Savannah River Site
Solid Waste Management Department
Consolidated Incinerator Facility Project
Operator Training Program

DIESEL FUEL OIL SYSTEM

Study Guide

ZIOTX09
Revision 02

Training Manager Approval/Date

Engineering Manager Approval/Date

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REVISION LOG

	AFFECTED SECTIONS	SUMMARY OF CHANGE
02	ALL	New Issue

TABLE OF CONTENTS

REFERENCES

- WSRC-SA-17, Consolidated Incineration Facility, *Safety Analysis Report,* DOE Approval Copy
- ZIOISX09, *Diesel Fuel Oil System Design Description*
- 261-SOP-DFO-01, *Diesel Fuel Oil* (U), Rev. 3D
- 261-SOP-RMAC-01, *Raw Materials Acceptance Criteria* (U), Rev. 0C
- 261-SOP-EEP-01, *Emergency Diesel Generator No. 1 Monthly* (U), Rev. 0D
- 261-SOP-EEP-03, *Emergency Diesel Generator No. 1 Weekly* (U), Rev. 0D

LEARNING OBJECTIVES

TERMINAL OBJECTIVE

1.0 Given the necessary procedures, documentation and references **OPERATE** the Diesel Fuel Oil System (DFO) in support of safe and efficient operations of the Consolidated Incinerator Facility (CIF).

ENABLING OBJECTIVES

1.01 **DISCUSS** the specific hazards and required safety precautions associated with the DFO System.

1.02 **DISCUSS** the purpose of the DFO System.

1.03 **DESCRIBE** the following major components of the DFO System including their functions, principles of operation, and basic construction:
a. main storage tank
b. daytank
c. system piping
d. supply pump

1.04 **DESCRIBE** the DFO System .arrangement to include a **sketch** showing the following system components and interfaces with other systems:
a. Main storage tank
b. daytank
c. system piping
d. supply pump

SYSTEM OVERVIEW

1.01 DISCUSS the specific hazards and safety precautions associated with the Diesel Fuel Oil (DFO) System.

Safety

Diesel fuel is a flammable liquid and will be handled with care. Only approved containers will be used for the transport and storage of fuel oils. Fuel oil is an irritant; do not let oil touch the skin or enter the eyes. If contact does occur, thoroughly rinse and wash the affected areas and notify supervision. When handling, wear at least the minimum protective clothing of safety glasses and dry leather gloves. Smoking is not permitted within a minimum of 50 feet of the DFO System. Take actions to avoid sparks or flash-causing evolutions, especially in the area of pressurized oil systems. Small spills will be immediately cleaned up using dry absorbent rags. In the event of a large, spill seek instruction from 261-AOP-RS-9562, *(CIF Response to Radioactive, Hazardous, and Petroleum Releases).* Spilled oil can be slippery on certain surfaces; caution should be exercised. Dry chemical fire extinguishers will be stowed in the vicinity of oil systems to be used in the event of a small oil fire.

Introduction

The Consolidated Incineration Facility (CIF) is located within the boundary of the Savannah River Site. The CIF consists of 2 main structures: the main process building (261-H) and the liquid storage, Tank Farm building (262-H). Within one of these buildings, all of the process equipment is housed and the storage, handling, and control of the waste is accomplished. Remote from the main process buildings are two outbuildings housing the standby diesel generators (SBDGs). Behind these buildings are two DFO tanks which supply each associated diesel generator.

The Diesel Fuel Oil System is a sub-system of the Electrical Power Distribution System. The standby diesels rely exclusively on the DFO System to provide fuel oil. Being such an important subsystem of the SBDG System and the CIF Electrical Distribution System, the DFO System must be maintained ready at all times to support the site on the occurrence of a loss of normal electrical power.

The DFO System capacity is based on providing enough fuel oil to the diesel generators on demand at full electrical loading (350 KW) to run for a minimum period of 16 hours. This is sufficient to allow the safe shutdown of the Process Systems and restoration of site power to the CIF.

