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

INCINERATION SYSTEM (RK, SCC, BMS) (U)

Study Guide

ZIOITX73

Revision 00

Training Manager / Date

Engineering / Date

Facility Manager / Date

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REVISION LOG

REV.	AFFECTED SECTION(s)	SUMMARY OF CHANGE
00	All	Deletion of additional material from ZIOITX25.01, CIF INCINERATION (RK, SCC, BMS)

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25. G-SYD-H-00046, System Design Description, *Incinerator System,* Rev. 0
26. J-SD-H-00002, Functional Description, *Incineration*, Rev. A

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27. John Zink Company, Project Number S-2787, Shop Order Number S 70663, Mechanical/Electrical Equipment Manual, *Incineration System*, 1991

28. John Zink Company, Job Number S70665, P.D. Number AXC 15323, memo from Mike Reynolds to Emory Brown dated 3-24-92 by Larry Anderson. *Required Steam Quantities.*

29. WSRC-SA-17, *Consolidated Incineration Facility Safety Analysis Report*, (DOE Approval Copy 12/95)

30. ZIOISX25, *Incinerator System Design Description,* Rev. 0

LEARNING OBJECTIVES

TLO

1.0 Without references, **EXPLAIN** the significance of the Incineration System (including each individual subsystem; the RK, SCC, and BMS) to the Consolidated Incinerator Facility (CIF) operations, including the importance to safety, and impact on plant operations upon a failure of any or all the system listed above.

ELO

1.1 **STATE** the purpose of the Incineration System and it's constituent subsystems:

a. Rotary Kiln (RK)
b. Secondary Combustion Chamber (SCC)
c. Burner Management System (BMS)

1.2 Briefly **DESCRIBE** how the RK, SCC, and BMS Systems accomplishes their intended purposes. Briefly describe how these subsystems operate together to achieve the function of the incineration system as a whole.

1.3 **EXPLAIN** the consequences of a failure of the Incineration System* to fulfill its intended purpose, including the effect on other systems, other components, overall plant operations, and safety.

TLO

2.0 Using system diagrams, **EVALUATE** any potential problems which could interfere with normal Incineration System flow paths. Determine the significance on overall system operations and the corrective actions required to return the system configuration to normal.

ELO

2.1 **DESCRIBE** the layout of the Incineration System* components including the general physical component locations, and general functional relationships for each of the following major components:

a. Rotary Kiln
b. RK drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System

g. Support Systems:
   1) air fans
   2) burner - nozzle assemblies
   3) Waste - fuel oil skids
   4) Burner ignition
   5) flame monitoring
   6) electrical distribution system
   7) steam system

2.2 **DESCRIBE** the Incineration System arrangement to include a simplified sketch showing the following system components and interfaces with other systems:

a. RK
   1) seal shrouds
   2) stationary heads
   3) center cylinder
   4) drive assemblies
   5) from BW, AQW, SWF, fuel oil
   6) to SCC, Ash receiving

b. SCC
   1) expansion joints
   2) crossover duct
   3) from RK, fuel oil, ROW
   4) Quench vessel
   5) thermocouples, oxygen sensor

2.3 Given a description of the Incineration System equipment status, **IDENTIFY** conditions which interfere with normal system flow paths.

2.4 Given a description of abnormal equipment status for the Incineration System, **EXPLAIN** the significance of the condition on system operations.

2.5 Given a description of the Incineration System equipment status, **STATE** any corrective actions required to return system operation to a normal conditional.

TLO

3.0 Given values of Incineration System operation parameters, **EVALUATE** potential problems that could effect the normal functioning of the system or its components to determine the significance of the existing condition and the actions required to return the system to normal operation.

ELO

3.1 **DESCRIBE** the following major components of the Incineration System including their functions, principles of operation, and basic construction:

a. Rotary Kiln
b. drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:
   1) air fans
   2) burner - nozzle assemblies
   3) Waste - fuel oil skids
   4) Burner ignition
   5) flame monitoring
   6) electrical distribution system
   7) steam system

3.2 **STATE** the design capacities and operational limitations for the following Incineration System major components:

a. Rotary Kiln
b. RK drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:
   1) air fans
   2) burner - nozzle assemblies
   3) Waste - fuel oil skids
   4) Burner ignition
   5) flame monitoring
   6) electrical distribution system
   7) steam system

3.3 Given values for key performance indicators, **DETERMINE** if the Incineration System components are functioning as expected.

3.4 **DESCRIBE** the following Incineration System instrumentation including indicator location (local or Control Room),m sensing points, and associated instrument controls:

a. burner - nozzle instrumentation
   1) mass flow
   2) pressure and temperature
   3) flame scanners

b. RK - SCC
   1) air flow
   2) solid waste flow
   3) pressure
   4) CO_2 - O_2
   5) seal cooling
   6) rotational drive
   7) temperature

c. stack flow
d. Expansion joint steam purge pressure
e. stack opacity
f. BMS

3.5 **INTERPRET** the alarms listed in Table 9, Incineration System alarms, including the conditions causing alarm actuation and the basis for the alarms.

3.6 **EXPLAIN** how the following Incineration System equipment is controlled in all operating modes or conditions to include control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation:

a. Rotary Kiln
b. RK drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:
   1) air fans
   2) burner - nozzle assemblies
   3) Waste - fuel oil skids
   4) Burner ignition
   5) flame monitoring
   6) electrical distribution system
   7) steam system

3.7 **DESCRIBE** the interlocks associated with the following Incineration System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary:

a. Interlock System Permissive
b. Incinerator general permissive interlocks
c. AQW, BW, FO, ROW pump interlock
d. combustion air
e. solids flow
f. RK temperatures
g. SCC temperatures

h. Emergency off
i. Mandatory off
j. CO - O_2
k. RK drive
l. purge complete
m. N_2 supply low
n. Tertiary air
o. fuel oil combustion air

TLO

4.0 Given necessary procedures or other technical documentation and system conditions, **DETERMINE** the operator actions required for normal and off normal operation of the Incineration System including problem recognition and resolution.

ELO

4.1 **STATE** the personnel safety concerns associated with the incineration system.

4.2 Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Incineration System operations:

a. Startup
b. Normal Operation of Equipment
c. Shutdown

4.3 **DETERMINE** the effects on the Incineration System and the integrated plant response when given any of the following:

a. Indications - alarms
b. Malfunctions - failure of components
c. Operator actions

SYSTEM OVERVIEW

ELO 4.1 **STATE** the personnel safety concerns associated with the Incineration System.

Safety

The following is a list of the possible hazards associated with the Incinerator System:

The primary safety concern of the Incinerator System has to do with the temperatures required for incineration of the waste streams. Surfaces of the incinerator (the RK shell) and certain auxiliaries and support systems will not only be hot to the touch, but they will also serve to raise the surrounding ambient temperatures to levels that range from uncomfortable to those having a potential for creating heat stressful situations. Personnel should always exercise care around the shell surface of the incinerator. In the unlikely event an operator would be required or need to place extremities on or near the shell, heavy gloves should be worn. The same precaution applies when manipulating atomizing steam or fuel valves.

Noise is also a factor to consider during incinerator operation. Hearing protection should be worn at all times in the vicinity of the incinerator or auxiliaries.

Many of the support systems use rotating equipment (pumps, fans, blowers, etc.) for process operations. Personnel should ensure that they do not wear chains, necklaces or loose articles of clothing in the vicinity of rotating equipment.

Many of the fuels used for incineration are not only chemically toxic, but they may present other hazards if they are spilled or leak. Personnel should take appropriate measures in dealing with spills and leaks of waste materials. Operators should always avoid walking through areas where spills or leaks have occurred.

Operators are routinely called upon to physically lift materials. Proper lifting techniques and protective gear should be used when performing any lifting.

There are numerous electrically powered components throughout the incineration facility. Proper electrical safety precautions are documented and proceduralized and should be adhered to any time that electrical equipment is being operated or aligned.

Introduction

The Incineration System at the Consolidated Incineration Facility (CIF) is designed to thermally destroy hazardous wastes and reduce the volume of low-level radioactive solid and liquid wastes in a controlled, high temperature environment. The system consists of a horizontal, refractory-lined Rotary Kiln (RK), a vertical Secondary Combustion Chamber (SCC), and associated support equipment. The incinerator is maintained at a negative pressure to prevent the release of combustible, radioactive, and/or hazardous gases to the environment.

Fuel oil supplied to one burner in the RK and one burner in the SCC is modulated to maintain optimum temperatures necessary for efficient combustion. Solid wastes, prepackaged in cardboard boxes, are fed to the RK. Liquid wastes are fed to the RK and SCC through burners and nozzles. Primary combustion of the solid waste and most of the liquid waste is carried out in the RK. Ash produced in the RK from the combustion of solid and liquid wastes is discharged at the outlet end of the RK to a water-filled receiving tank where it is cooled (quenched). The ash is then immobilized with cement and transferred to another location for disposal. The combustion gases from the RK proceed to the SCC where after-burning takes place to ensure complete combustion. The combustion gases from the SCC are discharged to an Off Gas system where additional processing/filtering occurs prior to release to atmosphere. The incinerator system is designed to operate with a greater than 99.99% destruction/removal efficiency.

Summary

- Incinerator safe operations requires operating personnel to be aware of both incinerator operating fundamentals, fuel and waste characteristics.

SYSTEM PURPOSE

ELO 1.1 **STATE** the purpose of the Incineration System and it's constituent subsystems:

a. Rotary Kiln (RK)
b. Secondary Combustion Chamber (SCC)
c. Burner Management System (BMS)

Incinerator System

The Incinerator System consists of the RK & SCC Incinerator sections, and the Burner Management System (BMS). The RK and SCC are designed to consolidate the incineration of the various waste streams by allowing simultaneous processing of liquid and solid wastes in any combination.

The composition of the solid/liquid wastes to be processed in the Incinerator System is listed in Table 1, *Waste Materials Composition*. Solid waste is processed in prepackaged 21 inch (") cubic cardboard boxes. The solid waste may contain low levels of radioactive material. The heat released while burning solids during normal operation is dependent upon the feed rate but can be as high as 52.5 x 10^6 BTU/hr. A BTU is defined as the amount of energy required to raise one pound of water at atmospheric pressure 1 degree Fahrenheit (°F). Liquid waste is segregated into 3 different categories: radioactive organic, blended, and aqueous. Radioactive Organic Waste (ROW) is high BTU (18,000 BTU/lb) liquid waste mainly comprised of benzene.

Blended Waste is medium to high BTU (>7,500 BTU/lb) liquid waste mainly comprised of oils and solvents. Aqueous Waste is low BTU (less than (<) 2,200 BTU/lb) liquid waste mainly comprised of water. The liquid waste will contain varying levels of radioactive material. The heat released while burning liquid waste is dependent upon the feed rate but can be as high as 12.5 x 10^6 BTU/hr. The heat released while burning Fuel Oil is dependent upon the flow rate, but can be as high as 15.5 x 10^6 BTU/hr.

COMBUSTIBLE MATERIALS	WEIGHT %	HIGH HEATING VALUE (HHV) BTU/LB
Solid Waste		
Cellulose	40	8,000
Polyvinyl Chloride	8	11,400
Polyethylene	23	20,000
Latex (Polyisoprene)	19	19,000
Water	5	0
Ash	5	0

Table 1 Waste Materials Composition.

COMBUSTIBLE MATERIALS	WEIGHT %	HIGH HEATING VALUE (HHV) BTU/LB
Liquid Waste		
Tritiated Oil	22.6	18,500
Purex Solvent	3.4	18,400
Naval Fuel	9.8	13,400
High BTU NRHW	44.8	18,850
Chlorinated NRHW	2.1	9,900
Fuel Oil Flush	17.2	18,400
Aqueous NRHW	0.1	2,200
Radioactive Organic Liquids		
Benzene	90.8	*
Biphenyl	4.95	*
Diphenylamine	3.37	*
Phenol	0.73	*
Phenylboric Acid	0.06	*
p-Terphenyl	0.07	*
Diphenyl Mercury	0.03	*
Chlorobenzene	0.02	*

Table 1 Waste Materials Composition. (Con't)

* - HHV of Radioactive Organic Liquids = 18,000 BTU/lb

ELO 1.2 Briefly **DESCRIBE** how the RK, SCC, and BMS Systems accomplish their intended purposes. Briefly describe how these subsystems operate together to achieve the function of the incineration system as a whole.

An electric ignitor, propane pilot, and fuel oil burner are used in the RK and SCC to "light off" and increase the temperature of each section during warmup. Once optimum temperatures are reached (RK-between 1450°F and 1840°F, SCC-between 1650°F and 1962°F), the fuel oil burners will automatically modulate to maintain these operating temperatures. When normal operating temperatures are reached, processing of solid waste, aqueous waste, blended liquid waste, and/or radioactive organic liquid waste can begin. Additional heat input to the incinerator sections from these waste streams will result in a decreased flow to the fuel oil burners thereby maintaining RK/SCC temperatures. There is no credit taken for the very small heat input from the evaporation of the low BTU aqueous waste.

Waste feed rates are selected and controlled by the operators. Maximum feed rates can add sufficient heat input to increase incinerator temperatures to optimum values with little input from the fuel oil burners. In this case, the fuel oil burners will go to a minimum firing rate. If incinerator temperatures exceed a set value and the fuel oil burners are at minimum firing rate, liquid and then solid waste feed rates will automatically be decreased until temperatures return to normal. Liquid and solid waste feed rates will automatically decrease to prevent exceeding a maximum value however they will not automatically increase to maintain temperature.

The RK is designed to incinerate all solid and liquid waste except ROW, which is incinerated in the SCC. Blended waste is ignited after being injected into the RK through a liquid waste burner. Aqueous Waste is evaporated after being injected into the RK through a nozzle. Solid wastes prepackaged in boxes are fed to the RK using a conveyor and hydraulic ram feed system. Between 1-3 of these boxes are batch fed into the RK feed head. The maximum total weight for each batch is 95 pounds (lbs). This limit is established to prevent feeding an undetected quantity (98 lbs or more) of inflammable liquid (solvent) which, could result in a greater than 15 psig RK pressure spike.

The RK is comprised of a stationary head at each end and a rotating center section. The horizontally positioned center section is supported by rollers and rotated through an external gear drive. Ash produced in the RK migrates toward the discharge head due to a slightly sloped surface. The rate of ash movement and, therefore, its retention time, is dependent upon the RK revolutions per minute (rpm).

The SCC, located downstream of and connected to the RK discharge head, is designed and operated so that gases entering the SCC reside in it (retention time) for a minimum of two seconds. The two second retention time ensures complete combustion of any unburned vapors exiting the RK as well as ROW which is burned solely in the SCC. ROW is ignited after being injected into the SCC through a ROW burner.

ELO 1.3 **EXPLAIN** the consequences of a failure of the Incineration System* to fulfill its intended purpose, including the effect on other systems, other components, overall plant operations, and safety.

ELO 2.1 **DESCRIBE** the layout of the Incineration System* components including the general physical component locations, and general functional relationships for each of the following major components:

a. Rotary Kiln
b. RK drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:
    1) air fans
    2) burner - nozzle assemblies
    3) Waste - fuel oil skids
    4) Burner ignition
    5) flame monitoring
    6) electrical distribution system
    7) steam system

The Incinerator is maintained at a slightly negative pressure as compared to atmosphere by Induced Draft (ID) fans. H-261-OGS-FCD-1704, Damper, Off Gas Quench to Separator, modulates to maintain pressure in the negative range. This ensures that any air leakage is into the Incinerator, thereby preventing the uncontrolled release of combustible, radioactive, and/or hazardous materials.

Combustion air is supplied by five fans (1-solids 2-fuel oil, 2-liquid). The Solids Combustion Air Fan maintains a minimum of 100% excess air in the RK combustion gasses when burning solids. The liquid combustion air fans each maintain 20% excess air, when their respective burners are in service. The Fuel Oil Combustion Air Fans will maintain 15% excess air in varying amounts dependent upon the fuel oil flow rate. Excess air is defined as the volume of air flow in excess of (in addition to) that required to just support combustion. Excess air ensures that the combustible material will burn as opposed to explode upon ignition in the incinerator.

The disadvantages of excess air is that it acts to reduce incinerator temperature. Excess air containing oxygen, not consumed in the combustion process, can combine with nitrogen thereby increasing nitrogen oxide emissions in the off gas. The Solids Combustion Air Fan is also used for purging combustible vapors in the incinerator prior to the initial ignition of the fuel oil burners and as a supply to the RK feed head seal.

Each burner has a combustion air supply, a propane pilot, and an electric ignitor and atomizing steam. In addition, each burner is also equipped with two flame scanners which are interlocked to shut off the waste/fuel feed safety shut-off valves (SSOVs) in the event of a flame failure.

Steam is provided for all liquid streams (i.e. fuel oil, blended waste, aqueous waste, radioactive organic waste). Atomizing steam is mixed with the liquid waste/fuel oil to develop a fine mist at the burners/nozzle tip which allows for complete and efficient combustion/evaporation. Steam is also supplied to the burners/nozzle to keep them relatively cool as compared to the high temperature environment of the incinerator. Steam connections upstream of the burners/nozzle at the local piping skids are used for purging (cleaning) of the burners/nozzle following shutdown.

Solid Waste

Solid Waste is fed from the Solid Waste Feed System through a series of hydraulically-operated gates and rams. Primary combustion of the solid waste occurs in the RK at a temperature of between 1450°F and 1840°F. The incineration reduces the waste to combustion products (ash and gases). The ash is deposited at the discharge end of the RK through a chute to the Ash Receiving Tank where it is quenched, solidified, temporarily stored, and finally transported to another location for long term storage and disposal. The gases are directed to the SCC and then the Offgas System where they are processed further, treated and filtered prior to release to atmosphere.

Combustion Air

Fans are provided for combustion air at both the RK and SCC. The RK has fans for Solid Waste, Blended Waste and Fuel Oil. The SCC has combustion air fans for Fuel Oil and ROW. Combustion air flows through a silencer, a control valve, the fan, dampers and then to the burner port(s).

Combustion Gases

The combustion gases leave the RK and proceed to the SCC where after-burning takes place at a temperature between 1650°F and 1962°F. The secondary combustion gases proceed through a refractory-lined duct at the discharge end of the SCC to the Offgas System where the gases are quenched, scrubbed (cleaned/treated), passed through a cyclone separator, filtered to remove particulate, and buffered with a caustic solution to remove acid generated as a result of combustion.

Fuel Oil And Liquid Waste

Blended Waste, Aqueous Waste and Fuel Oil supplied to the Incinerator System are delivered from associated storage tanks in the Tank Farm to valving/metering skids in Building 261-H. ROW is delivered from a storage tank located at the Defense Waste Processing Facility (DWPF) to feed pumps in the tank farm. Each liquid will travel through a remote skid, local skid, and then to the respective burner/nozzle. The skids are centralized locations for controls, instruments, valves, and metering pumps used for adjustment of incinerator waste/fuel oil operating parameters. (See Figure 1, *Remote Burner Skid*, and Figure 2, *Local Burner Skid*).

