls the CFS standard equipment is Automation Direct equipment. If your client requests a particular PLC manufacturer, please consult with the factory. A particular brand that is selected often is Allen Bradley for example.

1. Simple Relay Based Pump Set Controls.
2. Simple relay-based controls are typically found in boiler pump set applications. Operation is to turn on the pump set when the boilers need to run on fuel oil. This is done with a “Hand” operated switch to start the pump. The pump will run as long as the unit is in “Hand”. The other position is “Off” where the pump is deactivated. In “Auto” the pump will run based on a “call for oil” signal from the boiler(s) or any devices requiring fuel oil.
3. The controls will monitor the flow switch and if no flow is detected after a set number of seconds the lag pump is started. The lead pump is selected by a switch on the front panel. The lead pump will be deactivated.
4. The controls will monitor a base pan leak switch for the pump set, if a leak is detected the pump will stop.
5. All relay logic is based on 120VAC as developed from the power transformer, control panels voltages are based on the power requirements of the pumps.
6. Advanced Relay Bases Control Panels

This is usually referred to as a “Y” system. Also, every system will have a Y control component, but may have additional more advanced control requirements.

1. Provide relay-based control systems for boiler or day tank control systems. All controls are provided by relays. The control system is usually broken into a high voltage section that provides power to the pumps/motors that make up the system. The other section is a 24-volt based relay control system.
2. All sensors are powered by 24VDC and are brought into relay logic that is documented with ladder type diagrams.
3. Provide pump sets system with Hand - Off - Auto stations to controls the operation of the pump(s). If shown on the schedule disconnects for each pump shall be provided. A power on light shall be provided. A pump run light for each pump shall be provided. Level switches shall be shown via lights on the front of the panel.
4. For duplex pump sets provide a lead lag switch to select the lead pump, provide a switch to allow switching of the lead pump with each call for operation.
5. In automatic operation the lead pump shall be called for by a “call for fuel input”, or the logic can interface to level switches to cause the pumps to come on to fill a generator day tank as required.
6. Controls also include a base pan leak detector, a inlet strainer DP switch to alarm on a clogged strainer. A flow switch is used to indicate proper flow and if not achieved the lag pump will start and the lead pump will shut off.
7. Advanced PLC Based Control Panels

This is usually referred to as a “Z” system. Also, every system will have a Y control component, but may have additional more advanced control requirements.