1.02 Discuss the purpose of the Diesel Fuel Oil System.

System Purpose

The purpose of the DFO System is to store and supply diesel fuel to meet the demand requirements of the Standby Diesel Generator to provide electrical power for process requirements and diesel surveillance testing.

Fuel oil is analogous to the blood of the human body; without it the diesel engines would not be able to function. Fuel oil provides the stored chemical energy which, when injected at high pressures into the combustion chamber of the diesel engine, explodes, ultimately driving an attached generator to make electricity. The DFO System provides a means of storing and transferring the diesel fuel necessary for the operations of the standby diesel generators (SBDGs). The system is comprised of a main fuel tank, daytank supply piping, supply pump, recirculation lines, and heat tracing . These DFO System components are essential for the proper operation of the SBDGs.

System Flow Paths

Normal Flow path

The flow path of the fuel oil originates at the main fuel storage tanks outside of the SBDG enclosures. The diesel oil is pumped from the main tank to the daytank located inside the SBDG enclosure via the supply pump located on top of the daytank. On demand, the fuel oil will then be gravity fed, first to the suction of the diesel fuel oil pump, and then to the cylinder injector pumps. The basic flow path of the fuel oil to and from the SBDGs can be seen in Figure 2 *Diesel Fuel Oil System layout.*

Recirculation Flow path

The oil recirculation flow-paths originate in two locations: the fuel oil daytanks and the engines of the SBDG sets. The two recirculation lines merge forming a single line which returns to the main fuel storage tank. The recirculation lines route non-used excess fuel oil back into the system for later re-use. The recirculation flow path can be seen in Figure 2 *Diesel Fuel Oil System layout.*

Responsibility

The Diesel Fuel Oil System will be operated and maintained in accordance with procedures 261-SOP-DFO-01, *Diesel Fuel Oil*, and 261-SOP-RMAC-01, *Raw Materials Acceptance Criteria.*

The Facility Manager is overall responsible for the safe control and completion of operations procedure 261-SOP-DFO-01. The Operations Manager will be responsible for procedure 261-SOP-RMAC-01. Together they must ensure that all appropriate paperwork is completed.

The Shift Supervisor is overall responsible for the coordination, implementation and administration of the system operating procedures. All operations that require actions in the Instrumentation Control Room (ICR) will be the responsibility of the Control Room Operator. The plant operators are responsible for performing all actions of the procedure under the direction of the Shift Supervisor.

Summary

- Diesel oil is a hazardous material. It is a highly flammable skin irritant that must be handled with care. Protective clothing and caution shall be used when dealing with fuel oil and fuel oil systems.

- The Diesel Fuel Oil System is a simple piping and storage system. The role that it could possibly play makes it a much larger system in terms of importance than it physically represents. The DFO System's role can be critical in that it must be ready to support the SBDG operations in the event of a loss of site electrical power. This standby power is necessary to permit the safe shutdown of process system operations.

- The Facility Manager is overall responsible for the DFO System as well as all the CIF systems. Specific responsibilities fall to everyone from the Shift Supervisor down to the plant operators. Safe conduct of operations is equally the responsibility of all personnel.

MAJOR COMPONENTS

1.03 **DESCRIBE** the following major components of the DFO System including their functions, principles of operation, and basic construction:
a. main fuel tank
b. daytank
c. system piping
d. supply pump

The DFO System consists of five (5) major components: The main fuel oil storage tank, daytank, system piping, supply pump and the Heat Tracing System. Each item must be on line in order for the DFO System to properly support the operations of the SBDGs. (See Table 1, *DFO System Components*, for a component listing.)