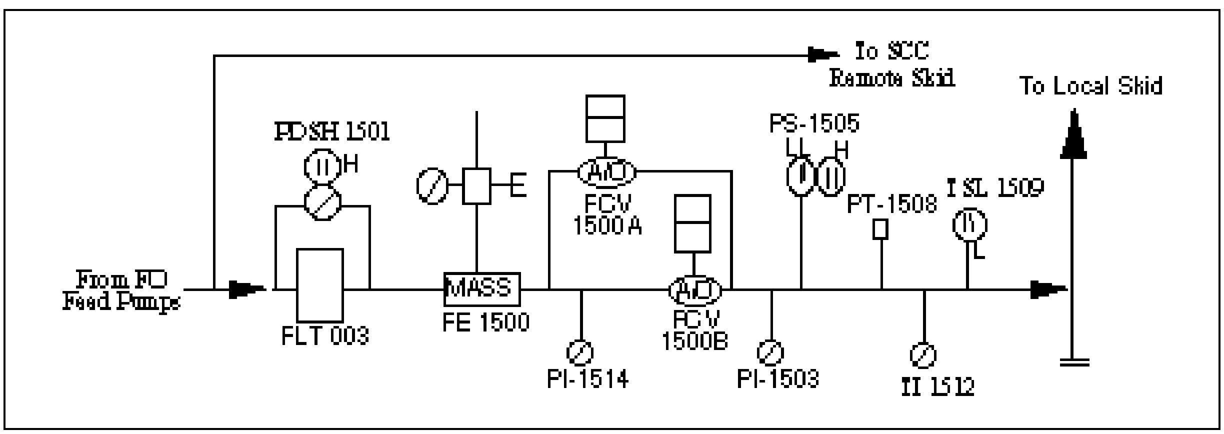


Figure 1 Remote Burner Skid

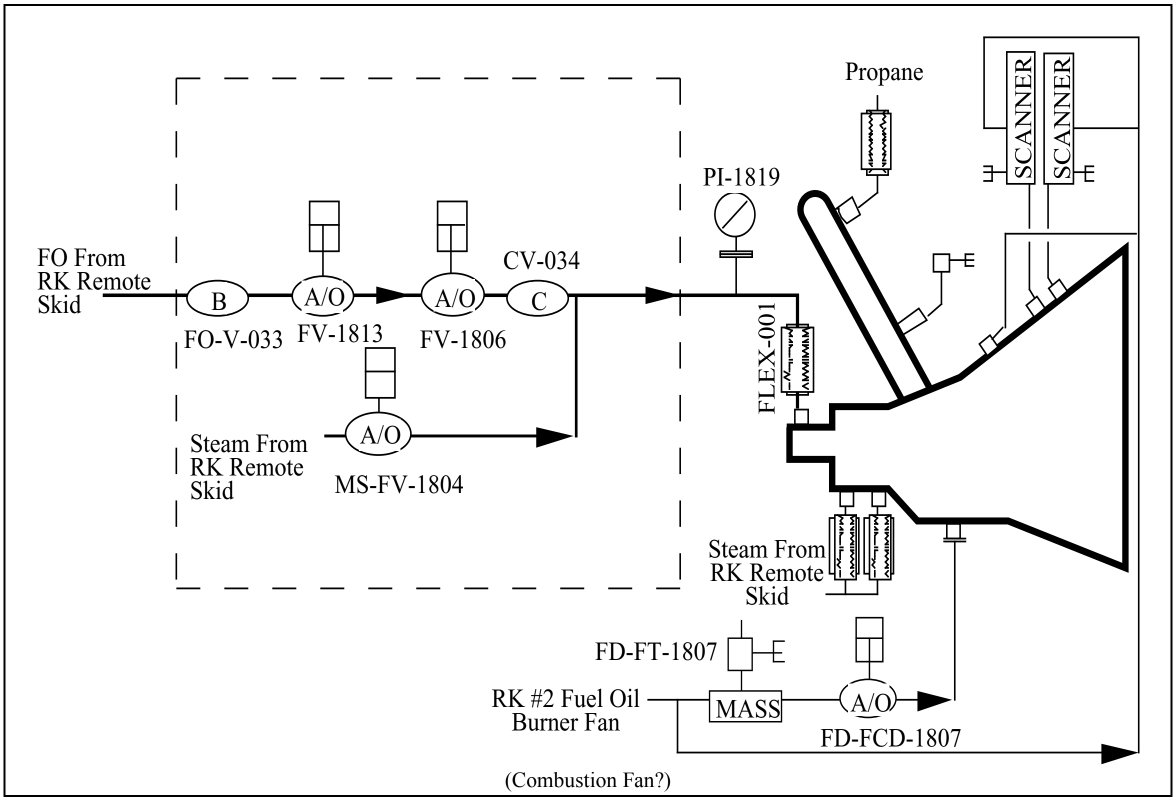


Figure 2 Local Burner Skid

(See Figure 3, *Waste/Fuel Oil Flow Diagram*). Fuel oil is delivered to the RK/SCC remote skids by feed pump(s) located near the Fuel Oil Storage Tank. Blended Waste is delivered by transfer pump(s) to a RK remote skid feed (metering) pump. Aqueous Waste (AQW) is delivered by a transfer pump to a RK remote skid feed (metering) pump. ROW is delivered by a DWPF transfer pump, to feed (metering) pump(s), and then to a SCC remote skid.

Fuel Oil, Blended Waste and Aqueous Waste are fed to the local skid and then to their respective burner/nozzle on the feed head of the RK. Fuel Oil and ROW are fed through their respective local skids and then to their respective burner on the SCC.

Summary

- The incinerator at CIF is designed to thermally reduce and/or destroy waste generated on site.
- The incinerator will process various types of liquid and solid waste
- The incinerator uses fuel oil and propane as auxiliary fuels to ignite and heat up the process
- Combustion air, generated by fans, is used for the incineration process
- Gases that are byproducts of combustion are burned in the Secondary Combustion Chamber and the residual gases are cleaned and filtered before emissions are released to the environment.

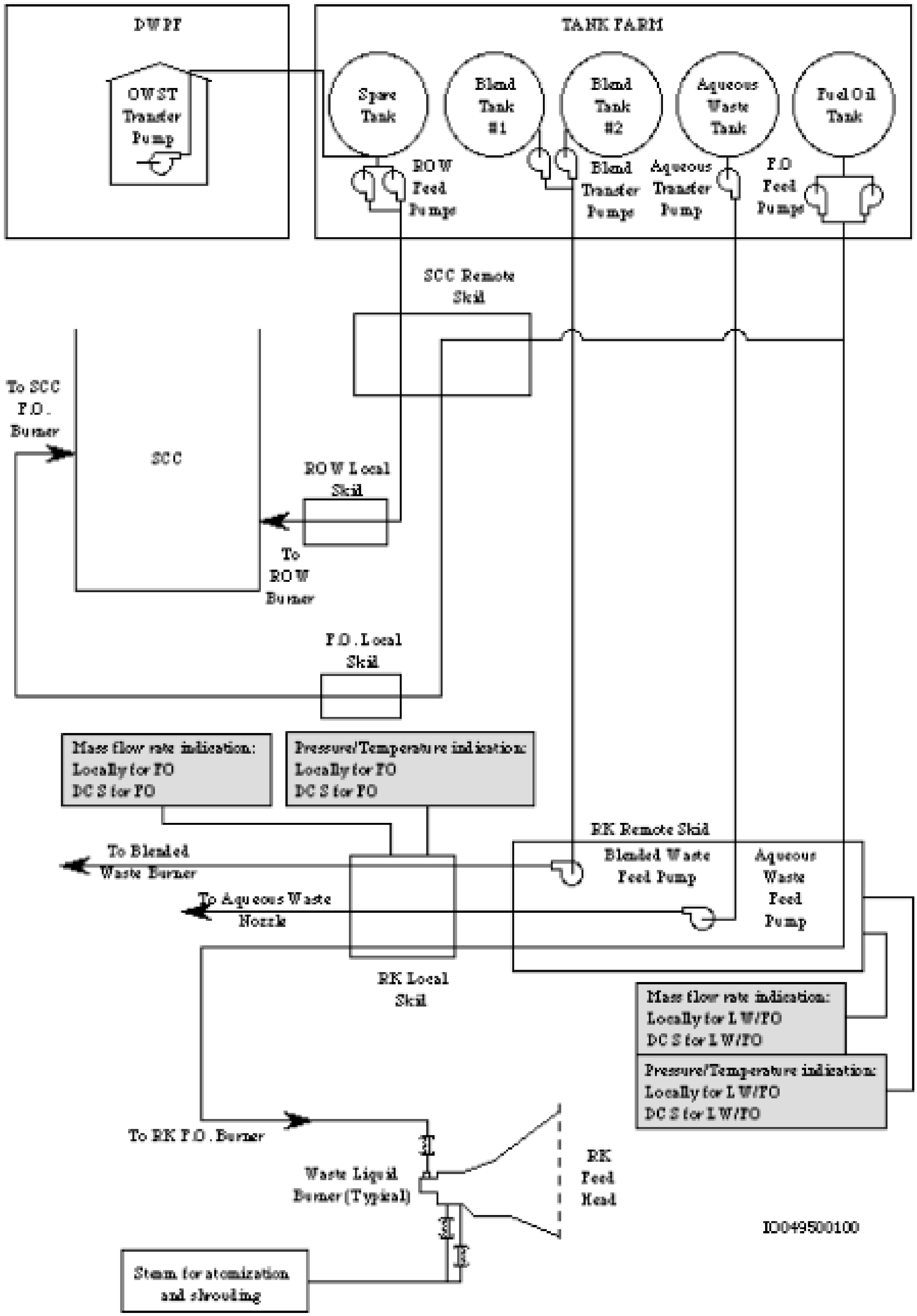


Figure 3 Waste/Fuel Oil Flow Diagram

MAJOR COMPONENTS

ELO 2.2 **DESCRIBE** the Incineration System arrangement to include a simplified sketch showing the following system components and interfaces with other systems:

a. RK
   1) seal shrouds
   2) stationary heads
   3) center cylinder
   4) drive assemblies
   5) from BW, AQW, SWF, fuel oil
   6) to SCC, Ash receiving

b. SCC
   1) expansion joints
   2) crossover duct
   3) from RK, fuel oil, ROW
   4) Quench vessel
   5) thermocouples, oxygen sensor

ELO 3.1 **DESCRIBE** the following major components of the Incineration System including their functions, principles of operation, and basic construction:

a. Rotary Kiln
b. drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:
   1) air fans
   2) burner - nozzle assemblies
   3) Waste - fuel oil skids
   4) Burner ignition
   5) flame monitoring
   6) electrical distribution system
   7) steam system

ELO 3.2 **STATE** the design capacities and operational limitations for the following Incineration System major components:

a. Rotary Kiln
b. RK drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:
   1) air fans
   2) burner - nozzle assemblies
   3) Waste - fuel oil skids
   4) Burner ignition
   5) flame monitoring
   6) electrical distribution system
   7) steam system

RK

RK Combustion Chamber

The RK is a refractory-lined carbon steel cylindrical vessel 10 ft. (') in diameter and 25' long. A wool blanket separates the refractory bricks and the carbon steel vessel. The RK refractory lining is 12" thick and will withstand temperatures up to 2800°F and pressures up to 15 psig. The feed end of the cylinder is tapered. The vessel has a stationary feed head which connects to the Solid Waste Feed System, Aqueous Waste System, and the Blended Waste System. The vessel also has a stationary discharge head which connects to the SCC, the Ash Receiving Tank, and the Tertiary Air Fan. The middle section of the vessel is a rotating cylindrical combustion chamber which is connected to the stationary feed and discharge heads by two sliding contact/labyrinth type seals. Each kiln seal is enclosed by a seal shroud which is exhausted to the HVAC system. The interior of the discharge head is protected by specially shaped nose tiles. The feed head provides ports for the waste burner/nozzle, fuel oil burners, combustion air, solid waste feed fire door, viewing ports, and instrumentation connections. The discharge head has a manway access opening, ash discharge port, exhaust gas port, tertiary air supply port, viewing/camera ports, and instrumentation connections. (See Figure 4, *Rotary Kiln (RK).* The RK rotating cylinder section is mounted on rollers. The rollers support the cylinder via forged steel riding rings, while thrust wheels prevent movement of the cylinder along its long (longitudinal) axis. (See Figure 5, *Rotary Kiln Support Assembly)*

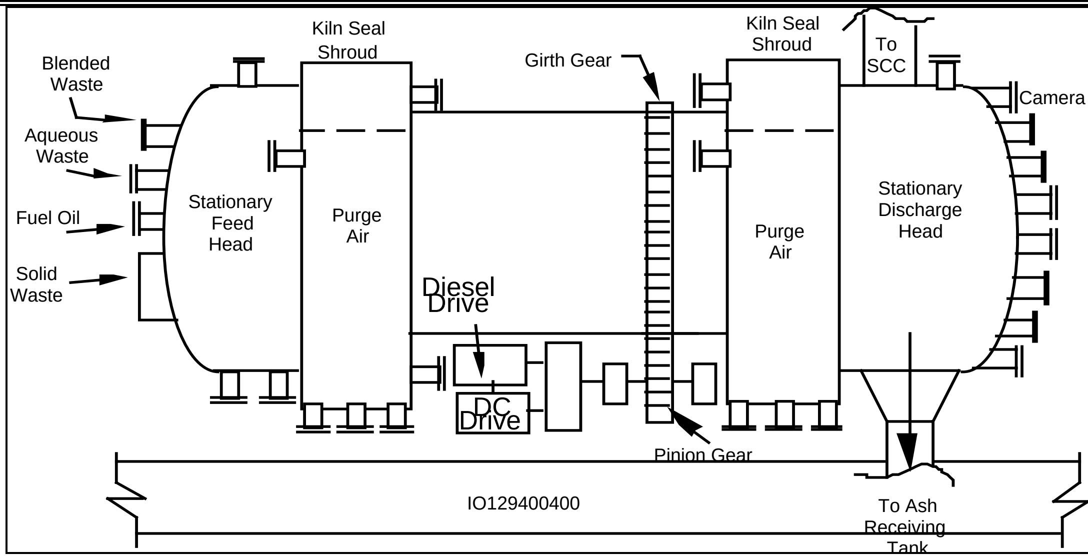


Figure 4 Rotary Kiln (RK)

Ash collected at the bottom of the RK slides down the inclined kiln surface (7/16" slope per foot length) to the lip edge of the discharge head as the cylinder rotates. When ash accumulates beyond the lip edge, it drops through an ash discharge chute fastened to the bottom part of the discharge head. The ash discharge chute extends at least 6" below the water surface of an Ash Receiving Tank. This arrangement forms a seal that prevents air from entering the incinerator system and combustion gases from escaping. Combustion gases are directed to the SCC from the top part of the discharge head.

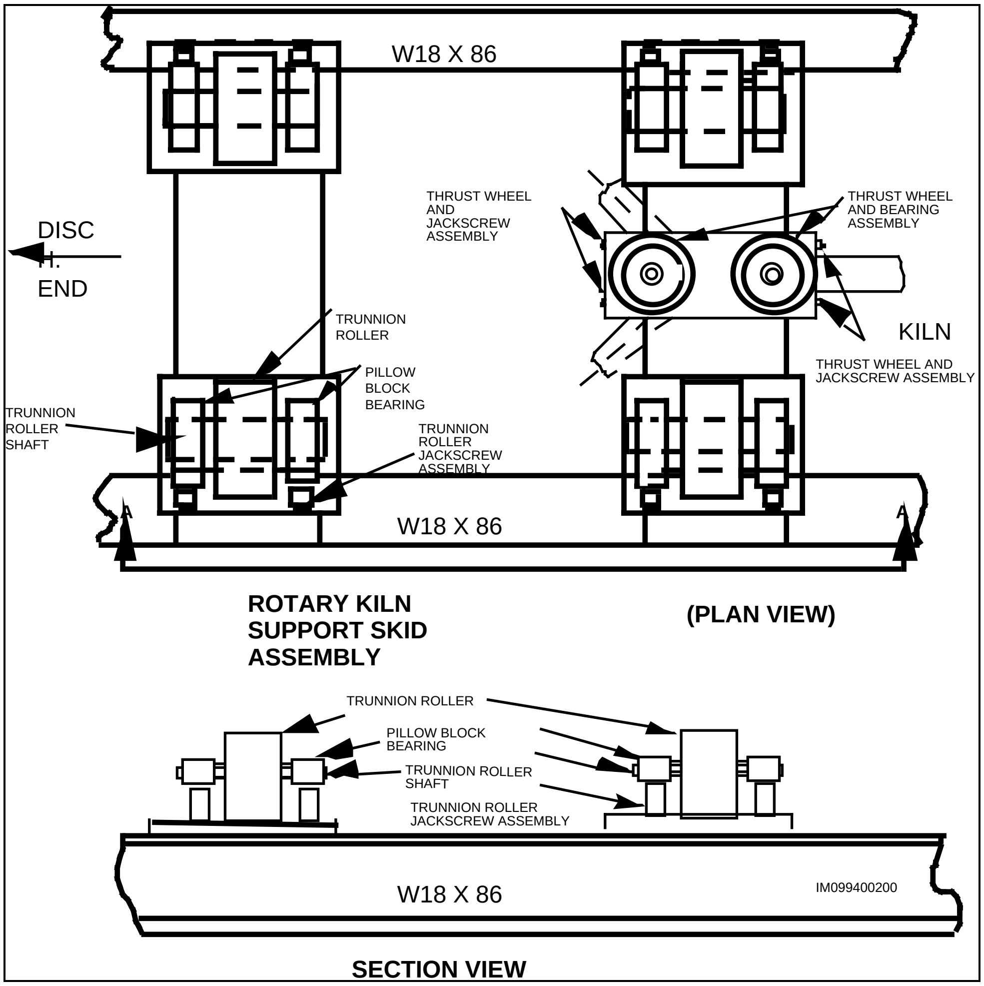


Figure 5 Rotary Kiln Support Assembly

RK Seals

The kiln is supplied with seals where the RK cylinder meets the feed and discharge heads. The seals are designed to allow rotation of the RK cylinder while preventing combustible, radioactive, and/or hazardous gas leakage as well as air in-leakage. The seals are sliding contact type seals. The fixed portions of the seals are connected to the stationary feed and discharge heads. The rotating portions of the seals are connected to the RK center cylinder. A pneumatic seal ring provides for thermal expansion and seal wear. A shroud encloses the seals as a backup feature and is connected to the building exhaust fan which maintains the shroud at a negative pressure. A refractory dam is provided at each end of the RK inside diameter to minimize ash collection at the seal locations. Two seal cooling fans provide cooling air to the lower section of the seals. The Seal Air Cooling Fans are axial direct-drive types with a rated air delivery of less than 150 standard cubic feet per minute (scfm). The area between the seals on the RK feed head is connected to the Solids Combustion Air Fan and the area between the seals on the RK discharge head is connected to the SCC Fuel Oil Combustion Air Fan. Exhaust from the seal shrouds is directed to the building exhaust system via three pipe lines at the bottom of each shroud. (See Figure 6 *Rotary Kiln Seal Assembly)*

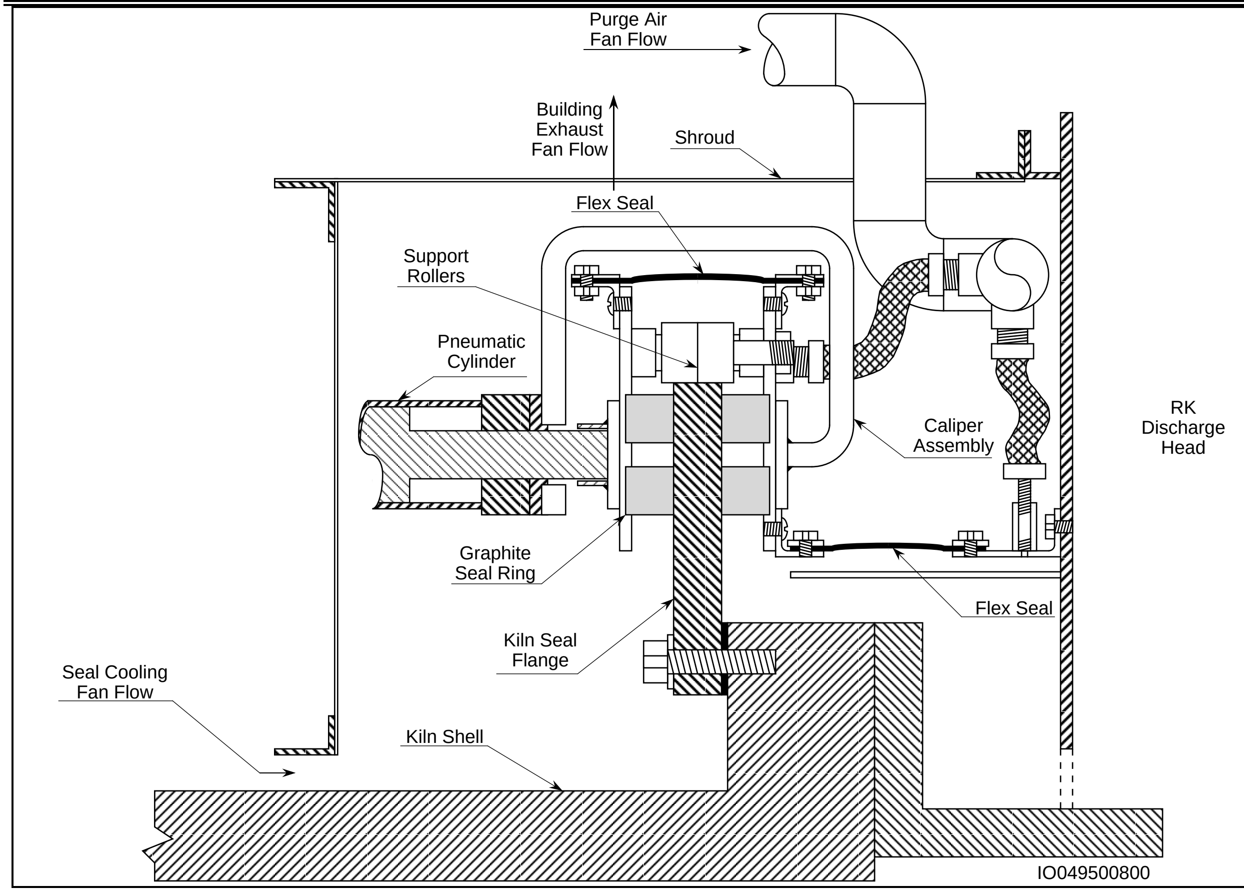


Figure 6 Rotary Kiln Seal Assembly

RK Drive

The kiln is rotated through a pinion drive-girth gear arrangement. The girth gear is attached to the RK cylinder and the pinion gear is part of the RK drive assembly. The pinion gear meshes with the girth gear to rotate the RK. The pinion gear is driven by a shaft coupled to a gear reducer (main gear box) and a DC variable speed motor. The 20 horsepower (hp) motor is rated at 500 volts (VDC), 32.9 amps and rotates at 1750 revolutions per minute (rpm). The drive is designed to rotate the cylinder in the range of 0.2 to 2 rpm by adjustment of the DC motor speed. Presently the speed is set to maintain 0.55 RPM.

