

**Operating Logic Sequence
for the SRCO 4000
Self Recuperating Catalytic Oxidizer**

CCC Project# J-04-0090

Operating Sequence:

The volatile organic compound (VOC)-laden process air is drawn from the extraction wells by an SVE system(s). The SVE system delivers the process air to the process blower on the oxidizer skid. The process air passes through the tube side of a primary self-recuperating heat exchanger where it is preheated prior to entering the gas fired heater. The gas fired heater raises the temperature to set point prior to entering the catalyst. As this vapor-laden air mixture passes through the catalyst, an exothermic reaction occurs which is in proportion to the VOC energy concentration. The hot clean air is then passed through the shell side of the heat exchanger and then vented to atmosphere through the exhaust stack.

Dilution & Purge Air Control

Dilution air control (exotherm) is achieved by an actuator with a valve (MV1) installed on the inlet piping of the Oxidizer. The dilution air valve is automatically controlled by a solid state process loop controller (TIC2-1) located on the Oxidizer panel.

Upon system start, the dilution air valve (MV1) is proven open (ZAO1) and the manual process valve (V1) is proven closed (ZSC2). The oxidizer process blower (M1) starts and fresh air is provided to the oxidizer for purge and warm-up. When normal operating conditions are achieved, a site operator must open the manual process valve (V1) when prompted by the operator interface. Once the manual process valve (V1) is open, the SVE systems are enabled (YC5). When any of the SVE systems are proven running (YC6), the process loop controller (TIC2-1) begins to modulate the dilution air valve (MV1) to control the exotherm control set point. During the entire system operation, the burner controller (TIC1-1) modulates the automatic gas valve (MV2) to maintain operating set point. This is normal system operation.

Control Panel Type:

The control panel is a NEMA 4 UL 508a listed panel mounted to the skid of the Oxidizer system. The enclosure houses all controls and indicators necessary to control the Oxidizer.

Main Power:

Main power, 460V/3PH/60Hz, is provided to the Oxidizer control panel Main Disconnect. Power is terminated prior to personnel entering the control panel by the main disconnect switch.

Oxidizer Process Blower (M1):

The Oxidizer process blower is controlled by one 3 position switch.

OFF

When the HAND-OFF-AUTO selector switch is placed in the OFF position, the Oxidizer process blower is disabled.

HAND

When the selector switch is placed in the HAND position, the Oxidizer process blower will run as long as a motor overload condition (YC2) is not present. When the switch is in HAND mode, the oxidizer system is disabled.

AUTO

When the selector switch is placed in the AUTO position, the Oxidizer process blower will be enabled if the following conditions are satisfied:

- A critical oxidizer fault does not exist (Table 2).

Note: the process blower is enabled, but will not actually start until the “Start” button on the operator interface is pressed.

Oxidizer Start Sequence:

Oxidizer start-up requires manual setup. **Do not attempt to start the unit without complete understanding and proper training.**

System Start:

The system “Start” button is a function key on the operator interface display panel. When the Oxidizer “Start” button is pressed, the Oxidizer starts the process blower (M1). All Oxidizer start conditions must be satisfied and no Oxidizer systems alarms may be present.

At this time the dilution air valve (MV1) must be proven open (ZAO1) and the manual process valve (V1) proven closed (ZSC2).

If adequate airflow is not detected (PS1 and PS2) within 8 seconds, the Oxidizer system will shut down for an air flow failure alarm.

Upon satisfactory completion of proven air flow (PS1 and PS2), the Oxidizer is purged for 60 seconds with fresh air through the dilution valve (MV1). The operator interface displays "System Purging - XX seconds left". The flame is then ignited and proved. A solid state combustion control device is used for this function (flame safety programmer). An analog meter mounted on the control panel displays the flame strength (+4 to+10VDC normal).

Once the burner operation is verified, the operator interface display reads "System Pre-Heating to Set Point Temperature".