Main Fuel Tank

The main fuel tank is a horizontally mounted cylindrical tank with a capacity of 660 gallons. Not all 660 gallons are available for use. Only 615 gallons of fuel oil are actually available. The supply pump suction piping penetrates into the storage tank from the top extending downward into the tank and ending at ~4 inches from the tank bottom. The piping is arranged this way to prevent the supply pump from taking a suction on any sediment or sludge that may have settled on the tank bottom and possibly passing it along into and fouling the diesel engine. The tank mounts are constructed so that there is a slight declination to the tank with a slope of $\sim\frac{1}{2}$ inch per foot. The tanks are provided with capped fill connections, capped drain valves allowing for water and sediment removal, and vents fitted with flame arrestors. A flame arrestor prevents the propagation of a flame or explosion throughout a system. Functionally, the arrestor absorbs and dissipates the heat of the flame below the ignition point of the vapors of the interior side of the arrestor. To accomplish this, the area of the metal surface must be sufficient to absorb the heat, and the material itself should possess high heat conductivity. Local level indication is provided by the use of a graduated sight glass located on the tank tops. An adequate inventory of fuel oil (defined as 16 hours of designed diesel engine run time) is assured if the fuel oil level is sighted to be at least greater than the 3/4 tank mark. This ensures approximately a 495-gallon supply of usable fuel oil exceeding the 480 gallons needed for a design engine run at a $\frac{1}{2}$ gpm rate.

Fuel Lines

There are two sets of fuel oil lines: the supply line and the recirculation line (See Figure 2, *Diesel Fuel Oil System*). The supply line runs from the main fuel tank, penetrating through the SBDG enclosure wall, ending at the supply pump located on the daytank. The return line from the daytank and the return line from the engine tee together to form the recirculation line. This line runs from the SBDG enclosure wall back to the top of the main fuel storage tank.

Supply Pump

The fuel oil supply pump is a rotary gear type positive displacement pump with a nominal flow rate of 2 gpm. It is driven by a 1/3 HP single-phase electrical motor. The supply pump is positioned on top of the daytank inside of the SBDG enclosure. The piping supply line connects to the suction side of the pump which will then discharge the fuel oil to the daytank. The supply pump will automatically start or stop when signaled from the daytank. The signal is controlled by two (2) daytank level conductivity switches. The supply pump controller is provided with a local test push-button and a pump running light indicator.

The supply pump suction piping is provided with two specialized valves, a foot valve which functions as a back flow prevention check valve and a solenoid control valve which cycles open or shut corresponding to daytank fuel level. With the foot valve in place, the suction supply line of the pump remains full following securing of the pump. This allows a faster daytank fill and reduces supply pump wear and tear. The solenoid control valve wired in parallel with the supply pump is energized open as the supply pump starts to allow the flow of fuel oil from the main fuel tank. At the specified daytank level both the solenoid and supply pump deenergize to secure the fuel oil transfer.

Heat Trace

The DFO supply lines to the SBDGs are heat traced to reduce the possibility of condensate forming within the piping. Condensate within the Fuel Oil System is undesirable because water has poor combustion characteristics and will not work well inside of the diesel engines. Also during the colder seasons, the condensate has the possibility of freezing shut the piping header. The heat trace is a 120 vAC electrical tape powered from its respective 208/120V lighting panel located inside the SBDG enclosures. Each heat tracing wrap is supplied with an indicating light signifying whether the tracing is energized or not.

Instrumentation

The diesel fuel oil instrumentation is used primarily for alarm and control functions. A low level alarm is provided for the main fuel storage tank. Indications and controls are provided for the supply pump and the heat tracing. This instrumentation is included within the diesel generator set instrumentation.

Tank Low Level Fuel

The main fuel storage tank is provided with a low-level float switch physically mounted to the top of the tank. This switch alarms at the SBDG Control Panel located inside the SBDG enclosure at a tank level of 515 gallons. A low-level signal from the main fuel tank also triggers a DCS alarm. Local-level indication is performed by using the attached sight glass. The minimum tank level should be no less than the 3/4 mark (495 gal) ensuring an adequate supply of fuel oil to support SBDG operations. The DFO daytank is provided with level switches which provide both alarm and controlling functions. The minimum daytank level should be no less than the 3/8 mark (3.75 gal). At the daytank low-level setpoint the low level alarm (local at DFO control panel) will actuate and both the supply pump and solenoid isolation valve energize to provide makeup fuel to the system.