A diesel engine auxiliary drive can be utilized to drive the pinion gear through an intermediate gearbox. The diesel is used in the event of a loss of electrical power to the DC electric motor. The diesel motor has a 12 volt starter and a constant speed governor rated at 1650 rpm. The diesel is a single cylinder, direct fuel injection, naturally aspirated (ventilated by suction) air cooled engine. The diesel drive rotates the RK at a constant 0.2 rpm.

NOTE: DCS indication of Rotary Kiln Drive motor amps and the local indication of Rotary Kiln Drive motor amps will be different due to different sensing points.

There is also a hand-operated inching mechanism mounted on the inching gearbox that is used for maintenance or in the event of an emergency when the diesel cannot be operated. The incinerator must be shut down if both the main DC and diesel drives are lost. The inching mechanism is used to allow an even cool down of the RK if the DC and diesel drives are not operable.

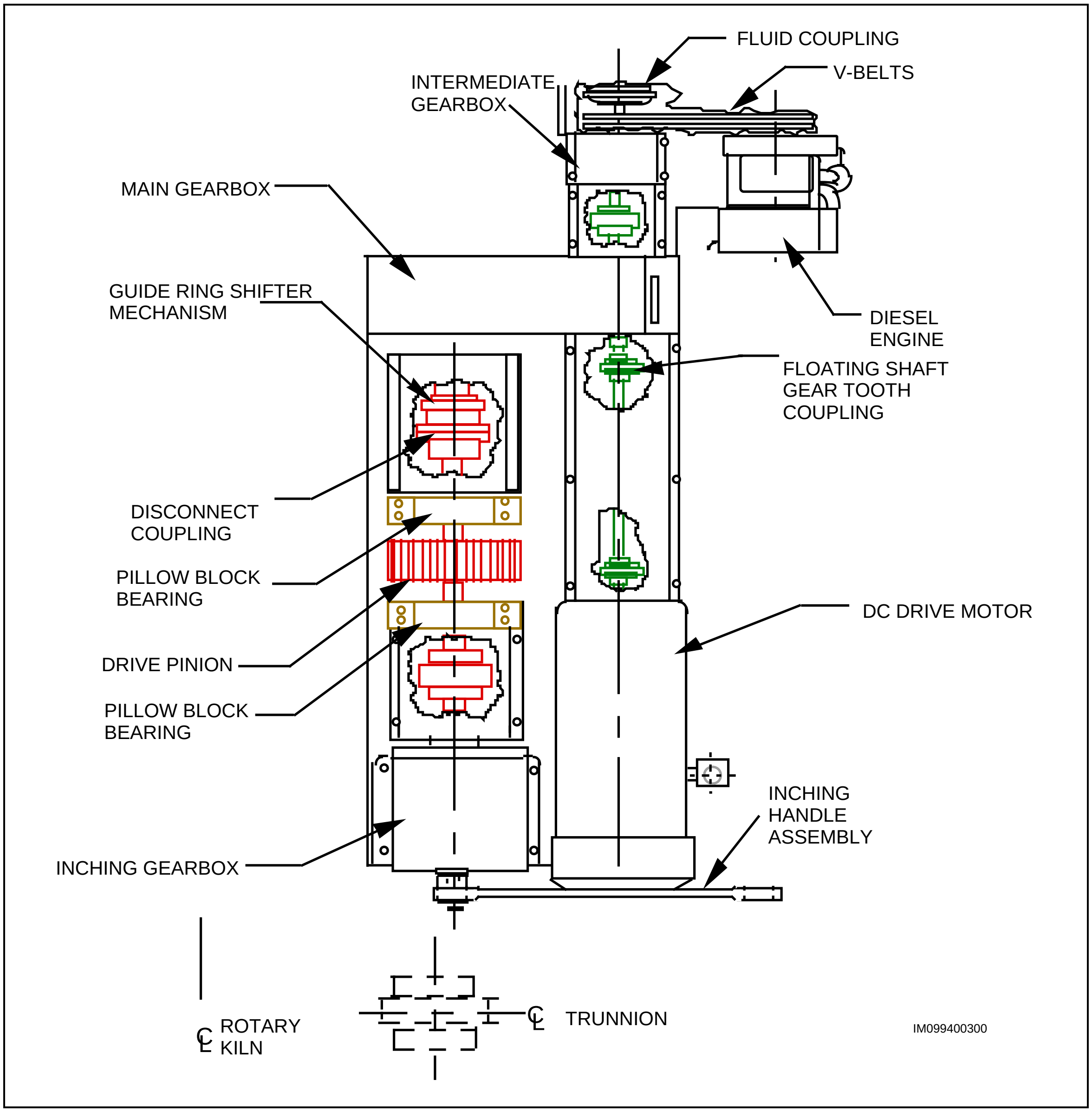


Figure 7 Rotary Kiln Drive Assembly

SCC

Secondary Combustion Chamber

The purpose of the SCC is to ensure complete combustion of the waste initially introduced into the RK. It also serves as the primary combustion chamber for ROW.

The SCC is a vertically oriented vessel, 21' 8" long with a 7' internal diameter, a 9" refractory lining, and a 2" layer of insulation. It has two burner ports located 180° opposite of each other. The burner port located on the south side utilizes fuel oil to warm-up the SCC and maintain it at operating temperature. The burner port located on the north side is utilized to incinerate the ROW. A 7' inside diameter refractory lined opening at the inlet to the SCC connects the combustion chamber to the RK discharge head. A 4' inside diameter refractory lined opening at the outlet of the SCC connects the combustion chamber to a crossover duct. The crossover duct directs the SCC combustion (flue) gas to the Off-Gas system's quench vessel. Stainless steel expansion joints, which are capable of axial and lateral movement, are located at both ends of the crossover duct.

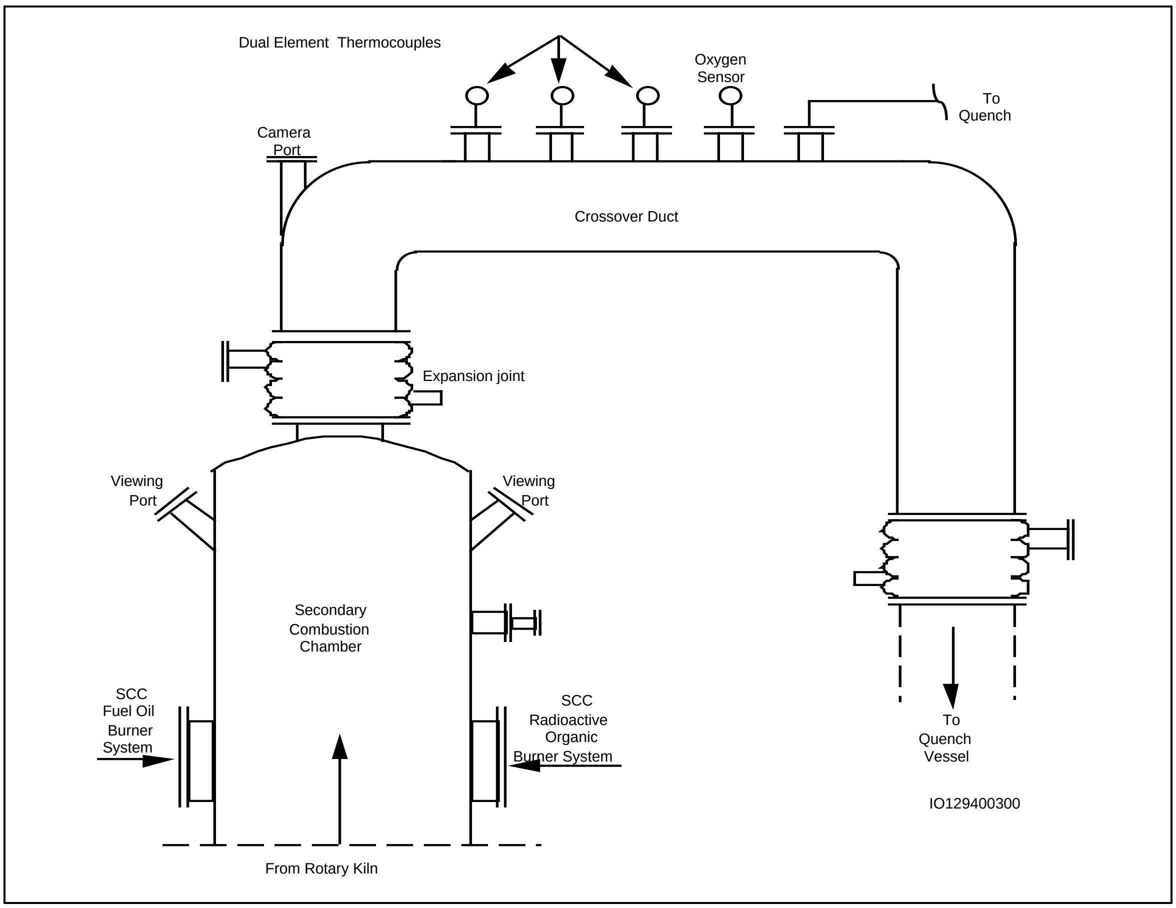


Figure 8 Secondary Combustion Chamber (SCC)

A low pressure steam purge is supplied to the expansion joints to minimize deposit buildup which could restrict their movement. The steam purge also helps to stabilize the temperature of the expansion joint which will minimize the thermal cycling. A camera port in the crossover duct provides for viewing of the Secondary Combustion Chamber from the control room.

Combustion gases between 1450°F and 1840°F leave the RK discharge head and are directed to the SCC. Gas temperatures are then increased to between 1650°F and 1962°F in the SCC through the operation of the Fuel Oil burner and, if in service, the ROW burner. Residence time for combustion gas in the SCC is 2 seconds at a maximum velocity of 1,200 feet per minute (fpm). By controlling the volumetric flow rate (cfm) of the combustion gas, the velocity, and therefore the residence time, of the gas can also be controlled. To maintain at least a 2 second gas residence time in the SCC, gas flow rate at the SCC exit is limited to 21,500 Actual Cubic Feet per Minute (acfm) at between 1650°F and 1962°F.

The SCC vertical vessel has two local viewing ports. The camera port (on the crossover duct) is provided with cooling air supplied from plant air and purge air (from the Purge Air Fan). The two viewing ports are provided with purge air to reduce carbon buildup. Openings for the radioactive organic and fuel oil burners are located near the bottom (inlet) of the vessel.

NOTE: Viewing ports may be damaged if Purge Air is lost. Cameras may be damaged if plant air is lost.

BMS

The Burner Management System provides a central location for the controls necessary for operation of the RK and SCC burners, fans, and control valves for testing and in an emergency situation. An emergency situation requiring local control of the Burner system has not been identified and procedures for local control of the Incinerator have not been written to date.

Burner control includes air purging of the system to remove combustibles before ignition is attempted, ignition sequences for all fuels and wastes, firing rates, temperature control, O_2 control and normal and safety shutdowns.

The BMS control panel is located next to the RK remote skids. The panel consists of a two section cabinet with pushbuttons, selector switches, controllers and indicators and their associated components. The BMS interfaces with the Distributed Control System (DCS), Programmable Logic Controller (PLC) and the individual component controls and their respective interlocks and permissives to allow personnel to operate the RK and SCC in a safe and efficient manner. The individual BMS instruments and controls are discussed in detail in the applicable sections of this guide.

Support

Air Fans

The RK Solids, RK Blended, RK Fuel Oil, SCC Fuel Oil, and SCC ROW Combustion Air Fans supply combustion air to their respective burners via pipelines. The fan motors are 60 hp. Each burner fan has the capacity to provide all of the combustion air required for burner operation in addition to a 35% excess. The Solids Combustion Air Fan has the capacity to provide all of the combustion air required for solids incineration in addition to a 100% excess. Each fan has a silencer at the fan intake to control noise levels. Backdraft dampers are provided downstream of each fan to prevent a backflow of gases in the event of an incinerator pressure spike. The RK Solids Combustion Air, SCC ROW Combustion Air, and Fuel Oil Combustion Air fans air flow also goes through intake filters, located upstream of the silencer, to remove any particulate matter.

FAN NAME	CAPACITY (SCFM)	CAPACITY (LB./HR.)	STATIC DISCHARGE PRESSURE ("WC)
RK FANS			
Combustion Air Fan RK Solids	5,645	25,400	26
Combustion Air Fan RK Blended Waste Burner	1,700	7,650	15 (6) *
Combustion Air Fan RK Fuel Oil	2,450	11,025	14 (6) *
Tertiary Air Fan	1,450	6,525	6
SCC FANS			
Combustion Air Fan Fuel Oil	2,100	9,450	26 (20) *
Combustion Air Fan Rad. Org.	1.215	5,470	28 (20) *

Table 2 RK and SCC Combustion Air Fan Capacities

* - Total static discharge pressure includes all line component losses. The values in parentheses account for pressure drops through the burner assemblies.

The Tertiary Air Fan supplies air to the SCC by way of the RK discharge head if the SCC temperature high limits are exceeded and other means of reducing temperature have failed. The fan motor is a 60 hp, 460 V, three phase, 60 Hz with a rated capacity as shown in Table 2, *RK and SCC Combustion Air Fan Capacities*. The Tertiary Air Fan is located near the RK discharge head.

The Purge Air Fan provides a supply of fresh air to purge areas where combustible/explosive gases may accumulate. The fan is utilized to prevent a buildup of these gases in the feed housings of the Solid Waste Feed System. The fan is also used to provide cooling air to the incinerator camera ports, the Ram Feed housing and flame scanners. The fan is located on grade level below the Solid Waste Feed housings.

Induced Draft (ID) fans, provided as part of the Off Gas system, help to maintain the incinerator and Off Gas System at a vacuum. This negative pressure prevents the release of combustible, radioactive and/or hazardous gases to the environment. The Solid Waste Feed System housings and Ash Handling backhoe housing are maintained at a vacuum by connections to the Off Gas System Quench Vessel.

Burner/Nozzle Assemblies

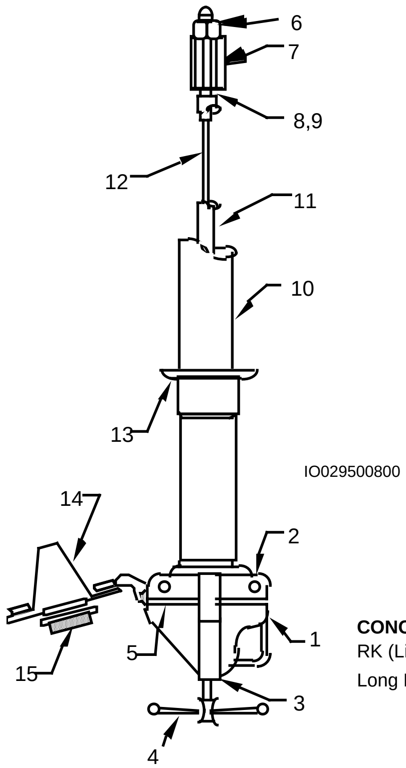
(See Figure 8, *Fuel Burner Assembly*) The burners and nozzle assemblies are similar in construction. Each assembly has three feed lines. These feed lines provide fuel, either fuel or oil or blended waste, atomizing steam to break up the fuel stream and provide a swirling mist pattern at the gun tip that can be easily ignited/evaporated and efficiently burned, and sealing steam. The waste burner/nozzle guns can be removed for cleaning or maintenance while the incinerator is in operation. Sealing steam is used to prevent leakage while the burner/nozzle assembly is removed from the incinerator. Atomizing steam, directed between concentric tubes of the gun, prevents damage from the high temperature environment of the incinerator. Each waste burner gun, fuel oil feed gun, and the aqueous waste nozzle must be cooled with atomizing steam whenever the RK or SCC is above 1000°F. If atomizing steam is not available for a particular gun, that gun must be removed from the incinerator prior to exceeding 1000°F to prevent damage to the nozzle assembly. The BMS provides the safety interlocking and control for the burners.

NOTE: Burner sealing steam must be isolated whenever the burners are in place. If the sealing steam is left on erosion of the burner will result.

The local skids are provided with a connection from the steam system. This steam connection is used to purge the guns of residue or water accumulation.

Minimum turndown ratio's for the burners are specified in the Hazardous Waste Permit. The turndown ratio is an adjustment range based on maximum flow value. For example a burner with a maximum flow of 1000 gpm with a 10:1 turndown ratio can satisfactorily operate in the range of 100 gpm to 1000 gpm. The turndown ratios for the burners are as follows:

- RK Fuel Oil Nozzle 10:1
- RK Aqueous Waste Nozzle 10:1
- RK Waste Liquid Nozzle 4:1
- SCC Fuel Oil Nozzle 4:1
- SCC ROW Nozzle 4:1



ITEM	DESCRIPTION
1	FUEL/WASTE BODY
2	FUEL BODY RECEIVER
3	CLEVIS
4	CLEVIS HANDLE
5	GASKET (2 REQ'D)
6	FUEL/WASTE TIPS
7	SLEEVE
8	ATOMIZER
9	ATOMIZER BUSHING
10	GUIDE TUBE
11	STEAM TUBE
12	FUEL TUBE
13	HUB
14	PRESSURE SEAL
15	O'RING-PRESSURE SEAL (2 REQ'D)

Figure 9 Fuel Burner Assembly

Waste/Fuel Oil Skids

Remote and local skids are provided as a centralized location for controls, instruments, valves, and feed (metering) pumps associated with the waste/fuel oil systems. The local skid contains the SSOVs and the purging steam connections into the waste/fuel oil lines. The local skids are always located just upstream of the burner/nozzle gun. The remote skids contain valving, controls, instrumentation, and (where applicable) feed pumps. The remote skids are always located upstream of the local skids. The SCC has one common remote skid and two separate local skids associated with its burners. The RK has one common local skid and one common remote skid associated with its burners/nozzle. Part of the Aqueous Waste system is located on a section of remote skid adjacent to the main RK remote skid.

Burner Ignition

The Fuel Oil, Blended Waste, and ROW burners are provided with a propane supplied pilot for the initial light off of the main burner. The propane supply originates at a storage tank located north of the tank farm and is routed through the remote/local skids . The propane is ignited by a high voltage electrical arc ignitor. The ignitor looks and operates similar to a spark plug.

Flame Monitoring

Flame scanners are positioned at various locations to indicate flame presence. The flame scanners use an Ultraviolet (UV) monitor for detection of a flame. The flame scanner probes are positioned to view the burner flame path and signal a processing unit that has input to the BMS. Each burner utilizes two flame scanners to ensure ignition while waste/fuel oil is being injected. Loss of 1 flame scanner will initiate an alarm on the DCS. Loss of both flame scanners associated with a waste stream will cause the waste stream to be isolated. A flame scanner is also located in the feed ram housing of the Solid Waste Feed System. This flame scanner is utilized to detect a fire in the housing and indicate the need for actuation of the fire suppression system. The flame scanners associated with the burners are supplied with cooling air from the RK and SCC Fuel Oil Combustion Air Fans. The flame scanner in the Feed Ram housing is supplied with cooling air from the purge fan.

Power Supplies

Power to the incinerator is fed from 480V Motor Control Center (MCC) 4. Power for the fuel oil and waste transfer pumps at the Tank Farm is from 480V MCC 3. Power for the main incinerator drive motor is from MCC 8. Some of the incinerator loads are also fed from MCC 4. These loads include the forced draft fans and the pumps on the remote skids. Instrument power for the BMS comes from 120V Instrument Power Panel A. Instrument power for the Incinerator PLC/IO cabinets and the RK diesel control panel is from 120V Instrument Power Panel B.