Catalytic Mode Function

The Oxidizer is capable of running in catalytic mode only. The following set points are used. (Table 2)

Table 2 – Catalytic Mode Temperature Control Set Points

Identifier	Meaning/Location	Value
		Catalytic Mode
TA1	Burner up to temperature	630°F
TA2	Catalyst High Inlet Temperature Limit	1000°F
TA2a	Catalyst High Exit Temperature Limit	1100°F
TE1	Thermocouple @ Oxidizer Inlet (burner temperature controller)	-
TE1a	Thermocouple @ Oxidizer Inlet (channel 1 of chart recorder)	-
TE1b	Thermocouple @ Oxidizer Inlet (high inlet temperature switch)	-
TE2	Thermocouple @ Oxidizer Outlet (dilution valve controller)	-
TE2a	Thermocouple @ Oxidizer Outlet (channel 2 of chart recorder)	-
TE2b	Thermocouple @ Oxidizer Outlet (high exit temperature switch)	-
TOL1	Timeout Limit #1-Burner up to temp	60 min.
TOL2	Timeout Limit #2-Oxidizer low temp	5 min.
TOL3	Timeout Limit #3-Oxidizer Stabilized	2 min.
SP1	Temperature Control Set Point	650°F
SP2	Exotherm Temperature Control Set Point	950°F

Pre-Heat mode

Note: The Oxidizer uses the main gas butterfly valve to achieve, and maintain pre-heat temperature. This valve is controlled by a 4-20mA Burner control loop (Burner controller). All set points and monitor points referred to in the following text are defined in table #2, review prior to proceeding.

With all purge conditions satisfied and a flame proved at the burner, the system will pre-heat to the **control set point (SP1-650°F)** at **(TE1-Oxidizer Inlet)**. Once the Oxidizer is initially started, the system must reach the **"burner up to temp"** value **(TA1-630°F)** prior to the expiration of **(TOL1-60 min.)**. Once this condition

is satisfied, the Oxidizer will stabilize for **(TOL3-2 min.)** on the set point temperature. After the Oxidizer temperature has stabilized, the Oxidizer will change to **“Run Mode”**. When Run Mode is achieved, the operator must manually open the process valve (V1). With the process valve proved open (ZSC2), the SVE systems are enabled (YC5). Once any of the SVE systems are proven running (YC6), the dilution valve (MV1) is enabled and the Oxidizer exit temperature is controlled to **(SP2-950°F)**.

Run mode (All purge and pre-heat procedures satisfied)

Once the “burner up to temp” **(TA1-630°F)** is reached and the temperature drops below **(TA1-630°F)** for a period greater than **(TOL2-5 min.)** the system mode will change to **“Shut Down”** for failing to maintain burner set point temperature.

An independent “High Limit Inlet Temperature Controller” is utilized to monitor **(TE1b-Inlet Temperature)**. If this location exceeds the value **(TA2a-1000°F)** the system mode will change to **“Shut Down”** for high catalyst inlet temperature.

An independent “High Limit Exit Temperature Controller” is utilized to monitor **(TE2a-Exit Temperature)**. If this location exceeds the value **(TA2-1100°F)** the system mode will change to **“Shut Down”** for high exit temperature.

System Start Sequence:

- 1) Press “Start” button
- 2) Oxidizer purges for 60 seconds
- 3) Burner is enabled and pre-heats Oxidizer
- 4) Pre-heat temperature attained
- 5) Oxidizer stabilizes on operating set point temperature
- 6) Operator Interface instructs operator to “open manual process valve”
- 7) Manual process valve is opened
- 8) SVE systems are enabled (closing of dry contacts from Oxidizer)
- 9) Any SVE system sends signal back to Oxidizer indicating at least one SVE system is running
- 10) Dilution valve is allowed to modulate
- 11) Normal system operation

If the SVE system shuts down after the dilution valve (MV1) has been enabled, the dilution valve will open and wait for the SVE system to start again. If the SVE fails to start after 4 hours, the Oxidizer will shut down.

Stop Sequence

- 1) Press the “Stop” button on the operator interface
- 2) Oxidizer disables SVE equipment
- 3) Oxidizer shuts off burner
- 4) Oxidizer performs cool down
- 5) Oxidizer is ready for re-start

Alarm Reset

- 1) Clear the alarm condition on the system (i.e. reset the low gas pressure switch)
- 2) Press the “Reset” button on the operator interface
- 3) Oxidizer is ready for re-start

Automatic Re-Start on Power Failure

The oxidizer is programmed to re-start on a power failure if the power failure duration is less than the operator entered value (1-60 minutes) when this feature is enabled from the operator interface display. If the oxidizer is running, the auto re-start function is enabled, and power fails to the system for less than the operator entered value, the oxidizer will perform a normal start-up as if the “start” button were pressed on the operator interface display. The power failure time date will be stamped on the alarm list. If power fails for more the operator entered value, the oxidizer will remain offline and display “power failure” on the alarm banner. A manual start of the system will be required.