Supply Pump Controls

The indications associated with the diesel fuel oil supply pump are intermixed with those of the fuel oil daytanks located on the Daytank Control Panel (Figure 1 *Daytank Control Panel).* This control panel contains a local daytank level indicator, the supply pump PUSH TO TEST button, a PUMP RUNNING indication light, and a DAYTANK LOW LEVEL alarm light. The control panel is physically located on top of the daytank.

Summary

- The DFO System consists of five (5) major components: The main fuel oil storage tank, daytank, system piping, supply pump, and the Heat Tracing System.
- The DFO main storage tanks are cylindrical, horizontally mounted, 660-gallon tanks. The capacity is based on providing sufficient fuel to run the SBDGs for the design run time of 16 hours. This is adequate time to allow the safe shutdown of the process systems and the restoration of normal site power.
- The supply pump and solenoid isolation valve are automatically controlled from day tank level switches, turning them on or off when the corresponding level is reached in the tank. The supply pump suction piping is provided with a foot valve which acts to keep the suction pipe full and the pump primed.
- Heat tracing is installed on DFO System piping to prevent the possibility of condensation formation inside of the fuel oil piping.

SYSTEM INTERRELATIONS

The DFO System interrelates with the SBDG System and the Distributed Control System (DCS). The DFO System association with the SBDGs is both mechanical and electrical while the DCS connection is electrical only. The DCS interconnection deals with alarms and readiness conditions of the DFO System. The SBDG interconnection deals with the controls for the DFO System and the operations of the two systems combined.

Distributed Control System

The DCS will show an alarm (SBDG SET NO. 1 [2] PROBLEM) if unsatisfactory conditions exists at the monitored points in the DFO System. The only condition that will cause a DCS alarm is a low-level condition (<515 gallons) in the main fuel oil storage tank.

Standby Diesel Generator System

The DFO System is the sole fuel source to the diesel generators. The DFO supply connects to the SBDG set via the daytank of each associated SBDG set. The recirculation lines of the DFO System return from the SBDG sets from two locations. A return line runs from the daytank and a return line runs from the diesel engine set; these combine to form the DFO System recirculation line.

In order for the DFO and SBDG Systems to interact correctly with each other, each system must be aware of the other system's needs. Each day tank has a 10-gallon capacity which is sufficient for about 20 minutes of diesel run time at the design diesel use of 1/2 gpm. The low- and high-level float switches of the SBDG daytank signals the associated system DFO supply components when makeup fuel is required. The positive displacement supply pump will deliver fuel to the daytank at a rate of 2 gpm. When sufficient makeup fuel oil has been added to the system the daytank high-level float sends a shut-down signal to secure the supply pump and deenergize the solenoid isolation valve. These two switches start and stop, open and shut, the DFO supply components automatically to keep a ready supply of fuel oil in the daytank for the SBDGs. If the supply pump does not start upon demand, a local alarm is signaled at the SBDG Control Panel.

Controls

The main fuel tank of the DFO System is not equipped with any electronic controls. The only manual "control" for the fuel tank is the attached gate valve in the drainage piping. This valve allows the draining of water and sediment that has collected in the bottom of the tank.

The controls for the supply pump are located on the daytank control panel. The only control for the supply pump is a "PUSH TO TEST" button. The control panel is located on top of the daytank inside the SBDG enclosures.

Interlocks

The supply line is equipped with a suction foot valve which will act as a mechanical interlock retaining fuel oil in the supply line after securing the supply pump. This in effect makes the supply pump self-priming, ensuring an easier, quicker start for the pump by reducing wear and tear to the pump internals. The daytank, supply pump and solenoid isolation valve are interlocked to operate together to maintain a ready supply of fuel oil for the SBDG's.

Summary

- Both the Distributed Control System and the Standby Diesel Generator System interact with the DFO System to ensure the readiness and operability of the CIF.

INTEGRATED PLANT OPERATIONS

Normal Operations

There are not any valves which require repositioning to accomplish a DFO System startup. However, prior to Process System operations, when the possible need for an alternate source of electrical power is present, the DFO system components must be aligned to support automatic and sustained operations of the SBDG sets.