Summary

- The major components associated with the incinerator are used for the operation of the RK, SCC, BMS and support systems
- RK major components include the kiln, drive and seals
- SCC major components are the burner assemblies
- BMS major components are the cabinets, controls and associated instrumentation
- Support systems major equipment includes fans, burner assemblies, skids, and flame monitoring

INSTRUMENTATION

Introduction

The instrumentation associated with the incineration system is designed to allow monitoring of the combustion process during startup, operation, and shutdown. Instrumentation associated with the process equipment is monitored by the DCS/PLC and BMS under normal operations. The BMS is controlled by a PLC which controls the RK and SCC burners. The control of the major system parameters is necessary to ensure a 99.99% Destruction and Removal Efficiency (DRE) by maintaining efficient combustion of the waste materials. A list of some of the common parameters and their associated instrument numbers is provided in Table 3, *Incinerator Instrumentation*.

WASTE STREAM	FEED FLOW	FEED PRESS	FEED TEMP	STEAM FLOW	STEAM PRESS
RAD ORGANIC WASTE	FI-2300 FT-2300	PT-2305 PC-2304 PG-2302 PG-2719	TG-2308	FT-2301 FG-2301	PT-2304 PG-2306 PG-2718
BLENDED WASTE	FI-1600 FT-1600 FG-1600	PT-1605 PG-1605 PG-1602 PG-1919	TG-1608	FT-1601 FG-1601	PT-1604 PG-1604 PG-1606 PG-1918
AQUEOUS WASTE	FI-2000 FT-2000	PT-2009 PG-2001 PG-2017	TG-2003	FT-2130	PG-2010
RK FUEL OIL	FI-1500 FT-1500 FG-1500	PT-1508 PG-1514 PG-1919	TG-1512	FT-1510 FG-1510	PT-1504 PG-1818
SCC FUEL OIL	FT-2200 FC-2200	PT-2208 PG-1919	TG-2209	FT-2201 FG-2201	PT-2204 PG-2207 PG-2618

Table 3 Incinerator Instrumentation

Legend

FI	Flow indicator	PG	Pressure gage
FG	Flow gage	PC	Pressure controller/indicator
FT	Flow transmitter	PT	Pressure transmitter
FC	Flow controller/indicator	TG	Temperature gage

ELO 3.4 **DESCRIBE** the following Incineration System instrumentation including indicator location (local or Control Room),m sensing points, and associated instrument controls:

a. Burner - Nozzle instrumentation
   1) mass flow
   2) pressure and temperature
   3) flame scanners

b. RK - SCC instrumentation
   1) air flow
   2) solid waste flow
   3) pressure
   4) CO_2 - O_2
   5) seal cooling
   6) rotational drive
   7) temperature

c. Stack flow
d. Expansion joint steam purge pressure
e. Stack opacity
f. BMS

Liquid Burner/Nozzle Instrumentation

Liquid waste to the burner/nozzle is monitored for:

- Mass flow rate - a mass flow element and transmitter are located at the remote skids on the associated liquid waste piping. Mass flow rate (lb/hr) is indicated at the remote skid and is available through the DCS. The DCS compares the flow signal to the operator desired flow rate and adjusts the stroke of the feed pump as necessary to match the two.

  NOTE: The mass flow element measures flow rate by measuring the pressure drop across an orifice and adjusts the flow rate to mass flow rate by measuring the density of the flow and multiplying the flow rate by the density to arrive at mass flow rate (lb/hr).

- Pressure and temperature - pressure/temperature sensors and transmitters are located at the remote skids on the associated liquid waste piping. Pressure (psig) and Temperature (°F) indicate locally and on the DCS. High and low pressure/temperature alarms indicate on the DCS.

  NOTE: The most common pressure measuring device used at the CIF is the Rosemont Pressure Transmitter. A pipe from the process line leads to a flexible box called a diaphragm. Pressure in the diaphragm causes it to flex and expand. A variable capacitor is attached to the diaphragm and the output of the capacitor changes as the pressure changes. The affect of the changing capacitance on an electrical current is measured and correlated to pressure in the system.

Temperature is measured with an RTD (Resistance Temperature Detector) in systems that don't exceed 300 °F. The RTD uses a material that exhibits a change in resistance to an electrical current as the temperature of the material changes. Resistance is measured and correlated to temperature. Thermocouples are used in processes that exceed 300 °F. A thermocouple consists of two dissimilar metal wires joined to produce a thermal electromotive force (emf) when the junctions are at different temperatures. The measuring or hot junction is the end inserted in the medium where the temperature is to be measured. The reference or cold junction is the open end that is normally connected to the measuring-instrument terminals. The emf generated is a function of the difference in junction temperatures.

Fuel oil to the burners is monitored for:

- Mass flow rate - a mass flow element and transmitter are located at the RK and SCC remote skids associated fuel oil piping. Mass flow rate (Lb/hr) is indicated at the local skid and is available on the DCS controller/indicator in the control room.

- Pressure and temperature - pressure/temperature sensors and transmitters are located at the RK and SCC remote skids Pressure (psig) is indicated at the burner and remote skids and is available through the DCS.

Steam to the burner/nozzle is monitored for:

- Pressure and flow - flow/pressure sensors and transmitters are located at the remote skid. on the associated steam piping. Flow is indicated at the remote skid. Low flow alarms, indicating on the DCS, are fed from sensors on the remote skid. Pressure (psig) is indicated at the remote skid, on steam piping locally and is available through the DCS. High and low pressure alarms, indicating on the DCS, are fed from sensors on the remote skids.

NOTE: The most common flow element used at the CIF consists of an orifice with a Δp gauge that compares pressure before the orifice with pressure after the orifice. The pressure drop across the orifice is proportional to the flow through the orifice, which is the flow through the system.

The burners are monitored for:

- Presence of flame - flame scanners are provided, two for each burner. Scanners will input to the BMS control panel as well as to the DCS for indications and alarms. Waste to the burners will be shut off if no flame is detected. Only one flame scanner input is required to maintain flow to the burner.

RK and SCC Instrumentation

The RK and the SCC are monitored for:

- Exhaust gas temperature - thermowells and temperature transmitters are provided on the discharge head of the RK shell and on the crossover piping of the SCC. DCS alarms for high and high-high temperature are also provided.
- Exhaust gas oxygen (O_2) content - O_2 sensors are provided in the outlet gas paths in both the RK and the SCC. Sensors that measure the O_2 content input to the DCS alarms and transmit signals to adjust controllers for the fuel and air are provided as required.
- Exhaust gas combustibles - combustibles are measured in the same locations as the O_2 sensors. DCS alarms and controls are the similar to the O_2 alarms and controls.

The RK alone will be monitored for:

- Internal pressure - Kiln pressure is measured by a transmitter installed at the kiln discharge head. The pressure signal is sent to a control damper at the inlet to the scrubber. The RK combustion chamber is designed for a maximum internal pressure of 15 psig.
- Purge air at the feed head - a local pressure gauge gives an indication of the purge air flow to the RK. A DCS indication is also provided for status of the Purge Air Fan.
- Purge air at the discharge head - local pressure indications are provided for purge air pressure to the cameras.

Solids Combustion Air Flow

The Solids Combustion Airflow is measured by ΔP flow transmitter 1700 FT. The transmitter sends its signal to a flow controller for comparison to setpoint. The output of the controller is used to adjust the control valve (damper) at the outlet of the Solids Combustion Air fan. The signal from the transmitter is also used for the DCS indication and alarm.

Solids Combustion Air fan outlet damper position is monitored by position switch 1700WS. The switch provides an input to the BMS for the incinerator start permissive.

NOTE: ΔP is the symbol for delta pressure or differential pressure. The instrument takes two pressure measurements and compares the two measurements. The result is the difference between the two pressures.

In a system with a flowing medium a device to constrict flow, such as an orifice (a blank flange with a hole that is a smaller diameter that the process line) is placed between two sections of pipe. The process stream has to undergo an increase in velocity to maintain the mass flow rate through this constricted section and the energy to increase the velocity comes from the process pressure. When the process exits the orifice it undergoes another velocity change and slows down. Velocity energy is transformed into pressure and the mass flow rate remains constant.

However, due to inefficiencies in energy conversion, the pressure after the orifice is not as great as the pressure before the orifice (The energy difference is absorbed in the random kinetic energy of the process, or enthalpy and is measured as an increase in the temperature of the process.) The difference in entrance pressure and exit pressure is proportional to the flow through the system and is the basis for the ΔP flow element.

Solid Waste Flow

The solid waste flow rate (lb/hr) is measured as a 16 minute rolling average. The current average is indicated on the DCS on the Solids Flow Controller indicator 1702 HC-1. Rolling average refers to the concept of continuous updating based on the last 16 minutes of indicated flow rate. The 17th minute is dropped off and the latest indication is averaged in.

Tertiary Air Fan Flow

Tertiary airflow is measured by ΔP flow transmitter 1715 FT. The transmitter sends its signal to a flow controller for comparison to setpoint. The output of the controller is used to adjust the control valve (damper) at the outlet of the Tertiary air fan.

RK Pressure

RK discharge head pressure is measured by pressure transmitters 1724 PT-1, 1724 PT-2, and 1724 PT-3. The output of these three sensors is averaged and transmitted to the DCS by 1724 PT for display. Low (-2 INWC) and High (-.01 INWC) pressure alarms alert the operator to take appropriate actions. Local pressure indication is also provided by pressure gage 1711 PG.

RK CO/O2 Levels

The level of O_2 and combustibles (CO) is measured in the RK exit gas. DCS indicator 1710XG will provide the combustible level. A LO O_2/HI combustibles alarm will be activated if the O_2 level drops below 3.5 percent (3.5%). Interlock C216 shuts off Aqueous Waste, Liquid Waste, Solid Waste and Organic Waste. Operators should verify waste feed to the incinerator is stopped. A FAIL alarm indicates a problem with the sensor.

RK Seal Cooling

Each seal cooling fan discharge pressure is monitored by pressure switch 1725 PS or 1726 PS. The switches provide low discharge pressure alarms on the DCS.
The RK feed and discharge head seal shrouds are monitored for air flow by mass flow transmitters 1719 FT and 1718 FT, respectively. The transmitters provide indication as well as Low Flow and Low Low Flow alarm capability on the DCS. The transmitters also provide an input to the Shroud Purge Flow Low Low interlock.

Incinerator Temperature

The RK temperature is monitored by thermocouples 1705 T-1, 1705 T-2 and 1705 T-3, located at the RK discharge head. The thermocouples provide individual as well as average temperature indication on the DCS. The average temperature feeds the RK Temperature Controller, 1705 TC, as well as five temperature alarms.

The alarms are, Upscale Burnout Detection, Low Low Low Temperature, Low Low Temperature, Low Temperature, High Temperature, and High High Temperature. Temperature controller 1705 TC primarily controls fuel oil flow and fuel oil combustion air flow to the RK.

NOTE: "Upscale Burnout Protection" means that thermocouple failure is annunciated. When a thermocouple fails, the output of the device decreases to zero. However, the thermocouple is an input device to a circuit which analyzes the signal and provides an output signal which is proportional to temperature. A zero input from the thermocouple results in a 2500°F output signal, which is the setpoint for the alarm.

The SCC temperature is monitored by thermocouples 2404 T-1, T-2, and T-3, located at the crossover duct. The thermocouples provide individual, high select, as well as average temperature indication on the DCS. The average temperature feeds the SCC temperature controller 2404 TC. Temperature controller 2404 TC primarily controls fuel oil flow and fuel oil combustion air flow to the SCC.

The temperature transmitters also input to the DCS alarms Low Low Low Temperature, Low Low Temperature, Low Temperature, High Temperature, High High Temperature, and Upscale Burnout.

SCC Gas Flow

The volumetric flow rate of gas through the SCC is computed as an approximate value derived from the flow controllers for Combustion Air, Tertiary Air, Fuel Oil, Steam, Blended Waste, Aqueous Waste, ROW and Solid Waste. The value is then modified with a correction factor for the SCC average temperature and displayed on the DCS flow indicator 2405 FG.

SCC CO/O2 Levels

The CO and O_2 levels in the CIF are monitored by an O2/Combustible Gas Analyzer Transmitter, 2401 XT, for display on the DCS. The transmitter signal also feeds, a failure alarm, a high gas outlet alarm, and the O_2 level controller.

SCC and Quench Vessel Expansion Joint Purge Steam Pressure

The Low Pressure Steam System supplies an automatic pressure reducing valve with a manual bypass which provides steam at 6 psig to the SCC and Quench expansion joints. Steam is supplied as a continuous purge to provide cooling and cleaning of any deposits that may collect in the joint and restrict proper expansion. H-261-LS-PI-2406, Gauge, Pressure, Discharge LS-PV-2406 is the local pressure indication for the purge steam to the expansion joints. Due to the physical size of the piping to the expansion joints, this gauge typically reads 0 psig. This is not a problem as the purge mechanism relies on flow, not pressure to accomplish its purpose. A back pressure regulator is to be added to the purge line during the spring 1996 outage to provide an indication on the pressure gauge.

Incinerator Stack Opacity Monitoring

Opacity monitoring is a permit requirement. Opacity is essentially cloudiness or the presence of gases that refract light waves. The permit limit for opacity is 10%. The DCS provides an alarm at 10% opacity. There is no automatic shutoff of waste feeds but the associated Alarm Response Procedure provides steps for manual shutoff of the waste feed streams.

Opacity levels are measured by light beam attenuation. A regulated beam of light is passed through the gas stream going to the stack. The reflected light is measured on the other side . This is done using an opacity monitor mounted on the ducting downstream of the sample probe taps for the CO. The opacity monitor contains a paired transmitter and a receiver. The transmitter consists of:

- Lamp tungsten/halogen bulb that produces a beam that is transmitted across the gas stream. Glass fiber optic cables are used for span and calibration lines for the receiver.
- Rotating disk rotates at approximately 1 revolution per second and directs generated beam to receiver. The disk contains two holes with 0.090 inch apertures; one for transmission and one for timing (used for calibration and testing).
- Collimating used to focus and direct the generated beam to the lens receiver.
- Air purge connected to instrument air supply to keep coverglass cavity clean of dust and smoke residue to ensure accurate beam transmission and measurement.

The light beam generated from the transmitter is directed to the receiver. The receiver consists of:

- Air purge cavity similar to the cavity on the transmitter.
- Focusing lens similar to collimating lens on the transmitter, it is used to focus generated beam that has passed across the gas stream onto the receiver.
- Beam splitter used to direct 20% of the beam to the receiver amplifier and 80% of the beam to the receiver bulls-eye. A metallic coating is used to split the beam.
- Beam filters both a green filter and an infrared filter are used to attenuate the signal low and high wavelengths for the silicon cell of the receiver (an EPA requirement exists for the wavelength of the light beam).
- Silicon cell used to convert the light beam into an electronic signal. Because the current is so low, the output signal is amplified and directed to the receiver instrumentation.

Several other components are provided for beam calibration (i.e. bulls-eye, alignment microscope, zero adjust block, etc.), but these components are used mainly by Maintenance or E&I personnel.

RK Rotational Drive

(See Figure 9, *Rotary Kiln Diesel Drive Control Panel*)The auxiliary diesel drive engine is monitored for an overspeed condition (1815 rpm). A local diesel control panel provides indicators for engine running (green), low engine oil pressure (red) and high engine temperature (red). The engine fuel oil and lubricating oil levels are determined by dipsticks.

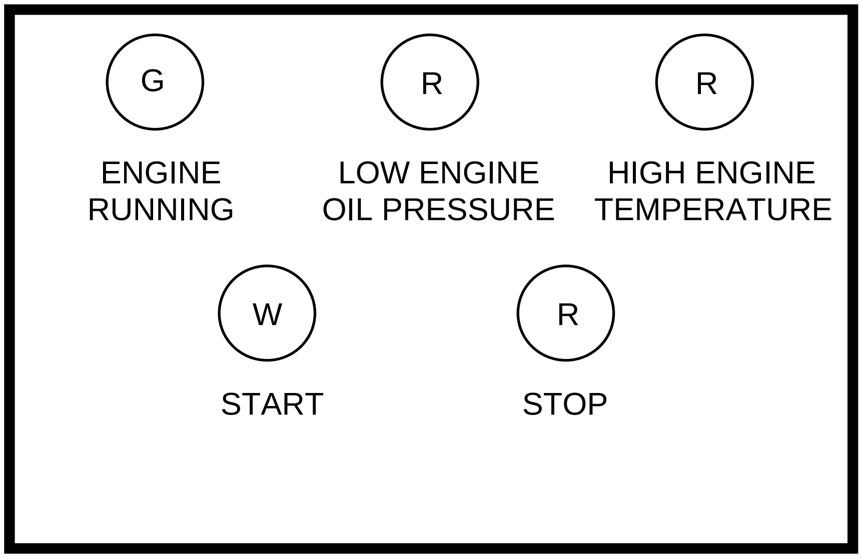


Figure 10 Rotary Kiln Diesel Drive Control Panel

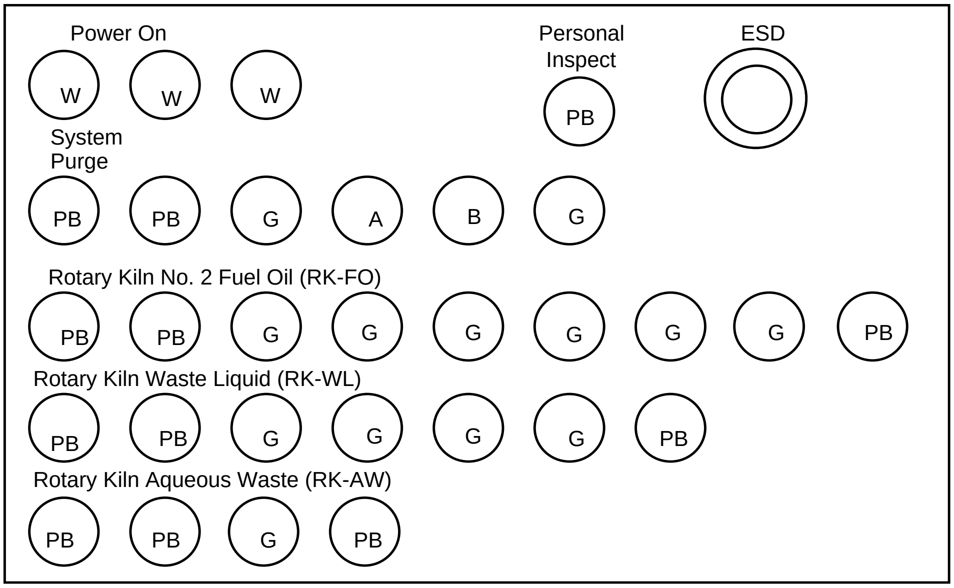
The RK rotational speed (RPM) is measured by speed transducer 1706 WT for display and Low speed alarm on the DCS.

The DC drive motor current is measured by device 1721 XT for high current alarm on the DCS.

Burner Management System (BMS)

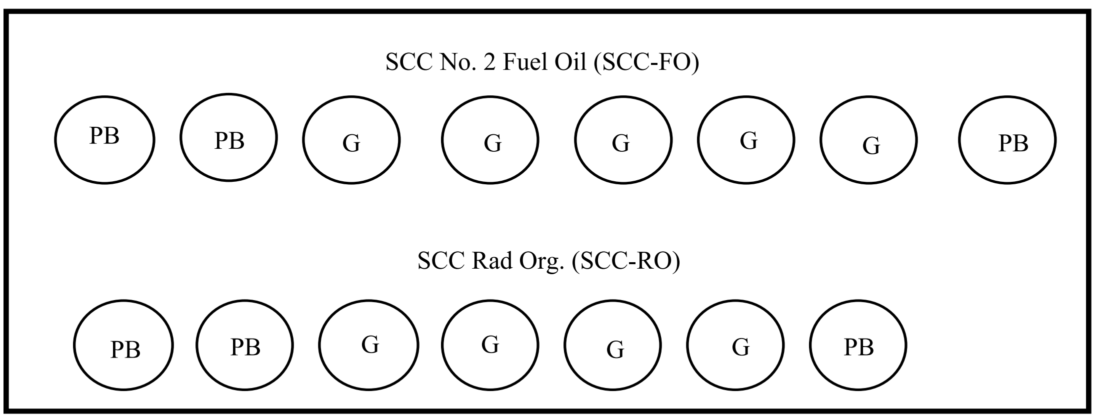
The BMS control panel houses the indications and controls associated with the RK and SCC burners. BMS monitors and controls the air purging (to ensure removal of combustibles) of each burner system prior to propane ignition. The BMS is also responsible for the ignition sequences for all fuels and wastes, firing rates, temperature control, O_2 control and normal and safety shutdowns. Figure 11, *BMS Local Control Panel Pushbuttons and Indications*, shows the instrumentation associated with the BMS.

NOTE: The Emergency Shut Down switch is a mushroom shaped switch that is mounted on one of the Burner Management System cabinet doors. The switch extends from the door and may be inadvertently actuated when the cabinet door is opened unless care is taken. Operators and other personnel working in the vicinity of this cabinet shall be aware that operation the ESD will shut down the Incinerator.