Shut Down Modes

There are three types of shut downs: 1) “**Normal Shut Down**”: This mode is activated any time the “STOP” key is pressed. A Normal Shutdown consists of the Oxidizer opening the dilution valve, disabling the SVE systems, shutting off the burner, and performing a cool down. The system is then ready for a manual re-start. 2) “**Oxidizer Alarm Shut Down Mode**”: This mode is activated during an active alarm condition from the Oxidizer system. An Alarm Shutdown consists of the Oxidizer opening the dilution valve, disabling the SVE systems, shutting off the burner, and performing a cool down (**TOL3-2 min.**). The alarm condition will be displayed on the operator interface and the “alarm contacts” will open. The alarm condition must be cleared before the system is allowed to start. 3) “**Critical Shutdown Mode**”: This shutdown will occur anytime a critical alarm occurs on the Oxidizer. All motors stop immediately, and a message is displayed on the operator interface.

A cool down will consist of running the Oxidizer blower with fresh air for 5 minutes

Alarm Signals:

Correction of the condition and reset of the alarm will be required to enable the system for re-start. A text message indicating the alarm type will be displayed on the operator interface panel. The operator interface also time and date stamps all runtime alarm conditions. Refer to Table 3 for alarm messages.

Table 3 – Alarm conditions and associated system response.

Alarm Condition	System Response
Oxidizer System Externally Disabled (YO4)	Alarm Shut Down Mode
Safety Shut Off Valve Not Closed (ZSC3)	Alarm Shut Down Mode
Process Low Air Flow (PAL1)	Alarm Shut Down Mode

Alarm Condition	System Response
Combustion Low Air Flow (PAL2)	
High Gas Pressure (PSH3)	Alarm Shut Down Mode
Low Gas Pressure (PSL4)	Alarm Shut Down Mode
Gas Modulating Valve Not Closed (ZSC4)	Alarm Shut Down Mode
High Exit Temperature (TAH2a)	Alarm Shut Down Mode
Catalyst High Inlet Temperature (TAH1)	Alarm Shut Down Mode
Fail to Meet Set Point Temperature (TAL1)	Alarm Shut Down Mode
Fail to Maintain Set Point Temperature (TAL1)	Alarm Shut Down Mode
Flame Safety Programmer Alarm - Flame Failure	Alarm Shut Down Mode
SVE System Failed to Start (after 4 hours)	Alarm Shutdown Mode
Process Blower Overload (YC2)	Critical Shutdown
Manual Valve Open out of Sequence (ZAC2)	Critical Shutdown
Manual Valve Closed while SVE system is Running (ZAC2)	Critical Shutdown
Dilution Valve Not Open (ZSO1)	Critical Shutdown
Oxidizer System Not in Auto mode (ZAO3)	Critical Shutdown
E-Stop Engaged (YO3)	Critical Shutdown
Power Failure	Critical Shutdown
PLC Low Battery	Display Only

External Interfaces:

The Oxidizer control provides several external interface signals, each is explained below.

Inputs:

External Enable: (dry contact) - must be closed for the Oxidizer to function. Tie fire alarms or external critical alarms into this contact.

SVE System Running (dry contact) - contact that closes *from* any of the SVE systems *to* the Oxidizer to indicate that any SVE system is running.

Outputs:

Oxidizer Ready: (dry contact) - contacts that close *to* the external systems when the Oxidizer is ready for process air.

Oxidizer Alarm: (dry contact) - contact that opens when the Oxidizer system is in an alarm condition.

Analog Re-Transmit Signals

The Oxidizer re-transmits the inlet and exit temperatures as 4-20mA signals.

Inlet Temperature: 4mA = 0°F, 20mA = 2000°F

Exit Temperature: 4mA = 0°F, 20mA = 2000°F

System Stop:

A "STOP" button is provided on the operator interface panel, pressing this will cause the Oxidizer to enter "Normal Shut Down" Mode.

E-STOP:

A red pushbutton is provided for emergency stop conditions. When pushed in the system is disabled.