During normal operations of the DFO System, all components will be aligned to supply diesel fuel to the SBDGs. Even though an abnormal condition exists if the diesel generators automatically start, the normal function of the DFO System is to operate as required to maintain adequate daytank fuel oil level.

During a standby condition (SBDGs preset in the automatic start mode), the main fuel oil storage tanks should contain greater than 515 gallons of fuel oil (i.e., no LEVEL LOW ALARM condition). The daytank level should also be in the normal range (no LEVEL LOW ALARM condition). With the SBDGs running, the main fuel tank level will lower as the DFO System operates to maintain daytank level.

The routine operator rounds for the DFO System consists of ensuring that an adequate level of fuel oil exist in the main storage tank. All rounds for the DFO System will be performed in conjunction with the operator rounds associated with the Standby Diesel Generators.

Infrequent Abnormal Operations

If the DFO supply pump fails to start as required, as noted by the “DAYTANK FUEL LEVEL LOW” alarm locked in at the SBDG control panel, the "PUSH TO TEST" button on the daytank local control panel can be used to run the pump and refill the daytank. Using this method, the high-level float switch will not automatically secure the supply pump leaving it to be done manually by the operator.

The Diesel Fuel Oil/Diesel Generator Set will be in continuous service (on-line in a standby ready condition) with the exception of during testing or maintenance of the system components. On occasion the main fuel tank will require refueling. This operation will replace the fuel oil used during automatic or manual starts of the diesel sets. For refueling of the main storage tanks, Maintenance personnel will aid in performing the procedure. During refueling, the caps must be removed from both the drain and fill lines of the main fuel tanks. A minimum of one quart of fuel should be drained removing any sediment or water that may be present in the storage tanks. Fuel can then be added to the tank per operational procedure specifications (261-SOP-DFO-01). Refueling the main fuel oil tanks will be performed for both SBDG sets. The SBDG System will periodically be tested for operability. During these sessions, the DFO System will be utilized to supply makeup fuel oil to the SBDG sets. The DFO System requires periodic monitoring and refueling as necessary.

Summary

Operational procedures of the DFO System are written with the intention of supporting the SBDG System. The normal condition for the Fuel Oil System is a standby ready condition aligned to support diesel operations. On the occasion that makeup fuel oil is required Maintenance personnel will work in conjunction with Plant Supervision and Operations to refuel the storage tanks.

TABLES

CLIs	DESCRIPTION
H-254-11-DFO-FAR-001	ARRESTOR, FLAME, VENT, SBDG #1
H-254-11-DFO-LSL-5483	LEVEL SWITCH LOW, SBDG #1 (IN MFT)
H-254-11-DFO-MO-P001	MOTOR, DAYTANK SUPPLY PUMP, SBDG #1
H-254-11-DFO-P-001	DAYTANK SUPPLY PUMP, SBDG #1
H-254-11-DFO-STR-001	STRAINER, FUEL OIL TO SBDG #1 (IN MFT)
H-254-11-DFO-TK-001	MAIN FUEL OIL TANK, SBDG #1
H-254-11-DFO-V-001	DAYTANK SUPPLY ISOL. VALVE, SBDG #1
H-254-11-DFO-501	DRAIN VALVE, MAIN FUEL OIL TANK #1
H-254-11-DFO-V-502	DRAIN VALVE, MFT #1 DIKE
H-254-12-DFO-FAR-002	ARRESTOR, FLAME, VENT, SBDG #1
H-254-12-DFO-MO-P002	MOTOR, DAYTANK SUPPLY PUMP, SBDG #2
H-254-12-DFO-P-002	DAYTANK SUPPLY PUMP, SBDG #2
H-254-12-DFO-STR-002	STRAINER, FUEL OIL TO SBDG #2 (IN MFT)
H-254-12-DFO-TK-002	MAIN FUEL OIL TANK, SBDG #2
H-254-12-DFO-V-002	DAYTANK SUPPLY ISOL. VALVE, SBDG #2
H-254-12-DFO-V-503	DRAIN VALVE, MAIN FUEL OIL TANK #2
H-254-12-DFO-V-504	DRAIN VALVE, MFT #2 DIKE