Legend

W - White Indicating Light
PB - Pushbutton Controller
B - Blue Indicatinglight
G - Green Indicating Light
A - Amber Indicating Light



Legend

PB - Pushbutton Controller
G - Green Indicating Light

Figure 11 BMS Local Control Panel Pushbuttons and Indications

Each indicator on the panel is described below.

NOTE: Burner Management System indication is also displayed on DCS.

Power On Lamps A, B and C **(*White*)**

Illumination indicates that each of the three phase control power feeds from the 120 VAC UPS are on.

Ready Light **(*Green*)**

The light indicates that the system is ready for start. The required conditions include the following:

- Rotary Kiln-Fuel Oil (RK-F.O.) Low Fire position
- RK-F.O. Low Low pressure OK
- RK-F.O. Atomizing (Atm) Steam Low Pressure OK
- RK-Blended Waste (RK-WL) SSOVs closed
- RK-F.O. SSOV closed
- RK-F.O. Steam Purge valve closed
- RK-F.O. burner gun in position
- RK Propane High High pressure OK
- RK Propane Low Low pressure OK
- RK-Aqueous Waste (RK-AW) SSOV closed
- Secondary Combustion Chamber-Fuel Oil (SCC-FO) Low Fire position
- SCC-F.O. Atm Steam Low Differential Pressure (ΔP)
- SCC-FO SSOV closed
- SCC-Rad. Organic (SCC-RO) SSOV closed
- SCC-F.O. Steam Purge valve closed
- SCC-F.O. burner gun position OK
- SCC Propane pressure not High High
- SCC Propane pressure not Low Low
- Emergency Shutdown Device (ESD) not pushed
- Personal Inspection complete indicator illuminated

Limits Satisfied Light **(*Amber*)**

The light indicates that the required conditions have been met for a system purge. Requirements include all those for the "READY light in addition to the following:

- RK-F.O. Central Permissive
- SCC-F.O. Central Permissive
- RK-Solids Combustion Air Fan ΔP not Low
- SCC-F.O. Combustion Air Fan ΔP not Low
- RK-F.O. Combustion Air Fan ΔP not Low
- RK-F.O. Combustion Air Flow not Low Low
- SCC-FO Combustion Air Flow not Low Low
- Solids Combustion Air Fan Suction damper open
- Solids Combustion Air Fan Discharge damper open

System Purging Light **(*Blue)***

This light indicates that the system purge cycle is underway.

System Purge Complete Light **(*Green*)**

This light indicates that the system purge is complete and that the permissive is present to allow the ignition sequence to begin.

Rotary Kiln (RK) No. 2 Fuel Oil (F.O.)

RK-F.O. Pilot Gas On Light **(*Green*)**

This light indicates that the pilot gas valves are energized (open).

RK-F.O. No. 2 Oil On Light **(*Green*)**

This light indicates that the fuel oil SSOVs are energized.

RK-F.O. Flame On Scanner No. 1 Light **(*Green*)**

This light indicates detection of a flame by Scanner No. 1.

RK-F.O. Flame On Scanner No. 2 Light **(*Green*)**

This light indicates detection of a flame by Scanner No. 2.

(Each scanner may be energized by either the propane pilot or main burner flame, but should not detect flame from any other source.)

RK-F.O. Low Fire Released Light **(*Green*)**

This light indicates that the RK-F.O. control valve is released from its low fire startup position and is ready for modulation by the DCS.

Rotary Kiln (RK) "Blended" Waste Liquid (WL)

RK Ready For Waste Light **(*Green*)**

This light indicates that the conditions are satisfactory for waste burning. The conditions include the following:

- SCC Ready for Waste
- RK Temperature above 1400°F
- RK-F.O. or RK-Blended Waste burner on

RK-WL Pilot Gas On Light **(*Green*)**

This light indicates that the propane pilot gas valves for the Blended Waste burner are energized.

RK-WL Waste Liquid On Light **(*Green*)**

This light indicates that the Blended Waste SSOVs are energized (open).

RK-WL Flame On Scanner No. 1 Light **(*Green*)**

This light indicates detection of a flame by Scanner No. 1.

RK-WL Flame On Scanner No. 2 Light **(*Green*)**

This light indicates detection of a flame by Scanner No. 2.

Rotary Kiln (RK) Aqueous Waste (AW)

RK-AW Aqueous Waste On Light **(*Green*)**

This light indicates that the AQW nozzle SSOVs are energized (open).

Secondary Combustion Chamber (SCC) No. 2 Fuel Oil (FO)

SCC-F.O. Pilot Gas On Light **(*Green*)**

This light indicates that the propane pilot gas valves for the SCC F.O. burner are energized (open).

SCC-F.O. No. 2 Fuel Oil On Light **(*Green*)**

This light indicates that the SCC fuel oil burner valves are energized (open).

SCC-F.O. Flame on Scanner No. 1 Light **(*Green*)**

This light indicates that scanner No. 1 detects a flame.

SCC-F.O. Flame on Scanner No. 2 Light **(*Green*)**

This light indicates that scanner No. 2 detects a flame.

SCC Ready For Waste Light **(*Green*)**

This light indicates that the conditions have been met for the SCC waste permissive. The conditions include the following:

- SCC-FUEL OIL **or** SCC-RO burner on
- SCC Temperature between 1650°F and 1962°F

Secondary Combustion Chamber (SCC) Rad Org (RO)

SCC-RO Pilot Gas On Light **(*Green*)**

This light indicates that the propane pilot gas valves for the SCC Radioactive Waste burner are energized (open).

SCC-RO Rad Org. On Light **(*Green*)**

This light indicates that the Radioactive Organic Waste SSOVs are energized (open).

SCC-RO Flame On Scanner No. 1 Light **(*Green*)**

This light indicates that the scanner No. 1 detects a flame.

SCC-RO Flame On Scanner No. 2 Light **(*Green*)**

This light indicates that the Scanner No. 2 detects a flame.

Summary

- Instrumentation is used for monitoring and control of the incineration process
- Instrumentation for the RK and SCC includes monitoring for temperature, pressure, gas flow, CO and Oxygen content, and fuel flow
- BMS instrumentation is used for local and remote indication to ensure safe operation of the incineration process.

CONTROLS, INTERLOCKS, AND LIMITS

Introduction

The incineration process is controlled by simultaneously and automatically adjusting fuel oil flow, atomizing steam flow, solid/liquid waste flow, combustion air flow and incinerator pressure. This control process will ensure the safe, efficient incineration of the waste product by maintaining it at a predetermined temperature for a minimum period of time (residence time). Operation of the incineration system is monitored and controlled by the Distributed Control System (DCS)/Programmable Logic Controllers (PLC) and the BMS.

The combustion process byproducts are maintained within the incinerator system and offgas system by operating under vacuum conditions. The negative pressure within the system is controlled by balancing the waste, fuel oil and combustion air flow with the ID fan operation, scrubber quench process and damper position.

The flue gas flow rate through the system and therefore the residence time of the combustion products is controlled by adjusting the differential pressure (ΔP) within the system. The system ΔP is controlled by adjusting dampers within the system. The residence time of the ash within the RK, is controlled by adjusting the rotational speed (rpm) of the RK.

Incinerator temperatures are affected by the waste and excess air flows, but controlled by regulating the fuel oil flow rates. Incinerator temperatures and residence times are controlled to assure complete combustion.

ELO 3.6 **EXPLAIN** how the following Incineration System equipment is controlled in all operating modes or conditions to include control locations (local or Control Room), basic operation principles of control devices, and the effects of each control on the component operation:

a. Rotary Kiln
b. RK drive assemblies
c. RK seals
d. RK shrouds
e. Secondary Combustion Chamber
f. Burner Management System
g. Support Systems:

1) air fans
2) burner - nozzle assemblies
3) Waste - fuel oil skids
4) Burner ignition
5) flame monitoring
6) electrical distribution system
7) steam system

RK Controls

The main process parameter controlled in the RK is temperature. Combustion air, waste feed, fuel oil feed, atomizing steam, and purging air are all controlled variables based upon the temperature value. Any temperature increase as measured by the temperature detectors on the RK discharge head will cause modulation and cycling of the feed, air and steam controls which results in decreased flow rates of waste and fuel oil feed. Conversely, any temperature decrease below the design operating temperature setpoint will result in an increase in the affected process variables.

RK Temperature Control

The RK temperature controller 1705 TC (utilizing average RK discharge head temperature), provides inputs to the solids air flow controller 1700 FC, the fuel oil flow controller 1500 FC, the fuel oil air flow controller 1807 FC, the waste liquid flow controller 1600 FC and the waste liquid air flow controller 1917 FC. RK temperature is mainly used to control fuel oil flow rate to the RK fuel oil burner, but will also reduce waste stream flow rates if temperatures become excessive. Fuel oil flow rate will be automatically decreased in response to high RK temperatures, however when temperature decreases, the fuel oil flow rate will not automatically increase. Flow rate must be manually adjusted to increase temperature. Combustion air flow rates will follow the fuel oil/waste flow rates, if the controls are in AUTO.

Minimum air flow rates will also decrease fuel flows.

If an excessive high temperature value (1735°F) is reached in the RK, the following actions will be initiated by the DCS:

- Fuel oil flow rate is lowered by the DCS to low fire setting.
- If temperature is still high, the Blended Waste feed pump is adjusted to lower its flow rate.
- Solid combustion air flow rate is increased by the DCS.
- The solid feed rate is decreased.

If the RK temperature reaches a preset low value (1400°F), the operator will be notified by an alarm to manually increase the blended or solid waste flow rate to raise the temperature.

During an extended idling period (no waste incineration), the RK and SCC temperature is maintained at about 1000°F. If the temperature is below a LO-LO level, the control room operator is alerted by an alarm to control the temperature at about 1000°F. A LO-LO-LO alarm will result in a shutdown of the incineration system.

RK Pressure Control

There are three pressure transmitters, H264-1704-PT-1, H264-1704-PT-2, H264-1704-PT-3, installed at the RK discharge head to monitor the RK internal pressure. The pressure transmitters provide an input to adjust the damper H-261-OGS-FCD-1704, Damper, Off Gas Quench to Separator, downstream of the quench vessel, to maintain a negative RK pressure.

RK Speed and Auxiliary Drive Control

RK speed of rotation is measured by speed transmitter 1706 WT. The transmitter sends a signal to the DCS. The signal is input to the RK remote speed controller/indicator 1706WC. The controller adjusts the speed of the drive motor through a transducer, 1706WR.

A panel for operation of the auxiliary diesel drive for the RK is located on the south side of the auxiliary drive diesel. The panel includes a pushbutton for starting and stopping the diesel drive engine.

RK Fuel Oil Burner- Fuel Oil, Air, Steam Control

The RK fuel oil controller and the RK combustion air controller interact with the RK temperature controller 1705 TC to control the fuel oil and combustion air ratio. The flow of fuel oil and combustion air are adjusted by the fuel oil controller and the combustion air controller in response to controller 1705 TC.

Pressure transmitters installed in the steam and fuel oil lines signal the DCS steam controller. Based on the pressure of the fuel oil, the controller adjusts the steam pressure to match the fuel oil pressure to a maximum of 100 psig.

RK Solid Waste and Combustion Air Control

The operator selects desired rate of solid waste addition the DCS. The DCS controls the addition of between 1-3 boxes to the RK and the dwell (delay) time between additions. If the RK temperature controller 1705 TC indicates that excessive temperatures have been reached, the solids feed rate controller setpoint will be modified as necessary to reduce the temperature.

The RK Solid Waste combustion air flow is adjusted by modulating the fan's "discharge" air flow damper. The air flow is modified as necessary to maintain the required excess air as sensed by the RK exit O_2 from controller 1710 XC.

RK Blended Waste Burner-Waste, Air, and Steam Control

The operator selects the desired (blended) waste liquid flow rate on the DCS. The DCS compares the actual flow rate to the desired flow rate and the blended waste feed pump stroke is adjusted as necessary to match the signal. Combustion air flow is adjusted as necessary to maintain at least 25% excess air. Atomizing steam to the burner is controlled at a constant 120 psig.

If the RK temperature controller 1705 TC indicates that excessive temperatures have been reached, the blended waste flow rate and combustion air controller setpoints will be modified as necessary to reduce the temperature.

RK AQW Nozzle-Waste and Steam Control

The operator selects the desired aqueous waste flow rate on the DCS. The DCS compares the actual flow rate to the desired flow rate and the aqueous waste feed pump stroke is adjusted as necessary to match the signals. Atomizing steam to the nozzle is controlled at 120 psig.

RK Oxygen (O2) and Combustibles Control

The level of O_2 and combustibles at the RK discharge head are measured by an O_2/combustibles sensor. The O_2 and combustibles (in units of equivalent CO) content are provided to the DCS and controller 1710 XC. Controller 1710 XC provides input to the solids combustion air controller 1700 FC which will then modulate the solids air fans damper as necessary.

SCC Controls

The main process parameter controlled in the SCC is temperature. ROW feed, combustion air, fuel oil feed, atomizing steam, and purge steam are all controlled variables based upon the temperature value. Any temperature increase as measured by the temperature detectors on the SCC discharge head will cause an associated modulation and cycling of the feed, air and steam controls which results in decreased flow rates of ROW and fuel oil feed. Conversely, any temperature decrease below the design operating temperature setpoint will result in an increase in the affected process variables.

Controls for the waste feed, fuel oil and combustion air are discussed in detail in the applicable student guides listed in the Description section of this guide.

SCC Temperature Control

The SCC temperature controller 2404 TC (utilizing high and low SCC outlet temperature), provides inputs to the tertiary air flow controller, fuel oil flow controller, fuel oil combustion air flow controller, ROW flow controller and ROW combustion air flow controller.
The SCC gas exit temperature is primarily controlled by modulation of fuel oil. Fuel oil flow to the SCC No. 2 fuel oil burner is controlled to maintain the SCC exit temperature at 50°F above the low setpoint of 1650°F. The tertiary air fed into the RK discharge head also helps to control the SCC temperature. The tertiary air flow controller in the DCS modulates the air flow control valve of the fan to maintain SCC flue gas temperature at the controller setpoint. If the SCC temperature reaches the LO setpoint, the following automatic actions will be initiated:

- No. 2 fuel oil flow is increased gradually.
- Tertiary fan will be shut off if it is on.
- If the exit gas temperature is still low at maximum fuel oil feed rate, an alarm is activated for the operator to manually increase the ROW feed rates.

If an excessive high temperature value (2012°F) is reached in the SCC, the following actions will be initiated by the DCS:

- No. 2 fuel oil flow is gradually decreased to the minimum turndown ratio of the burner (SCC Fuel Oil Burner turndown ratio is 4:1).
- If the temperature is still high, the ROW feed pump feed rate is reduced.
- Tertiary fan damper is adjusted to increase tertiary air flow as long as the O_2 level in the RK is above 3.5% vol.

An interlock, C205, SCC RO Flow Rate High, is also associated with the ROW flow/Air ratio control.

SCC Fuel Oil Burner- Fuel Oil, Air, Steam Control

The SCC fuel oil controller and the SCC combustion air controller interact with the SCC gas exit temperature controller to control the flow of fuel oil and the "fuel/air" ratio. The flow of fuel oil and combustion air are adjusted by the fuel oil controller and the combustion air controller in response to the temperature controller, which uses the SCC gas exit temperature as the primary control variable.

Pressure transmitters installed in the steam and fuel oil lines signal the DCS steam controller. Based on the pressure of the fuel oil, the controller adjusts the steam pressure to match the fuel oil pressure to a maximum of 100 psig.

SCC Rad. Organic Liquid and Air Ratio Control

The operator selected ROW flow rate is compared to the actual flow rate. The ROW feed pump stroke is then adjusted as necessary to match the signals.

Combustion air flow is adjusted as necessary to maintain at least 25% excess air. Atomizing steam to the burner is controlled approximately 30 psig above ROW pressure. If the SCC temperature controller indicates that excessive temperatures have been reached, the ROW flow rate and combustion air controller setpoints will be modified as necessary to reduce the temperature. If the SCC temperature is too high, an override is provided to reduce the ROW flow and increase the combustion air flow.

SCC Oxygen (O_2)Control

The level of O_2 and combustibles at the SCC outlet are monitored using a gas analyzer. The information gathered by the analyzer is used for gas flow rate calculations and records. Alarms are provided for LO O_2/HI CO level and sensor failure.

Burner Management System (BMS) Controls

Each burner is controlled by the Burner Management System (BMS). The main function of the BMS is to provide the safety interlocking and control of the burners to prevent an unplanned/uncontrolled ignition or an explosion in the incinerator. The BMS control logic includes purge, pre-light, fuel safety, startup, and shutdown logic. The BMS contains equipment for indication and control of burners in the RK and the SCC. The BMS is operated from the DCS. In an emergency, the BMS can be operated locally using panel mounted controls and indications. An emergency situation requiring local control of the Burner system has not been identified and procedures for local control of the Incinerator have not been written to date.

System Stop/Reset Pushbutton

Causes an immediate programmed shutdown of the incinerator system including all burners, fans and pumps. Atomizing (cooling) steam for burner nozzle tips will remain on until temperature falls below 1000 °F.

Personal Inspection Complete Pushbutton

Pushbutton is pushed when the startup checks have been performed. Activation of the control lights an indicator, enables the System Start pushbutton, and starts a four hour timer for the startup. If system conditions do not permit a startup within four hours, the controls must be reset and the startup must be performed from the beginning.

System Purge

Start System Purge Pushbutton

Starts the system purge sequence. The RK and the SCC must be purged with combustion air before an ignition sequence can begin. This is done to remove any combustibles and gases remaining in the incinerator that could cause an explosion when a burner is initially ignited. Purge air is provided by the Solid Waste Combustion Air Fan. The sequence requires a reset before purge can be repeated. Reset can be from "System", "RK-FO" or "SCC-FO". The sequence includes the following:

- Monitor ready light (Pushbutton is inactive if light is not illuminated)
- Start fans (SCC-FO, RK-FO, Solids, Seal Cooling Fan)
- Start FO pump
- Start purge relay
- Open solids waste combustion air fan dampers timed purge (400 sec.)
- System Purge Complete
- Purge valid timer (maintains purge validity for 6.5 minutes. If ignition sequence is not started within 6.5 minutes, the system must be repurged)

Rotary Kiln (RK) No. 2 Fuel Oil (FO)

RK-FO No. 2 Fuel Oil Stop Pushbutton

Stops the kiln fuel oil burner. Resets the system steam purge relay and timer to permit another purge cycle. Will not stop any fans or pumps.

RK-FO No. 2 Oil Start Pushbutton

Starts the kiln fuel oil burner ignition sequence which includes the following:

- Starts the ignition timer. During the 10 seconds this timer is activated the:
- pilot gas (propane) vent valves close
- Propane valves on remote and local skids open
- Ignition transformer energized creating ignition spark
- Pilot Ignition trial
    - Initiates 10 Second Timer
    - Flame Scanners Are Bypassed
    - Ignition Transformer De Energized
    - Propane Valves Remain Open
    - Atomizing Steam Valves Open Unless Already Open (Atomizing Steam Valves Will Be Open Already If SCC temperature is above 1000°F)
- Main burner ignition trial
    - Initiates 10 second timer
    - Opens liquid waste Safety Shutoff Valves (SSOV's)
    - Shuts Propane valves
    - After the 10 second timer times out, fuel oil control valve is released from low fire position

NOTE: Fuel oil start pushbutton is not interlocked with combustion air fans. There are no interlocks with combustion air fans. The only interlock with combustion air dampers is associated with the purge operation. When the Purge function initiates, the Combustion air fans output dampers open to the full open position regardless of the previous position.

The ignition trial is performed to ensure a flame is produced within the ten second interval. This prevents any accumulation of unburned fuel in the incinerator (a fire or explosion hazard) in the event that the burner does not light off.

RK-FO Steam Purge Pushbutton

Shuts down the RK-FO burner and steam purges (cleans) the oil gun. The propane pilot is ignited and the combustion air valve fails open for this operation. A 400 second timer automatically shuts off the purge. The operator should plan on purging the oil gun unless an immediate restart is planned. The steam purge also cleans a substantial portion (approximately 4 feet) of the fuel line. This may require several ignition trials to refill the fuel pipe.

Rotary Kiln (RK) Waste Liquid (WL)

RK-WL Waste Liquid Stop/Reset Pushbutton

Stops the kiln waste liquid burner, fan and feed pump. Will also stop the steam purge sequence and reset the steam purge timers

RK-WL Waste Liquid Start Pushbutton

Starts the kiln waste liquid burner ignition sequence. Permissives (limits) for the sequence include the following:

- Monitor RK-WL limits satisfied
- Start fan
- Start feed pump
- Pre-ignition test of scanners
- 10 second pilot ignition trial
- 10 second burner ignition trial
- Interrupt (turn off) pilot

RK-WL Steam Purge Pushbutton

Shuts down the kiln waste liquid burner and steam purges (cleans) the burner gun. The propane pilot is ignited and the combustion air valve fails open. The sequence is automatically stopped by a 400 second timer. The combustion air fan is also shut off.