1. Provide a PLC based control system making use of commercially available PLC components. No proprietary controls are to be used.
2. Provide PLC Control Cabinets as show on the contract documents. Each Control Cabinet shall be completely pre-wired, and factory programmed. To ensure job site reliability and rapid commissioning, each cabinet shall be tested both individually and also communicating with all other Fuel System distributed PLC’s, HMI’s and Tank Gauges. All distributed control cabinets in this section shall be the product of one manufacturer for single source responsibility. Cabinet to be approved by a nationally recognized independent testing laboratory, per standard UL- 508A. Provide a factory assembled NEMA 4 rated steel enclosure.
3. To the extent possible, all Fuel System PLC’s shall use identical hardware. Provide spare parts list with one spare PLC module for each PLC module type supplied (power supply, CPU, Inputs, Outputs, communications, etc.)
4. Provide color touchscreen operator interface terminals (HMI) where shown on the contract drawings. As a minimum provide two HMI’s located on the duplex pump set and in the vicinity of the day tanks. All HMI’s shall use the same hardware and the same screen configuration. An Operator shall be able to monitor and control any PLC on that network from any HMI connected to any PLC.
5. Where applicable, alarm status shall be displayed on the HMI generated process pictorials. In addition, all alarms shall be logged in an alarm and event log. The alarm log shall indicate the time at which the alarm occurred, the time at which the alarm was acknowledged and the time at which the value returned to normal status. In addition to alarm conditions, this log shall also document status changes such as a transfer from automatic to manual, a setpoint change, etc. so that the resultant collection of alarms and events is a true and complete log of plant operating conditions.
6. Provide a Master Panel control panel as noted on the drawings. This master panel will display all the data contained in the fuel oil control system to allow system wide monitoring and control. The Master Panel will make use of a touch screen interface that will show data as shown on the various operating screens throughout the system in one location.
7. Provide a Remote Screen control panel as noted on the drawings. The remote screen is to provide information that is provided at another location within the control system.
8. Distributed Controller Locations
9. Provide a PLC for each area shown on the contract drawings. Provide PLC-to-PLC communications as described above and as shown on the contract drawings. For multiple generator installations, as a minimum provide one PLC for each of the following:
10. Duplex Pump Set Control
11. Day Tank Level Control (no more than 3-day tanks per PLC)
12. Main Tank Filtration System (if specified)
13. Multiple Main Tank Selector Valves System (if specified)
14. Tank Truck Off-Loading System (If specified)
15. Redundant Distributed Control System
16. Provide a multiple PLC based distributed control system in order to prevent fueling system failure due to a common mode controller or communication failure.
17. Provide multiple independent PLC’s. Each PLC shall have an independent power supply, CPU and I/O. A single (or redundant) CPU with networked remote I/O is not acceptable.
18. To the extent possible, all Fuel System PLC’s shall use identical hardware. Provide one spare PLC module for each PLC module type supplied (power supply, CPU, Inputs, Outputs, communications, etc.)
19. All Fuel System PLC’s shall be interconnected via dual communication cables and dual communication ports per PLC. The communication ports shall be electrically isolated from ground and from PLC to PLC. Logic shall test each communication cable at least once every 10 seconds and logic shall auto-failover to the operating cable if one cable fails. Provide cable and PLC failure alarms to the BAS. PLC to PLC communications shall be Master-less.
20. For systems with large numbers of generators, provide multiple independent distributed control networks and PLC’s in order to further prevent a common mode failure. See contract drawings for quantity and distribution of control networks.
21. Operator Interface Terminals (HMI)
22. Provide color touchscreen operator interface terminals (HMI) where shown on the contract drawings. As a minimum provide two HMI’s located on the duplex pump set and in the vicinity of the day tanks. All HMI’s shall use the same hardware and the same screen configuration. An Operator shall be able to monitor and control any PLC on that network from any HMI connected to any PLC.
23. Each HMI shall include a time/date stamped Alarm and Event Log for rapid trouble shooting, verification of filtration cycles, etc.
24. The HMI shall provide remote monitoring capability via a standard personal computer internet browser remote via the BAS Ethernet network, with access security provided by BAS network firewalls, routers, VPN’s, etc.
25. Software features shall include the following: Operator interaction shall be touch screen-based to allow for easy selection of screens, manual / automatic status changes, start/stop functions, setpoint changes, output changes and without any special programming skills. Screen selection shall also be available through tactile feedback function keys. The HMI shall provide facsimiles of the local controllers and clearly labeled English language and engineering unit display of the control parameters.
26. Where applicable, alarm status shall be displayed on the HMI generated process pictorials. In addition, all alarms shall be logged in an alarm and event log. The alarm log shall indicate the time at which the alarm occurred, the time at which the alarm was acknowledged and the time at which the value returned to normal status. In addition to alarm conditions, this log shall also document status changes such as a transfer from automatic to manual, a setpoint change, etc. so that the resultant collection of alarms and events is a true and complete log of plant operating conditions.
27. The HMI shall be manufactured in accordance with UL50, IEC 1010-1 and EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
28. BAS Interfaces: Provide a Building Automation System Protocol Convertor into the control panel to interface all data from the fuel oil system to a BAS system as shown on the drawings. A tag list of available data points to be monitored shall be provided in the O&M Manual. This tag list will provide description of the data, its format, and its address. Protocol shall be selected by the BAS vendor and shall be either BACnet/IP or Modbus TCP/IP. BAS vendor to provide the Ethernet routers, switches, and backbone cabling.
29. Automatic Pump Prime, Suction Line, and Day Tank Level Switches Integrity Safety Check Test: The control system shall include a battery backed, real time clock and must be capable of automatically energizing the lead pump once every day. This safety check is to verify the suction piping integrity, pump prime, and to verify pump operation including the day tank level switches operational readiness. Once the lead pump has proven satisfactory operation, the lag pump shall be energized and run through the same test. These tests shall be recorded in the controller memory with a Time/Date stamp for later verification or diagnosis. If either lead or lag pump fails any of these tests, the control system shall generate an audible and visual alarm and log the “Failed Pump” condition. The day tank return pump(s) shall be similarly tested whereby each return pump shall be activated and return oil back to the main tank continuing until the day tank low level switch is activated. The return pump shall stop and the lead supply pump will restart. The Supply pump will refill the day tank up to the 90% level, activating that switch again. The supply pump will shut off and the return pump restart until the day tank level has dropped to the supply pump-off level. The supply pump will finally restart and fill the tank back to the pump-off (80%) level and then stop. This test sequence will demonstrate that not only the supply and return pumps, but also all level switches in the day tank are functioning properly. If during this sequence, any pump or level switch shall prove faulty, the control system shall generate an audible and visual alarm and log such event as a “failure” condition.

This automatic prime test feature is an option, found on very critical applications.

1. Wiring shall be in accordance with NEC standards, using stranded copper conductors in liquid tight conduit. Special care shall be taken to ensure the conduit is not over capacity in accordance with NEC.
2. Approved manufacturers
3. The only manufacturers approved shall be actively involved in the manufacturing of fuel oil equipment. The equipment shall be a Total Fuel Management System and manufactured by Critical Fuel Systems, a division of BFS Industries LLC or approved