Chart Recorder (optional):

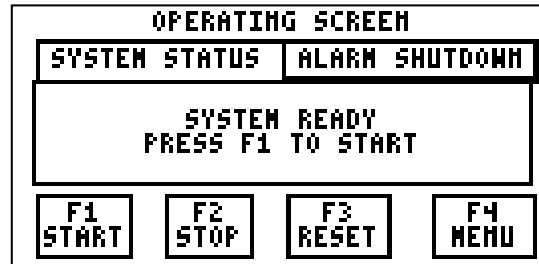
The Oxidizer system is configured with a 2 pen circular chart recorder. The chart recorder is capable of recording 30 days of data on one piece of chart paper. The pen assignment for the recorder is as follows:

Channel #1 = Inlet/Chamber Temperature
Channel #2 = Exit/Chamber Temperature

System Operator Interface:

Operating Screen

The Operating Screen gives a description of what condition the system is currently in as well as giving instructions to the operator.



F1-START: the "F1-Start" button will initiate a normal system start sequence. This is the only screen that allows for a system start.

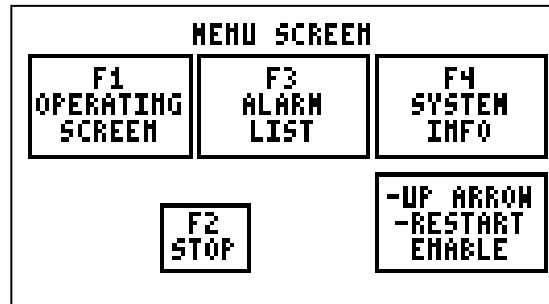
F2-STOP: the "F2-Stop" button places the system in a normal shutdown mode.

F3-RESET: the "F3-Reset" button clears all runtime alarms from the system.

F4-MENU: the "F4-Menu" button changes the operator interface screen to the Menu Screen.

Menu Screen

The Menu Screen allows the operator to change the display to different screens.



F1-Operating Screen: changes display to Operating Screen (see Operating Screen).

F2-STOP: the “F2-Stop” button places the system in a normal shutdown mode.

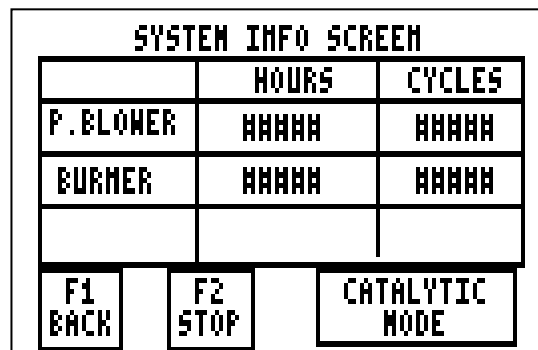
F3-System Info Screen: changes display to System Info Screen (see System Info Screen).

F4-Alarm List: changes display to Alarm List Screen (see Alarm List Screen).

Up Arrow: press the “Up-Arrow – ReStart Enable” button to enable the “re-start on 10 second power loss” feature.

System Info Screen

The System Info Screen gives a running total of system blower hours & cycles, system burner hours & cycles, and system mode.

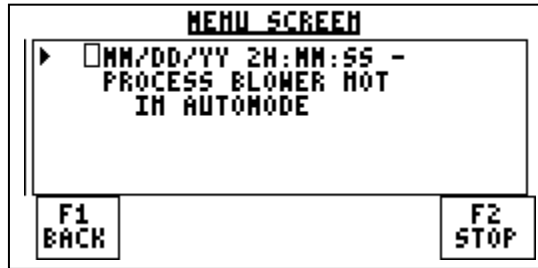


F1-BACK: changes display to Menu Screen (see menu screen)

F2-STOP: the “F2-Stop” button places the system in a normal shutdown mode.

Alarm List Screen

The Alarm List Screen displays the last 25 alarms that have occurred. Each alarm is time and date stamped.



F1-BACK: changes display to Menu Screen (see menu screen)

F2-STOP: the “F2-Stop” button places the system in a normal shutdown mode.

Alarm Banner Screen

The Alarm Banner Screen will “pop-up” anytime an alarm condition occurs after the system has been started. The screen will cover any screen that is being displayed and will only disappear after the alarm has been acknowledged.



F1-ACK: the “F1-Ack” button acknowledges the alarm and returns the display to the current screen.