Rotary Kiln (RK) Aqueous Waste (AW)

RK-AW Aqueous Waste Stop/Reset Pushbutton

Shuts off the AQW nozzle and feed pump. Will also stop the steam purge sequence.

RK-AW Aqueous Waste Start Pushbutton

Starts the AQW feed pump and opens the SSOVs.

RK-AW Steam Purge Pushbutton

Shuts off the AQW nozzle and feed pump and starts the steam purge of the nozzle gun. A timer stops the steam purge.

Emergency Shutdown (ESD) Mushroom Head Switch

Shuts down all RK and SCC functions, pumps, burners and fans, by removing power from PLC output modules. Emergency Shutdown function can only be initiated at the Emergency Shutdown Switch on the BMS or the Emergency Shutdown Switch on the Critical Alarm Panel in the Instrument Control Room (ICR) or by toggling switch D-2 on Point Tag Display INC1709E-1. (Reset is switch D-1).

NOTE: BMS permissive trips do not remove power from PLC output modules.

Secondary Combustion Chamber (SCC) No. 2 Fuel Oil (FO)

SCC-FO No. 2 Fuel Oil Stop/Reset Pushbutton

Closes the SCC fuel oil burner SSOV. Resets the steam purge relay. Stops SCC-FO steam purge. Will NOT stop combustion air fans or pumps.

SCC-FO No. 2 Fuel Oil Start Pushbutton

Starts the SCC-FO ignition sequence to include the following:

- Starts the ignition timer. During the 10 seconds this timer is activated the:
  - Propane valves on remote and local skids open
  - Ignition transformer energized creating ignition spark
- Pilot Ignition trial
  - Initiates 10 second timer
  - Flame scanners are bypassed
  - Ignition transformer de energized
  - Propane valves remain open
  - Atomizing Steam valves open unless already open (atomizing steam valves will be open already if SCC temperature is above 1000°F)
- Main burner ignition trial
  - Initiates 10 second timer
  - Opens liquid waste Safety Shutoff Valves (SSOV's)
  - Shuts Propane valves
  - Releases fuel oil control valve from low fire position

NOTE: Fuel oil start pushbutton is not interlocked with combustion air fans. There are no interlocks with combustion air fans. The only interlock with combustion air dampers is associated with the purge operation. When the Purge function initiates, the Combustion air fans output dampers open to the full open position regardless of the previous position.

SCC-FO Steam Purge Pushbutton

Shuts down the SCC-FO burner and steam purges the gun. The propane pilot is ignited and the combustion air valve fails open. A timer automatically shuts off the steam purge.

Secondary Combustion Chamber (SCC) Rad Org (RO)

SCC Rad Org Stop Pushbutton

Shuts down the SCC-RO burner, combustion air fan and feed pump. Also stops the steam purge sequence.

SCC Rad Organic Start Pushbutton

Starts the SCC-RO ignition which includes the following:

- Start combustion air fan and feed pump
- Monitor RO Low pressure, combustion air low ΔP
- Perform pre-ignition test of scanners
- 10 second pilot ignition trial
- 10 second main burner ignition trial
- Interrupts (turns off) pilot

SCC-RO Steam Purge Pushbutton

Shuts down the SCC-RO burner and steam purges the gun. The propane pilot is ignited and the combustion air valve fails open. A timer automatically shuts off the steam purge and combustion air fan.

ELO 3.5 **INTERPRET** the alarms listed in Table 9, Incineration System alarms, including the conditions causing alarm actuation and the basis for the alarms.

ELO 3.7 **DESCRIBE** the interlocks associated with the following Incineration System equipment to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary:

a. Interlock System Permissive
b. Incinerator general permissive interlocks
c. AQW, BW, FO, ROW pump interlock
d. combustion air
e. solids flow
f. RK temperatures
g. SCC temperatures
h. Emergency off
i. Mandatory off
j. CO - O_2
k. RK drive
l. purge complete
m. N_2 supply low
n. Tertiary air
o. fuel oil combustion air

Interlocks

Interlocks are provided throughout the Incinerator System to ensure safe, efficient and coordinated operation of the equipment. A list of the interlocks that cause automatic shutdowns is provided in Table 4, *Incinerator Emergency Shutdown Conditions*. Some of the major interlocks and their operation are discussed as follows:

Incinerator System Permissive

Many interlocks are used as input for the Incinerator System permissive C215. The system permissive signal is an output signal from the DCS/PLC to the BMS. The BMS input is hardwired to the four burner control relays (RK Fuel Oil, RK Waste Liquid, SCC Fuel Oil, SCC ROW). The BMS uses the permissive for the following:

- RK Fuel Oil Burner
- RK Waste Liquid Burner
- RK Waste Liquid Combustion Air Fan
- RK Aqueous Waste Nozzle
- RK Solids Permissive
- SCC Fuel Oil Burner
- SCC ROW Burner
- SCC ROW Combustion Air Fan
- Purge sequence starting

A listing of the major incinerator general permissive interlock numbers and a brief description are provided below.

- G38 - Steam supply pressure must not be at or below the low setpoint
- G40 and G43 - Automatic Transfer Switches (ATSs) 1 and 2 must be in the normal position for providing backup electrical power
- H3 - Fire must not be detected in the incinerator area by the Fire Detection and Alarm System (FDAS)
- C050 - RK pressure must not be at or below the low setpoint
- C051 - RK pressure must be below the High High setpoint
- C052 - SCC temperature not be at or above the High High setpoint
- C066, C135, and C195 - Ram feed pressure must not be low unless requesting nitrogen or water snuffing
- C071 - kiln feed fire door not open for more than five minutes
- C046 and C212 - RK rotation speed must not be Low if RK temperature is above the Low Low Low Low setpoint

The listed conditions will **automatically** initiate an Incinerator BMS Permissive Trip. If any of the listed conditions are found during incinerator operations and an automatic shutdown **did not** occur, the operators should **manually** initiate an emergency shutdown in accordance with 261-SOP-INC-05, *Incinerator Emergency Shutdown*.

CONDITION	DCS POINT TAG DISPLAY NUMBER	DCS POINT TAG DISPLAY NAME
Emergency Fire Water to Offgas Quench Valve OPEN	OGQ4001E-1	OGQ EMERGENC FIRE WATER
Emergency Service Water to Offgas Quench Valve OPEN	OGQ4005E-1	OGQ EMERGENC PROCESS WTR
Loss of Offgas Quench Recirculation Pumps No. 1 and No. 2	OGQ3103E-1	OGQ RECIRC PUMPS CTRL
Loss of all three Induced Draft Fans	OGE3505E-1	ID FAN #1
	OGE3506E-1	ID FAN #2
	OGE3513E-1	ID FAN #3
High-High Stack Exhaust CO of 125 ppm	3501XA-1 indicated by OGE3501X-1	OFFGAS STACK CO LEVEL
Actuation of Fire Protection System in Fire Alarm Zone 3	6504XA indicated by 6502XA-1	FIRE ALARM ZONES 1-4
Actuation of Fire Protection System in Fire Alarm Zone 5 or 6	6506XA indicated by 6506XA-1	FIRE ALARM ZONES 5-8
High-High temperature of 1832°F in the RK	1705TA-5 HIGH HIGH RK TEMP indicated by INC1705TC-2	RK TEMP ALARMS
High High Cyclone pressure of -1.0 INWC\ (5 sec time delay)	3207PA-1HIGH HIGH CYCL PRESSURE as indicated by OGS3207PA-1	OGS CYCLONE PRESS CTRL
High-High Inlet Offgas Scrubber Temperature of 210°F	3002TA-2 HIGH HIGH OGS TEMP indicated by OGS3002T-1	OGS INLET TEMPERATURE
Low-Low Feed RK Head Purge Air Flow of 950 lbs/hr OR Low-Low Discharge Head Purge Air Flow of 950 lbs/hr	1718FA RK FEED HEAD SHROUD AIR indicated by INC1718FC-1 OR 1719FA DISC HEAD SHROUD AIR indicated by INC1719FC-1	RK FEED HEAD SHROUD AIR/ RK DISC HEAD SHROUD AIR
	1719FA LOW LOW SHROUD AIR indicated by INC1719F-1	RK DISC HEAD SHROUD AIR
High-High SCC Temperature of 2012°F	2404TA-4 HIGH HIGH SCC TEMP indicated by INC2404TC-2	SCC TEMP ALARMS
Low Instrument Air Pressure of 75 psig	5800PA LOW INST AIR PRESS indicated by IA5800P-1	INSTRUMENT AIR PRESS
Low Steam Supply Pressure of 230 psig	5854PA LOW PLANT STM PRESS indicated by MST5855P-1	MAIN STEAM PRESS/TEMP

Table 4 Incinerator BMS Permissive Trips

CONDITION	DCS POINT TAG DISPLAY NUMBER	DCS POINT TAG DISPLAY NAME
ATS Transfer Switch	EMERGENCY ATS 1 as indicated by EEP5400W-1	ATS #1 STATUS
	EMERGENCY ATS 2 as indicated by EEP5400W-1	ATS #2 STATUS
Low Air Flow in the Ram Feed enclosure of 200 scfm	SWF6259E-1	RAM ENCLOSUR PURGE FAN
Ram Feed Housing flame indicated	6256XA FLAME IN RAM FD ENC indicated by SWF6265T-1	RK RAM FEED HOUSING TEMP
Kiln Firedoor open for five minutes or longer	6254WE-2 OPEN as indicated by SWF6254E-1	RK FEED FIRE DOOR STATUS
RK Rotation/Speed Low for 5 minutes or greater	1706WA SLOW RK ROTATION indicated by INC1706SC-1	RK SPEED CONTROLLER
RK Speed 0 RPM for ≥ 5 min. and RK temp ≥ 1000°F	1703WA SLOW RK ROTATION indicated by INC1706SC-1	RK SPEED CONTROLLER

Table 4 Incinerator BMS Permissive Trips

Aqueous Waste Feed Pump

The Aqueous Waste feed pump is adjusted from the flow controller, 2000 FC. The High Waste Liquid Flow interlock, C202, will prevent pump operation if the High Flow switch, 2000 FS, is activated.

Blended Waste Feed Pump

The Blended Waste feed pump is adjusted from the flow controller, 1600 FC. The High Waste Liquid Flow interlock, C203, will prevent pump operation if the High Flow switch, 1600 FS, is activated. 1600 FS set point is 385 lb/hr.

Fuel Oil Pump

The fuel oil summary flow transmitter, 1807 FT-4, provides a signal to the High switch, 1807 WS. The High switch sends a signal to activate interlock C209 which permits operation of the second fuel oil pump to meet demand.

Rad Organic Feed Pump

The Rad Organic Waste feed pump is adjusted from the flow controller, 2300 FC. The High Rad Organic Flow interlock, C205, will prevent pump operation if the High Flow switch, 2300 FS, is activated. If the demand for Rad Organic exceeds the initial operator adjusted setpoint on the flow controller, 2300 FC, the secondary pump is activated by the PLC through High Flow switch 2707 WS and the interlock C210.

Solids Combustion Air Fan (C201)

The Solids Combustion Air Flow is interlocked with the operation of the solid and liquid waste streams. A low solids combustion air flow as measured by the flow element 1700 FT will back down the flow rate of solids fed to the incinerator. Output from the temperature controller 1705 TC, waste liquid loading station 1710 HC and the O_2 controller 1702 XC are used to determine the setpoint for the solids combustion air flow.

Solids Flow Rate Control (C218)

The solids flow rate controller, 1702 HC-1, is interlocked with the DCS/PLC controls from the Solid Waste Handling System. Flow control rates to the RK are controlled by preprogrammed design requirements for batches of solid waste containers as well as results from testing and monitoring performed in the Solid Waste Handling System.

The solids waste flow rate is measured as a 16 minute rolling average and operates the timer for the flow rate measurement, 1702 FC.

RK Temperature Low Low Low (C213)

The RK Temperature Low-Low-Low interlock C213 is interlocked through the BMS with the steam valves for the RK waste burners and nozzle and the fuel oil burner. Interlock is actuated by 1705 TS-1 at 1000°F

RK Temperature Low Low (C048)

The RK Temperature Low-Low interlock C048 is interlocked through the BMS with the steam valves for the RK waste burners and nozzle and the fuel oil burner. Interlock is actuated by 1705 TS-2 at 1400°F.

SCC Temperature Low Low Low (C204)

The SCC Temperature Low-Low-Low interlock C204 is interlocked through the BMS with the steam valves for the SCC waste and fuel oil burners. Interlock is actuated by 2404 TS at 1000°F

SCC Temperature Low Low (C053)

The SCC Temperature Low-Low interlock C053 is interlocked through the BMS with the steam valves for the RK and SCC waste and fuel oil burners and nozzle. Interlock is actuated by 2404 TS-1 at 1962°F

Emergency Off (C043)

The Emergency Off Interlock C043 is interlocked with the fans, pumps, burners, nozzle and incinerator equipment through the BMS to prevent operation of associated equipment until the controller is reset.

Mandatory Off (C044)

The Mandatory Off Interlock C043 is interlocked with the fans, pumps, burners, nozzle and incinerator equipment through the BMS to prevent operation of associated equipment until the controller is reset.(See Table 5A "Individual Burner Mandatory Shutdown, "Table 5B "Solid Feed Mandatory Shutdown", and Table 5C "Complete Mandatory Shutdown".)

Shutdown shall be manually initiated if any of the following conditions occur:

Conditions which shall require one or more individual burner shutdown(s):

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
Blend Waste Fuel pressure ≤ 2.5 PSIG	BW1605P-1 261-ARP-BW1605PA	LOW RK WL PRESS"
Blend Waste Fuel pressure > 65 PSIG	BW1605P-1 261-ARP-BW1603PA-1	HIGH RK WL PRESS"
Rad Organic Waste Fuel pressure ≤ 18 PSIG	ROW2304PC-1 261-ARP-ROW2303PA	LO LO SCC ROW PRESS
Rad Organic Waste Fuel pressure ≥ 95 PSIG	ROW2303PA-1 261-ARP-ROW2303PA-1	HIGH SCC ROW PRESS
Combustion Air flow to Blend Waste Burner ≤ 0.068 INWC	BW1900FA-1 261-ARP-BW1900FA-1	LOW RK WL AIR FLOW
Combustion Air flow to Rad Organic Waste Burner ≤ 500 LB/HR	ROW2707FC-1 261-ARP-ROW2707FA	LOW SCC ROW C-AIR FLOW
Blend Waste Atomizing Steam pressure ≤ 80 PSIG	BW1604PC-1 261-ARP-BW1610PA	LO LO RK WL STEAM PRES
Blend Waste Atomizing Steam pressure ≥ 150 PSIG	BW1604PC-1 261-ARP-BW1610PA-1	HIGH RK WL STEAM PRES
Rad Organic Waste Atomizing Steam pressure differential ≤ 20 PSID	ROW2307PA-1 261-ARP-ROW2307PA	L-L SCC ROW STEAM ΔP
Rad Organic Waste Atomizing Steam pressure differential ≥ 40 PSID	ROW 2307PA-1 261-ARP-ROW2307PA-1	HI SCC ROW STEAM ΔP
Loss of Flame to Blend Waste Burner	BW1913E-1 261-ARP-BW1915XA or 261-ARP-BW1916XA	#1 FLAME FAILURE or #2 FLAME FAILURE

Table 5A Mandatory Shutdown Initiating Conditions

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
Loss of flame to Rad Organic Waste Burner	ROW2717E-1 261-ARP-ROW2715XA or 261-ARP-ROW2716XA	SCC ROW #1 FLAME FAILURE or SCC ROW #2 FLAME FAILURE
Rad Organic transfer line ≤ 1 PSIG	ROW0624PA-1 261-ARP-ROW0624PA-1	LOW OWST XFER PRESS
Low OWST Xfer Temp ≤ 55° F	ROW0624PA-1 261-ARP-ROW0625TA	LOW OWST XFER TEMP
Aqueous Waste Atomizing Steam pressure ≤ 80 PSIG	AW2012PA-1 261-ARP-AW2012PA	LOW RK AQW STEAM PRES
Aqueous Waste Atomizing Steam pressure ≥ 150 PSIG	AW2012PA-1 261-ARP-AW2012PA-1	HI RK AQW STEAM PRES

Table 5A Mandatory Shutdown Initiating Conditions (Cont.)

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
Functional failure of any Box Pusher or Feed Ram component including the hydraulic power unit.	N/A	N/A
Hydraulic pressure ≥ 650 PSIG	SWF6207P-1 261-ARP-SWF6207PA-1	HIGH HYD PRESSURE
Hydraulic pressure ≤ 5 PSIG	SWF6207P-1 261-ARP-SWF6207PA	LOW HYD PRESSURE
Hydraulic Accumulator pressure ≤ 50 PSIG	SWF6207P-1 261-ARP-SWF6211	"LOW ACCM PRESSURE
Nitrogen Snuffing System ≤ 350 PSIG	FP2105P-1 261-ARP-FP-2101PA	LOW $N_2$1 SPLY PRESS
Nitrogen Snuffing System ≤ 350 PSIG	FP2105P-1 261-ARP-FP-2104PA	LOW N_2 SPLY PRESS
"Box Present" beneath gate	SWF6258E-1	PHOTO EYE AT BX PUSH GATE
Flame detected in the Feed Ram Housing ≥ 180°F	SWF6265T-1 261-ARP-SWF6265TA	HIGH HOUSE TEMP
Failure of the Ash Removal System	AH6367E-1 261-ARP-AH6351EA	ASHOUT FAILURE
Failure of a D/G #1	EEP5401E-1 261-ARP-EEP5402EA	TROUBLE D/G #1
Failure of a D/G #2	EEP5405E-5 261-ARP-EEP5406EA	TROUBLE D/G #2

Table 5B Solid Feed Mandatory Shutdown

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
RK Fuel Oil pressure ≤ 5 PSIG	FO1501PA-1 261-ARP-FO1505PA-1	LOW LOW RK FO PRESSURE
SCC Fuel Oil pressure ≤ 30 PSIG	FO2200FC-1 261-ARP-FO2205PA	LOW LOW SCC FO PRESS
RK Fuel Oil pressure ≥ 55 PSIG	FO1501PA-1	HIGH RK FO PRESSURE
SCC Fuel Oil pressure ≥ 120 PSIG	FO2201PA-1	HIGH SCC FO PRESS
RK Steam pressure ≤ 30 PSIG	FO1506PA-1 261-ARP-FO1502PA	LOW RK STEAM PRESS
SCC Steam pressure ≤ 50 PSIG	FO2206PA-1 261-ARP-FO2202PA	LOW SCC FO STEAM PRESS
RK Steam pressure ≥ 110 PSIG	FO1506PA-1 261-ARP-FO1502PA-1	HIGH RK STEAM PRESS
SCC Steam pressure ≥ 150 PSIG	FO2206PA-1 261-ARP-FO2202PA-1	HI SCC FO STEAM PRESS
RK Combustion air flow ≤ 0.015 INWC	FO1800FA-1 261-ARP-FO1800FA	LOW LOW RK FO AIR FLW
SCC Combustion air flow ≤ 0.035 INWC	FO2600FA-1 261-ARP-FO2600FA	LO LO SCC FO AIR FLOW
RK exit temperature ≤ 1400°F	INC1705TA-1 261-ARP-INC1705TA-2	LOW LOW RK TEMP
RK exit temperature ≥ 1832°F	INC1705TA-1 261-ARP-INC1705TA-5	HIGH HIGH RK TEMP
SCC exit temperature ≤ 1600°F	INC2404TA-1 261-ARP-INC1705TA-1	LOW LOW SCC TEMP
SCC exit temperature ≥ 2012°F	INC2404TC-1 261-ARP-INC2404TA-4	HIGH HIGH SCC TEMP
Fire door fails to close	SWF6254E-1 261-ARP-SWF-	RK FEED FIRE DOOR STATUS
Loss of RK Oil Burner flame	FO1812E-1 261-ARP-FO1815XA	#1 FLAME FAILURE
Loss of RK Oil Burner flame	FO1812E-1 261-ARP-FO1816XA	#2 FLAME FAILURE
Loss of SCC Oil Burner flame	FO2612E-1 261-ARP-FO2615XA	#1 FLAME FAILURE
Loss of SCC Oil Burner flame	FO2612E-1 261-ARP-FO2616XA	#2 FLAME FAILURE

Table 5C Complete Mandatory Shutdown

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
Low Ram Housing purge flow ≤ 200 SCFM	SWF6259E-1 261-ARP-SWF6261FA	LOW PURGE FLOW
Low Kiln Seal Hood air flow ≤ 1000 LB/HR	INC1718F-1 261-ARP-INC1718FA-1	LOW DISCH SHROUD AIR
Low Kiln Rotation Speed ≤ 0.1 RPM	INC1706SC-1 261-ARP-INC1706WA	SLOW RK ROTATION
High Kiln Motor Current ≥ 21 amps	INC1721X-1 261-ARP-INC1721XA	HI RK MTR CURRENT
Low Incinerator room HVAC flow ≤ (Look up)	SAAM 5317F-1 261-ARP-5317FA	LO HVAC DUCT FLOW
Loss of a portion of the refractory as identified by Operator observation of local skin hot spots.	N/A	N/A
ROW transfer line leak	ROW09001L-1 261-ARP-ROW0900XA-1	OWST LEAK DETECTOR
Explosive Gas Monitor Alarms		
Combust Gas REG Unload'g ≥ 10% LFL*	HM6800X-1 261-ARP-HM6800XA-1	HI COMBUST GAS REG UL
Combust Gas Tank Farm #1 ≥ 10% LFL*	HM6800X-2 261-ARP-HM6800XA-2	HI COMBUST TK FM1
Combust Gas Reg. Unloading ≥ 10% LFL*	HM6800X-3 261-ARP-HM6800XA-3	HI COMBUST TK FM2
Combust Gas Tank Farm #3 ≥ 10% LFL*	HM6800X-4 261-ARP-HM6800XA-4	HI COMBUST TK FM3
Combust Gas Tank Farm #4 ≥ 10% LFL*	HM6800X-5 261-ARP-HM6800XA-5	HI COMBUST TK FM4
Combust Gas Tank Farm #5 ≥ 10% LFL*	HM6800X-6 261-ARP-HM6800XA-6	HI COMBUST TK FM5
Combust Gas Tank Farm #6 ≥ 10% LFL*	HM6800X-7 261-ARP-HM6800XA-7	HI COMBUST TK FM6
Combust Gas TK FRM Stack ≥ 10% LFL*	HM6800X-8 261-ARP-HM6800XA-8	HI COMBUST TK STK
Combust Gas RK Burn #1 ≥ 10% LFL*	HM6801X-1 261-ARP-HM6801XA-1	HI COMBUST GAS RK BN1
Combust Gas SCC Burn #1 ≥ 10% LFL	HM6801X-2 261-ARP-HM6801XA-2	HI COMBUST GAS SCC BN1
Combust Gas SCC Burn #2 ≥ 10% LFL*	HM6801X-3 261-ARP-HM6801XA-3	HI COMBUST GAS SCC B3

*Lower Flammability Limit

Table 5C Complete Mandatory Shutdown (Cont.)