Table 1 DFO System Components

FIGURES

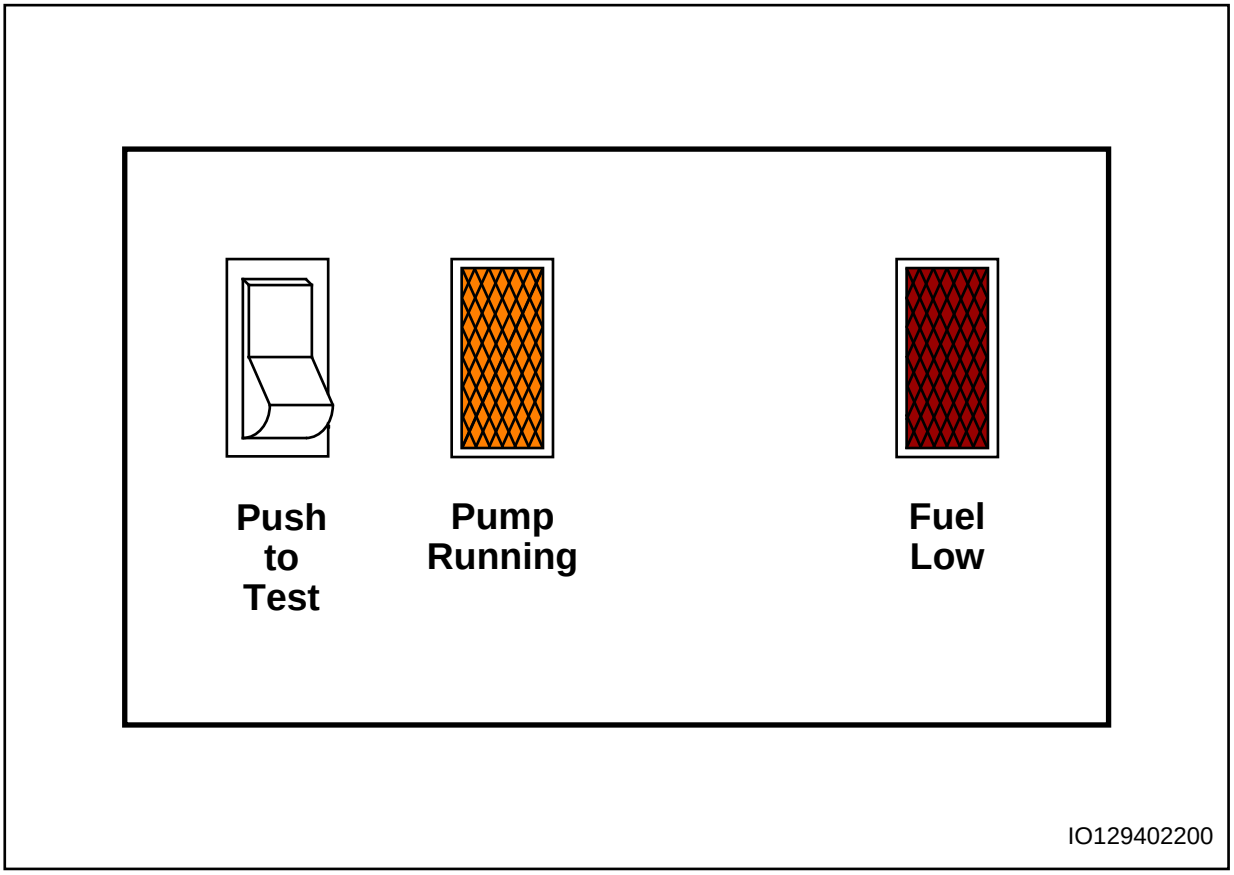

Figure 1 Daytank Control Panel

Figure 2 Diesel Fuel Oil System Layout

1.04	**DESCRIBE** the DFO System .arrangement to include a **sketch** showing the following system components and interfaces with other systems: a. Main storage tank b. daytank c. system piping d. supply pump