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
Combust Gas RK REM Skid ≥ 10% LFL*	HM6801X-4 261-ARP-HM6801XA-4	HI COMBUST GAS RK RS
Combust Gas SCC REM Skid ≥ 10% LFL*	HM6801X-5 261-ARP-HM6801XA-5	HI COMBUST GAS SCC RS
Ashcrete CAM Rad	AM6608X-1 261-ARP-AM6608XA-1	HI ASHCRET CAM RAD
Box Handling N.Cam Rad	AM6600X-1 261-ARP-AM6600XA-1	HI BX HNDL N. CAM RAD

*Lower Flammability Limit

Table 5C Complete Mandatory Shutdown (Cont.)

RK High CO/Low O2 (C216)

The RK High CO/Low O_2 interlock C216 is interlocked through the BMS with the steam valves for the RK and SCC waste and fuel oil burners and nozzle. Interlock is actuated by 1710 XT at 3.5% O^2.

RK Drive Motor (C223)

The interlock is a permissive for C223, to start the RK Drive motor. If the current switch 1721 XS, is not High, the RK Drive Motor may be started.

Purge All Complete (C214)

The Purge All Complete Interlock C214 is interlocked with the Fuel Oil Control Valves and will not permit opening of the Low Fire Valve until the purge interval has elapsed.

Nitrogen Supply Pressure Low (C200)

The Nitrogen Supply Pressure Low Interlock C200 is associated with the Solid Waste Feed Nitrogen Fire Suppression bottles. The Kiln Feed Fire Door is interlocked to prevent operation if the Nitrogen Suppressive Supply Pressure is low.

Tertiary Air Fan (C207 and C208)

Input from the SCC temperature controller, 2404 TC, controls operation of Tertiary Air Fan. At High temperature, interlock C208 is actuated to permit starting the fan. When temperature returns to normal, interlock 207 actuates to allow shutting down the fan.

RK Fuel Oil Combustion Air (C041)

The RK Fuel Oil Combustion Air Fan Interlock C041 is interlocked to operate the fan when the fuel oil firing rate calls for excess air for the fuel oil flow rate. Flow rate setpoints are controlled by the Temperature Controller, Master Feed Flow Controller and the Excess Air Controller.

Limits

Incinerator Flow Rates

The maximum flow rates and heat value for waste and fuel oil designed for the RK and SCC are shown in Table 6, *Incinerator Flow and Heat Values*:.

Any combination of the above waste and fuel oil may be burned in the incinerator system with the maximum heat loads of the RK and the total system being the limiting factor.

	MAX. FLOW RATE (LB/HR)	AVERAGE HEAT VALUE (BTU/LB)
RK		
Solid Waste	900*	4,765
Liquid Waste	385	17,951
Aqueous Waste	950	2,200
Fuel Oil	543	19,200
SCC		
Rad. Organic Waste	191	18,000
Fuel Oil	462	19,200

Table 6 Incinerator Flow and Heat Values

*Minimum 90% combustible

Flue Gas Velocity

The residence time for the flue gas in the SCC is 2 seconds at a maximum velocity of 1,200 fpm. The residence time for the solid waste in the RK is between 30 to 90 minutes, based upon rotational speed. Table 7, *Incinerator Flue Gas Velocities*, show gas flow rates for the RK and SCC.

	MAXIMUM (Ft/Min)	MINIMUM (Ft/Min)
RK	600	N/A
SCC	1200	600

Table 7 Incinerator Flue Gas Velocities

Incinerator Temperatures

The maximum and minimum estimated exterior surface temperatures for the RK and SCC, at normal operating conditions are shown in Table 8 *Estimated Incinerator Surface Temperatures*.

	MAXIMUM (°F)	MINIMUM (°F)
RK SURFACE		
Feed Head	600	165
Rotating Cylinder	650	165
Discharge Head	275	165
SCC SURFACE		
Vertical Vessel	400	165
Crossover Duct	400	165

Table 8 Estimated Incinerator Surface Temperatures

The RK design exit temperature is between 1450°F and 1735°. The SCC exit temperature is maintained between 1650°F and 1962°F.

Other Parameters

During normal operation, the maximum heat load for the RK is 15 x 10^6 BTU/hr, and 18 x 10^6 BTU/hr for the entire incinerator system. These are Resource Conservation and Recovery Act (RCRA) permit limits, and combined feeds will be controlled to prevent exceeding them.

The maximum allowable temperature for the refractory in the RK and SCC is 2800°F. The maximum internal design pressure for the RK and SCC is 15 psig.

Limits for the rotational speed of the RK are in the range of 0.2 - 2 rpm

The incinerator system alarms and setpoints are listed in detail in Table 9, *Incinerator Alarms and Setpoints, below.*

INSTRUMENT NO.	DESCRIPTION	SETPOINT
RK ALARMS		
FO-1501 PS	Diff Press. Over 510 01 02 High	5 psid
MS-1502 PS	RK Fuel Oil Steam Pressure Low	5 psig
MS-1502 PS	RK Fuel Oil Steam Pressure High	110 psig
MS-1504 PS	RK Fuel Oil Steam Pressure Diff. Low	5 psid
FO-1505 PS	RK Fuel Oil Pressure Low Low	5 psig
FO-1505 PS	RK Fuel Oil Pressure High	200 psig
MS-1506 PS	RK Fuel Oil Steam Pressure Low Low	80 psig
MS-1506 PS	RK Fuel Oil Steam Pressure High	190 psig

Table 9 Incinerator Alarms and Setpoints

INSTRUMENT NO.	DESCRIPTION	SETPOINT
RK ALARMS		
FO-1508 PS	RK Fuel Oil Pressure Low	4 psig
FO-1509 TS	RK Fuel Oil Temperature Low	20° F
MS-1510 FS	RK Fuel Oil Steam Flow Rate Low	12.6 lb/hr
BRW-1600 FS	RK Waste Liquid Flow Rate High	385 lb/hr
MS-1601 FS	RK Waste Liquid Steam Flow Rate Low	20 lb/hr
BRW-1603 PS	RK Waste Liquid Press. Low Low	3 psig
BRW-1603 PS	RK Waste Liquid Pressure High	65 psig
MS-1604 PS	RK Waste Liquid Steam Pressure Low	90 psig
BRW-1605 PS	RK Waste Liquid Pressure Low	2.5 psig
MS-1607 PS	RK Waste Liquid Steam Pressure High	150 psig
BRW-1609 TS	RK Waste Liquid Temperature Low	10° F
MS-1610 PS	RK Waste Liquid Steam Pressure Low	100 psig
MS-1610 PS	RK Waste Liquid Steam Pressure High	135 psig
BRW-1613 TS	RK Waste Liquid Temp. High	200° F
BRW-1614 FS	RK Waste Liquid Pump Bypass Flow High	0.817 gpm
BRW-1616 PS	Diff Press Over 510 28 High	5 psid
FD-1700 FS	Solids Comb Air Flow Low (25%)	5000 lb/hr
INC-SAL-1703	RK Rotation Speed Low	0.1 rpm
INC-PAL-1704	Rotary Kiln Pressure Low	-2.0 INWC
INC-PAH-1704	Rotary Kiln Pressure High	-0.1 INWC
INC-PAHH-1704	Rotary Kiln Pressure High High	-0.01 INWC
INC-TSLL-1705-(C)	Rotary Kiln Temp. Low-Low-Low-Low	500° F
INC-TSLL-1705-(B)	Rotary Kiln Temp. Low-Low-Low	1000° F
INC-TSLL-1705-(A)	Rotary Kiln Temp Low-Low	1400° F
INC-TSL-1705	Rotary Kiln Temp Low	1450° F
INC-TSH-1705	Rotary Kiln Temperature High	1735° F
NC-TSHH-1705	Rotary Kiln Temperature High-High	1832° F
INC-TS-1705	Rotary Kiln Temp Sensor Fail	2500° F
INC-SSL-1706	Rotary Kiln Rotation Speed Low	0.1 rpm
BMS-From Either PB	Incinerator Has Been E-Stopped	N/A
INC-ASHL-1710	Rotary Kiln High CO (1000 PPM) or Low O^2	3.5% O^2

Table 9 Incinerator Alarms and Setpoints (Cont.)

INSTRUMENT NO.	DESCRIPTION	SETPOINT
	RK ALARMS	
INC-AS-1710	Rotary Kiln CO/O_2 Transmitter Failure	Actuate
BMS--From Either PB	Incinerator Has Been Shutdown	N/A
ME-1718 FS	RK Feed Head Purge Air Flow Low Low	950 lb/hr
ME-1718 FS 1	RK Feed Head Purge Air Flow Low	1000 lb/hr
ME-1719 FS	RK Discharge Header Air Flow L-L	950 lb/hr
ME-1719 FS 1	RK Discharge Head Air Flow Low	1000 lb/hr
INC-1721 XS	RK Drive Current High	21 amperes
INC-1725 PS	RK Seal Fan Pressure Low	1 INWC
INC-1726 PS	RK Seal Fan Pressure Low	1 INWC
FD-1800 FS	RK Fuel Oil Comb Airflow Low Low	1188 lb/hr
FD-1800 FS 1	RK Fuel Oil Comb Air Flow Low (25%)	1372 lb/hr
FD-1807 FS	RK Fuel Oil Comb Air Mass Flow Low	95%
BMS--From 1815XS	RK Fuel Oil Scanner #1 Flame Fail	N/A
BMS--From 1816XS	RK Fuel Oil Scanner #2 Flame Fail	N/A
INC-1820 WS	RK Fuel Oil Gun Position Failure	N/A
FD-1900 FS	RK Waste Liquid Comb Air Flow Low Low	1571 lb/hr
FD-1900 FS 1	RK Waste Liquid Comb Air Flow Low (25%)	1763 lb/hr
BMS--From 1915XS	RK Waste Liquid Scanner #1 Flame Fail	N/A
BMS--From 1916XS	RK Waste Liquid Scanner #2 Flame Fail	N/A
FD-1917 FS	RK Waste Liquid Comb Air Mass Flow Low	95%
INC-1920 WS	RK Waste Liquid Gun Position Failure	N/A
AQW-2000 FS	RK Aqueous Waste Mass Flow Rate High	950 lb/hr
AQW-2002 PS	RK Aqueous Waste Pressure Low-Low	1 psig
AQW-2002 PS	RK Aqueous Waste Pressure High	114 psig
AQW-2004 TS	RK Aqueous Waste Temperature Low	40° F
AQW-2008 PS	RK Aqueous Waste Steam Pressure Low	90 psig
AQW-2009 PS	RK Aqueous Waste Pressure Low	0.5 psig
MS-2011 PS	RK Aqueous Waste Steam Pressure Low Low	80 psig
MS-2011 PS	RK Aqueous Waste Steam Pressure High	150 psig
MS-2012 PS	RK Aqueous Waste Steam Pressure Low	80 psig
MS-2012 PS	RK Aqueous Waste Steam Pressure High	150 psig

Table 9 Incinerator Alarms and Setpoints (Cont.)

INSTRUMENT NO.	DESCRIPTION	SETPOINT
	RK ALARMS	
MS-2013 FS	RK Aqueous Waste Steam Flow Rate Low	40 lb/hr
INC-2019 WS	RK Aqueous Waste Gun Position Failure	N/A
AQW-2050 PS	Diff Press Over 510 25 High	5 psid
AQW-2056 FS	RK Aqueous Waste Pump Bypass Flow High	2 gpm
FO-2201 PS	Fuel Oil Diff Press Over 520 01 01 High	5 psid
FD-2514 PS	RK Solids Feed Fan dp Low	14.7 INWC
FD-2515 PS	RK Waste Liquid Fan dp Low	13.3 INWC
FD-2516 PS	RK Fuel Oil Fan dp Low	13.1 INWC
FD-2519 PS	RK Tertiary Air Fan dp Low	5.9 IN WC
PRIG-2806 PS	Propane to RK Pressure High	17 psig
PRIG-2806 PS	Propane to RK Pressure High-High	19 psig
PRIG-2808 PS	Propane to RK Pressure Low-Low	3 psig
PRIG-2808 PS	Propane to RK Pressure Low	5 psig
SCC ALARMS		
MS-2202 PS	SCC Fuel Oil Steam Pressure Low	50 psig
MS-2202 PS	SCC Fuel Oil Steam Pressure High	150 psig
MS-2204 PS	SCC Fuel Oil Steam Diff Press Low	20 psid
FO-2205 PS	SCC Fuel Oil Pressure Low-Low	30 psid
FO-2205 PS	SCC Fuel Oil Pressure High	120 psid
MS-2206 PS	SCC Fuel Oil / Steam Diff Press Low-Low	25 psid
MS-2206 PS	SCC Fuel Oil / Steam Diff Press High	35 psid
FO-2208 PS	SCC Fuel Oil Pressure Low	20 psig
MS-2210 FS	SCC Fuel Oil Steam Flow Rate Low	20 lb/hr
FO-2211 TS	SCC Fuel Oil Temperature Low	10° F
ROW-2300 FA	SCC Rad Organic Flow Rate High	400 lb/hr
MS-2301 FS	SCC Rad Organic Steam Flow Rate Low	14 lb/hr
ROW-2303 PS	SCC Rad Organic Pressure Low Low	20 psig
ROW-2303 PS	SCC Rad Organic Pressure High	95 psig
MS-2304 PS	SCC Rad Organic Steam Diff Press Low	20 psid
ROW-2305 PS	SCC Rad Organic Pressure Low	25 psig
MS-2307 PS	SCC Rad Organic / Steam Diff Press Low-Low	20 psid

Table 9 Incinerator Alarms and Setpoints (Cont.)

INSTRUMENT NO.	DESCRIPTION	SETPOINT
SCC ALARMS		
MS-2307 PS	SCC Rad Organic / Steam Diff Press High	40 psid
ROW-2309 TS	SCC Rad Organic Temp Low	10° F
MS-2310 PS	SCC Rad Organic Steam Pressure Low	25 psig
MS-2310 PS	SCC Rad Organic Steam Pressure High	110 psig
INC-2401 XT	SCC High Combustible or Low O_2	250 ppm CO / 3.5% O2
INC-2401 XT	SCC CO/O_2 Transmitter Failure	N/A
INC-2404 TS	SCC Temperature Low Low Low	1000° F
INC-2404 TS 1	SCC Temperature Low Low	1600° F
INC-2404 TS 2	SCC Temperature Low	1650° F
INC-2404 TS 3	SCC Temperature High	1962° F
INC-2404 TS 4	SCC Temperature High High	2012° F
INC-2404 TS 5	SCC Temperature Sensor Failure	2500° F
FD-2517 PS	SCC Fuel Oil Fan dp Low	24.2 INWC
FD-2518 PS	SCC Rad Organic Fan dp Low	25.3 INWC
FD-2600 FS	SCC Fuel Oil Comb Air Flow Low Low	1835 LB/HR
FD-2600 FS 1	SCC Fuel Oil Comb Air Flow Low (25%)	2080 LB/HR
FD-2607 FS	SCC Fuel Oil Comb Air Mass Flow Low	2150 LB/HR
BMS--FROM 2615XS	SCC Fuel Oil Scanner #1 Flame Fail	N/A
BMS--FROM 2616XS	SCC Fuel Oil Scanner #2 Flame Fail	N/A
INC-2620 WS	SCC Fuel Oil Gun Position Failure	N/A
FD-2700 FS	SCC Rad Organic Air Flow Low Low	844 LB/HR
FD-2700 FS 1	SCC Rad Organic Air Flow Low (25%)	950 LB/HR
FD-2707 FS	SCC Rad Organic Comb Air Mass Flow Low	800 LB/HR
BMS--FROM 2715XS	SCC Rad Organic Scanner #1 Flame Fail	N/A
BMS--FROM 2716XS	SCC Rad Organic Scanner #2 Flame Fail	N/A
INC-2720 WS	SCC Rad Organic Gun Position Failure	N/A
PRIG-2807 PS	Propane to SCC Pressure High	17 psig
PRIG-2807 PS	Propane to SCC Pressure High-High	19 psig
PRIG-2809 PS	Propane to SCC Pressure Low-Low	3 psig

Table 9 Incinerator Alarms and Setpoints (Cont.)

INSTRUMENT NO.	DESCRIPTION	SETPOINT
SCC ALARMS		
PRIG-2809 PS	Propane to SCC Pressure Low	5 psig
SUPPORT ALARMS		
SWF-6205 TS	Hydraulic. Reservoir Temperature High High	160° F
SWF-6207 PS	Hydraulic Accumulator Press Low	5 psig
SWF-6207 PS 1	Hydraulic Accumulator Press High	650 psig
SWF-6209 LS	RAM Feed Hydraulics Level Low	N/A
SWF-6211 PS	RAM Feed Hydraulic Press Low	50 psig
SWF-6256 XS	Flame in RAM Feed Enclosure	No Flame
PRGA-6261 FS	RAM Enclosure Purge Flow Low	200 scfm
SWF-6265 TS	RAM Feed Housing Temperature High	180°F
SWF-6266 PS	RAM Feed Housing Pressure Low	-0.5 INWC
SWF-6267 PS	Box Pusher Housing Pressure High	0.1 INWC
FP-2101 PS	Bottled Nitrogen Pressure Low	350 psig
FP-2104 PS	Bottled Nitrogen Pressure Low	350 psig
FP-2105 PS	Nitrogen Snuffing Pressure Low	5 psig

Table 9 Incinerator Alarms and Setpoints (Cont.)

Summary

- Controls are provided for the safe automatic operation of the incineration process
- Controls are provided on the incinerator for the operation of all the major equipment on both the RK and SCC as well as for the support equipment
- BMS controls are provided as safeguards to ensure safe and efficient operation of the incineration process
- Interlocks are used in the facility to prevent unsafe operation or initiate shutdown of equipment
- Limits are established for many of the incineration process parameters to ensure that the design requirements for the materials used in the facility are not exceeded

SYSTEM INTERRELATIONS

ELO 3.3	Given values for key performance indicators, **DETERMINE** if the Incineration System components are functioning as expected.
ELO 4.3	**DETERMINE** the effects on the Incineration System and the integrated plant response when given any of the following: a. Indications - alarms b. Malfunctions - failure of components c. Operator actions

Offgas System

Flow of combustion gases from the SCC is directed to the Offgas System for processing, filtering and discharge to the atmosphere.

Ventilation System

The Ventilation System keeps the building enclosure pressure higher than the incinerator pressures to maintain a relative vacuum in the Incinerator System. This is done to prevent leakage of combustible gases and contaminants from the incinerator to the atmosphere.

Steam Supply System

Steam from the Medium Steam System is used for burner atomization, purging and cooling.

High pressure steam is also supplied for cooling of the combustion gases from the SCC in the Off Gas Scrubber.

Low pressure steam purge is supplied to the expansion joints to minimize deposit buildup. The steam purge also helps to stabilize the temperature of the expansion joint which will minimize the thermal cycling.

Propane System

Propane is supplied to the incinerator burners for ignition of the fuel oil and liquid wastes in both the RK and the SCC.

Fuel Oil System

Fuel oil is provided to the incinerator for combustion in both the RK and SCC. Fuel oil is used to control temperatures and for mixing with liquid wastes to achieve a stable mixture for burning.

Ash Handling System

The Ash Handling System is used to remove and process residual ash and non-combustibles from the discharge end of the RK.

Electrical Distribution System

The Electrical Distribution System supplies electrical power for the operation of pumps, fans, cameras, and controls associated with the incinerator.

Distributed Control System

The DCS is responsible for controls on the ventilation, waste flow, combustion air flow, fuel oil flow, steam flow, and furnace pressure.

INTEGRATED PLANT OPERATIONS

Normal Operations

Initial Configuration

The startup and shutdown of the incineration system follow the sequence of the CIF facility startup and shutdown specified in the General Operating Procedures (GOPs). In the Cold Standby mode, the incineration system does not receive waste. The fuel oil burners and propane ignitors are off. System temperature is decreasing or ambient. In the Warm Standby mode, the system does not receive waste. The fuel oil burner(s) and/or propane ignitor(s) are on. In the normal operation mode, the incineration system will receive solid and/or liquid wastes. The fuel oil burners are on, and the incinerator system is above the minimum required temperatures for incineration.

Initial configuration of the system is set up by performing an initial facility supporting system and equipment preparation as outline in procedure 261-GOP-01, *Process Startup from Cold Standby to Warm Standby*. Procedure 261-GOP-01 provides instructions for sequential performance system operating procedures in preparation for incinerator startup. The following operations are included:

- Utilities are on (electrical, air, steam etc.)
- Supporting equipment is ready (standby diesel generator, waste tanks, caustic, fuel oil system, etc.)
- Incinerator support systems aligned for startup (off gas, purge air, forced draft, propane ignitor, caustic treatment, etc.)

ELO 4.2	Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Incineration System operations: a. Startup b. Normal Operation of Equipment c. Shutdown

Startup

Incinerator startup is initiated by performing 261-SOP-INC-01, *Incinerator Startup from Cold Standby to Warm Standby.* and 261-SOP-INC-02, *Incinerator Normal Operations,* includes the following operations:

- System Alignment for the DCS Controlled Components
- Incinerator Inspection
- Incinerator Purge Air initiation
- RK No. 2 Fuel Oil Burner Light-off
- SCC No. 2 Fuel Oil Burner Light-off

The following controllers will be in the "required position" prior to initiating 261-SOP-INC-01.

DCS DISPLAY	REQUIRED POSITION	SET POINT
INC1700FC-2	AUTOMATIC	N/A
INC1702FC-1	MANUAL	N/A
INC1704PC-1	AUTOMATIC	-2.5 INWC
INC1705TC-1	MANUAL	0
INC1706SC-1	1 RPM	N/A
INC1710XC-1	MANUAL	50% OUTPUT
INC1715FC-1	MANUAL	0%
INC1723E-1	FAN 1 ON	N/A
INC2401XC-1	MANUAL	50% OUTPUT
INC2404TC-1	MANUAL	0
*INC2405FC-1	MANUAL (RK)	100%
*INC2405FC-2	MANUAL (SCC)	100%

Table 10 DCS Controller Alignment

* Non adjustable setpoint

Placing a DCS controller in "MANUAL" erases the controller setpoint. The setpoint must be reinserted when controller is placed back in "AUTOMATIC."

After the initial preparation is completed, the facility enters a warm standby mode. The DCS is used by the operators to perform the startup of the RK and SCC burners, fans and control valves. An automated, sequenced air purge is performed first to remove any unburned fuel or combustibles that may have remained in the kiln firebox from the preceding shutdown. After the purge has been completed, the ignition sequence for fuel oil is performed. The sequence entails starting the propane ignitor and opening the Low Flow fuel oil SSOV. The DCS will then control all fuels and wastes feeds, combustion air flows, firing rates, temperature control, O_2 control and normal shutdowns . BMS provides safety shutdowns.

The incinerator is gradually warmed up using fuel oil. Hold points and ramp rates for startup and associated temperatures are displayed in Table 11, *Incinerator Hold Points and Ramp Rates below*. A hold point is defined as the parameter (temperature) at which the incinerator is maintained for a specified duration to ensure a gradual warmup during the startup process. The ramp rate is the speed at which the parameter is adjusted to ensure a gradual warmup during the startup process.

The Kiln and Secondary Combustion Chamber shall be heated up in accordance with the following time/temperature schedule AFTER a minimum of one day air curing if refractory repairs have been performed. To prevent SCC Refractory damage, the Incinerator shall be heated with the RK Fuel Oil Burner to 600°F prior to lighting the SCC Fuel Oil Burner.

STEP	TEMPERATURE (°F)	RAMP RATE/HOLD TIME	ELAPSED TIME
1	< 200°F	50°F/Hour	4 Hours
2	<300 but ≥ 200	10°F/Hour	10 Hours
3	Hold At 300°F	12 hrs W/O refractory cure 24 hrs W/refractory cure, Following Repair	24 Hours
4	≥300°F <600°F ±100°F	100°F/Hour	3 Hours
5	Hold At 600°F ±100°F	12 hrs W/O refractory cure 24 hrs W/refractory cure	24 Hours
6	≥600°F ≤1200°F	100°F/Hour	6 Hours
7	Hold At 1200°F ±100°F	6 Hours	6 Hours
8	Temp. ≥1200°F & Setpoint >1200°F	Ramp To Setpoint +100°F at 100°F/Hour for RK 150°F/Hour for SCC	4 Hours
9	Hold At Setpoint +100°	6 Hours	6 Hours
10	Return To Setpoint	-100°F/Hour	1 Hour

Table 11 Incinerator Hold Points and Ramp Rates

If the unit has been shutdown for any length of time, the following schedule should be used to prevent excessive damage to the refractory.

EXTENDED SHUTDOWN — One month or longer - Complete cure-out according to the heatup table.

MODERATE SHUTDOWN — One week to one month - Raise temperature from ambient to 300°F at 50°F/hour. At 300°F follow steps 2 through 9.

SHORT TERM SHUTDOWN — Less than one week - Raise temperature from ambient to 300°F at 100°F/hour. At 300°F follow steps 2 through 9.

SYSTEM TRIP — ≥1200°F raise temperature 300°F/hour or 200°F/hour if temperature falls below 1200°F. There are no hold points during the recovery from a system trip.

If the system has cooled, restart ramp at nearest holding temperature below current temperature.

The SCC ramp controller SETPOINT shall be 1800°F while running and 1200°F while idle.

The RK ramp controller SETPOINT shall be 1600°F while running and 1200°F while idle.

If the facility is already in warm standby mode following completion of 261-GOP-01, *Process Startup from Cold Standby to Warm Standby*. 261-GOP-02, *Process Startup from Warm Standby to Normal Operations*, can be performed to direct the facility operation from the warm standby mode to the normal operations mode.

Normal Operation

In the normal operation mode, procedure 261-GOP-03, *Process Startup from Warm Standby to Normal Operations*, is performed for solid and liquid waste feed, ash handling and ash treatment operations.

NOTE: When the SCC Fuel Oil Burner is being fed at the maximum rate, RK temperature will exceed its high temperature setpoint.

The Incinerator is at normal operating temperature of between 1450°F and 1735°F at the RK exit and between 1650°F and 1962°F at the SCC exit. The propane pilot and propane main shutoff valves are closed with waste, steam, and propane pressures within set limits. SOP 261-S0P-INC-02R, *Incinerator Normal Operations*, provides instructions for the RK and SCC normal operations. The procedure includes the following operations:

- System Alignment for the DCS Controlled Components
- Introduction of Waste Liquid to the RK
- Introduction of Liquid to the SCC
- Introduction of Solids Waste to the RK
- Initiation of AQW Feed
- RK and SCC Operation

Shutdown

Normal Shutdown

Normal system shutdown procedures are provided by 261-GOP-04, *Process Shutdown from Normal Operations to Warm Standby*. After termination of incinerator feed for normal shutdown, one of the three shutdowns is performed: 261-SOP-INC-03, *Incinerator Normal Shutdown*, 261-SOP-INC-04, *Mandatory Incinerator Shutdown*, or 261-SOP-INC-05, *Emergency Incinerator Shutdown*.

Normal shutdown procedure 261-SOP-INC-03 includes the following operations:

- Shutdown of the AQW Nozzle
- Shutdown of the Solid Waste Feed
- Shutdown of the Blended Waste Burner
- Shutdown of the Radioactive Organic Waste Burner
- Shutdown of the SCC No. 2 Fuel Oil Burner
- Shutdown of the RK No. 2 Fuel Oil Burner
- Cooldown of the Incinerator

During a normal shutdown, the CIF will be in the mode of Warm Standby. After the incineration system has reached ambient temperature, the CIF will be in Cold Standby mode. The procedure which directs the shutdown from the full temperature Warm Standby mode to the Cold Standby mode of less than 200°F is 261-GOP-05, *Process Shutdown from Warm Standby to Cold Standby*.

Mandatory Shutdown

Mandatory shutdown of the system initiated by the operation's personnel or the DCS is due to a component or system malfunction. The system is placed in warm standby or cold standby. Personnel can return the system to operational mode once the problem has been resolved.

Procedure 261-SOP-INC-04, *Mandatory Incinerator Shutdown*, includes the following operations:

- Mandatory Shutdown Diagnostics
- Individual Burner Mandatory Shutdown
- Solid Feed Mandatory Shutdown
- Complete Mandatory Shutdown

Component or system conditions that initiate or require Manual Shutdown are listed in:

- Table 5A "Individual Burner Mandatory Shutdown"
- Table 5B "Solid Feed Mandatory Shutdown"
- Table 5C "Complete Mandatory Shutdown"

ELO 2.3	Given a description of the Incineration System equipment status, **IDENTIFY** conditions which interfere with normal system flow paths.
ELO 2.4	Given a description of abnormal equipment status for the Incineration System, **EXPLAIN** the significance of the condition on system operations.
ELO 2.5	Given a description of the Incineration System equipment status, **STATE** any corrective actions required to return system operation to a normal conditional.

Abnormal Operations

Loss of Electrical Power

Fuel SSOVs close on loss of electrical power resulting in:

- RK failure
- DCS/PLC failure
- Combustion air fan low ΔP
- Fuel oil system failure
- RK and SCC high/low propane pressure

Incinerator Fuel Oil Burner Troubleshooting

Fuel oil burner problems will exhibit several symptoms that are easily observed by the operator. The symptoms are:

- Smoky flame
- Sparklers in the kiln
- Uncontrollable flame pattern
- Instability in flame
- Coke formation
- Oil spills

Some of the causes and corrective actions are shown on Table 12, *Burner Flame Troubleshooting Table*, below and listed as follows:

Smokey Flame	Sparklers	Uncontrollable pattern	Instability	Coke	Oil Spill	Possible Causes
●	●	●	●	●	●	Oil Tip Mispositioned
●			●			High Atomizing Steam Temperature
	●		●			Leaking Steam Purge Valve
			●			High Atomizing Steam Pressure
●	●	●	●	●	●	Low Oil Pressure
			●		●	Low Oil Flow
●	●	●	●	●	●	Atomizer/Tip Failure
●	●	●		●	●	Cold (heavy) oil
	●		●			Wet Steam
●	●	●		●	●	Lack of Atomizing Steam Flow
●	●	●		●	●	Lack of Atomizing Steam Pressure
●		●	●	●	●	Insufficient Air

Table 12 Burner Flame Troubleshooting Table

Insufficient Air

A single burner operating with insufficient air will still smoke even though the total kiln firebox (the area inside of the kiln where the burning of the fuel and waste materials occurs) has sufficient excess air for complete combustion. Inspection should be made of the valve positions on the fuel, air and atomizing steam. If no abnormalities are observed after these inspections, the combustion air fan ducts and piping should be inspected for obstructions or damper problems. If no duct problems are observed, O_2 readings should be taken in the firebox to see if the plenum distribution is affecting the air flow. The plenum is a device built into the incinerator to distribute air flow for thorough combustion.

Lack of Atomizing Steam Pressure

Because the burner guns have an internal mixing chamber, they are subject to variations in fuel flow at any given pressure. A small drop in atomizing steam pressure can change the internal pressure of the mixing chamber resulting in an increase in the fuel flow. The increase in fuel flow will increase the BTU output which causes the burner to "overfire" at a pressure at which it normally would have sufficient combustion air.

Lack of Atomizing Steam Flow

A pluggage or flow restriction in the atomizing steam supply piping can cause a reduction in steam flow which could reduce the mixing chamber back pressure and have the same result as a loss of atomizing steam pressure.

Wet Steam

Since wet steam is lower in energy than dry steam, atomization is not as effective. Lower energy atomization results in a larger fuel droplet size and some oil coated water droplets dispersing into the combustion zone. These droplets are slower burning and can lead to fireflies/sparklers on the internal firebox combustion air currents. Fireflies are a major source of ash and soot buildup on radiant convection heat transfer surfaces and the burners.

Cold/Heavy Fuel

Viscosity is the measure of the fluids resistance to flow. Fuels should be heated to the suggested viscosity range. Any reduction in the temperature results in increase in the viscosity. As the viscosity increases, the quality of atomization and combustion will decrease.

Atomizer/Tip Failure

The tip is subject to highly abrasive and corrosive fuel flows and requires frequent maintenance, cleaning and sometimes replacement. Some of the effects of atomizer/tip deterioration are as follows:

- Enlargement of fuel orifice - high oil flow, low atomizing steam to fuel ratio, poor atomization, burner overfiring
- Enlargement of atomizing steam orifices - High atomizing steam flow, low oil flow, reduction in gun capacity, reduction in stability
- Enlargement of atomizer exit - lower mixing chamber pressure, reduction in steam quality, burner overfiring
- Deterioration of atomizer seal - steam bypassing atomizer, poor atomization, instability, poor flame pattern, high back pressure in other lines (PTB event)
- Deterioration of dispersion chamber - reduction of exit port, deterioration of dispersion pattern, coking, oil spills

Low Fuel Flow/Pressure

Reduction in fuel firing rate or plugging of the fuel orifice can cause burner stability problems. Low fuel flow exit port velocity can cause burner dripping and oil spills.

High Atomizing Steam Pressure

High steam pressure increases the mixing chamber back pressure and reduces oil flow which can blow out the flame or cause stability problems.

Leaking Steam Purge Valve

A leaking steam purge valve can cause disruption of oil flow to the gun resulting in burner instability.

High Atomizing Steam Temperature

High steam temperature can cause vaporization of the fuel in the burner gun. The vaporized fuel flowing through the orifices designed for liquid flow will reduce the oil gun capacity and stability. Sometimes, with heavy oil, the temperature can cause slugs to be formed resulting in smoke and poor atomization.

Oil Tip Mispositioning

Positioning of the oil tip can be adjusted by maintenance personnel during cleaning. Tip positioning may be affected by variations in fuel, steam temperature, steam pressure, steam quality, burner air side (combustion air) pressure, and flame pattern requirements.

Mandatory Shutdown

Mandatory shutdown of the system initiated by the operation's personnel or the DCS is due to a component or system malfunction. The system is placed in warm standby or cold standby. Personnel can return the system to operational mode once the problem has been resolved.

Procedure 261-SOP-INC-04, *Mandatory Incinerator Shutdown*, includes the following operations:

- Mandatory Shutdown Diagnostics
- Individual Burner Mandatory Shutdown
- Solid Feed Mandatory Shutdown
- Complete Mandatory Shutdown

Component or system conditions that initiate or require Manual Shutdown are listed in:

- Table 5A "Individual Burner Mandatory Shutdown"
- Table 5B "Solid Feed Mandatory Shutdown"
- Table 5C "Complete Mandatory Shutdown"

Waste Feed Burner Only Trips

Waste Feed trips are initiated automatically to prevent the incinerator from exceeding a permitted setpoint. Exceeding the setpoint could result in emissions that exceed the permit limits. The Waste Feed Burner Only Trips shut down the liquid waste feeds and the solid waste handling system. Fuel oil guns and fans are not affected. See Table 13 below for a list of conditions that should result in a Waste Burner Only Trip. If a condition exists which should have resulted in a Waste Burner Only Trip, then the operator shall initiate an Emergency Shutdown.

CONDITION	DCS POINT TAG ARP (LOOP) NUMBER	ALARM DISPLAY NAME
Low pH in the Cyclone Drain	3208XS (6.0pH)	LO LO pH Cyclone Drain
High pH in the Cyclone Drain	3208XS1 (7.5pH)	HI HI pH Cyclone Drain
High Combustion Products	3518XS-1 (100ppm)	Average CO HI HI
High Combustion Products	3501XS-1(100ppm)	Average CO HI HI
Low Scrubber Recirc Flow	3308FS (44gpm)	Scrubber Recirc Flow LO LO
Low Scrubber Steam Flow	3006FS (6000LB/HR)	Scrubber Steam Flow LO LO
Low Quench Recirc Flow	4007FS (296gpm)	Quench Recirc Flow LO LO
Low RK Pressure	1704PS (-5.0”WC)	LO RK Pressure
High RK Pressure	1704PS-2 (-.01”WC)	HI HI RK Pressure
High RK Temp.	1705TS-5 (1832°F)	HI HI RK Temp
High SCC Temp.	2404TS-4 (1832°F)	HIGH HIGH SCC Temp
Fuel Oil SSOV Shut on RK	FO1813HV-1	
Fuel Oil SSOV Shut on SCC	FO2613HV-1	
Minimum 2 ID Fans running	OGE3505E-1	ID FAN #1
	OGE3506E-1	ID FAN #2
	OGE3513E-1	ID FAN #3

Table 13 Waste Burner Only Trips

BMS Permissive Trip

BMS Permissive trips are initiated automatically when permissive setpoints are satisfied. Table 4 lists the conditions and DCS Point Tags that display the instrument that provides the input to the Permissive circuit.

BMS Permissive trips shut the incinerator down when a monitored parameter exceeds the incinerator safe operating condition or equipment availability does not support safe operation of the incinerator. The Permissive trip initiates a waste feed and fuel oil cutoff. If a condition exists which should have resulted in a BMS Permissive Trip, then the operator shall initiate an Emergency Shutdown.

Emergency Shutdown

Emergency Shutdown is manually initiated by the operator when a condition exists which should have resulted in a BMS permissive trip, Waste Burner Only Trip or Mandatory Shutdown. Emergency Shutdown can be initiated by depressing the Emergency Shutdown pushbutton at the BMS or Critical Alarm Panel in the ICR, or by toggling switch D-2 on Point Tag Display INC1709E-1. (Reset is switch D-1) The system is placed in warm standby or cold standby until the problem is resolved. Emergency shutdown instructions are provided by 261-SOP-INC-05, *Emergency Incinerator Shutdown*

Scram

The SCRAM Relay Panel (H-261-DCS-CAB-020) provides operator with the capability to bring the facility to a safe shutdown (SCRAM) in the event of an incident which requires the operators to abandon the ICR. A SCRAM pushbutton on the DCS panel ion the ICR will be used to initiate the SCRAM signal. The signal will de-energize PLCs A and B causing most equipment to fail to its safe position. Selected motors and valves will remain in their operational state prior to the SCRAM signal. At the present time the Scram function is not installed. Exact motor, pump and valve positions are not available.

Infrequent Operations

Refractory Curing

After repairs to the RK or SCC refractory, the incinerator is cured to allow the new refractory to temper, expand, and reseat. The repaired section(s) are opened or left open to the atmosphere for twenty four hours to allow the sections to cure. If required, the combustion air fans can be operated at a reduced flow capacity to create an air flow that will assist in the curing process.

Summary

- The incinerator may be operated in several different modes depending upon the process requirements of the facility
- Shutdown of the incinerator may be either by design or requirement depending upon process parameters
- Incinerator operation out of ideal operating conditions may be due to a failure or poor operation of burners, nozzles, fans, support systems or fuels.
- Emergency shutdown of the incinerator is performed to prevent, damage to the incinerator.