PROCESS DESCRIPTION

AROCLOR MANUFACTURING FACILITIES

PROJECT CEA 1800

T A B L E O F C O N T E N T S

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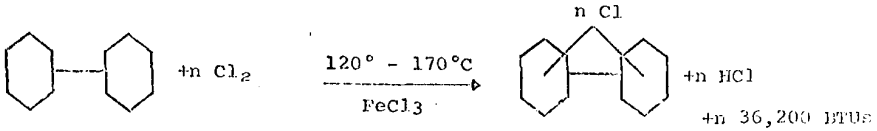
Section I - Synopsis of Aroclor Process

Aroclor is a trade name used to designate the chlorination products of biphenyl, biphenyl high boilers or a mixture of the two. Liquid Aroclors are produced by chlorinating biphenyl to 21, 32, 42, 48, 54, 60 or 62% chlorine content. Chlorination above 63% yields a solid product at normal temperatures. Liquid Aroclors are identified by a four digit number. The last two digits represent the chlorine content (percentage by weight) and the first two numbers represent the chlorine condition. If the first digit is "1" it signifies that the Aroclor has been made from biphenyl. If the second digit is "1" the product has not been distilled. If it is "2" the product is a distilled grade. As an example, Aroclor 1242 is a distilled chlorinated biphenyl containing 42% chlorine.

The first process step in the manufacture of Aroclors is a chlorination step. Biphenyl and chlorine gas in the presence of Ferric chloride catalyst are reacted to form a chlorinated aromatic compound. Hydrogen chloride gas is liberated during the reaction and either recovered or drowned in a scrubber and sewered. The main reaction is a simple replacement of hydrogen by chlorine but the product of the chlorination contains trace amounts of halogen containing by-products which are less stable than the direct ring substitution products. Many isomers are formed.

A schematic representation of biphenyl chlorination is as follows:



Biphenyl Chlorine Aroclor Hydrogen Chloride

Molecular Weights:

Biphenyl	=	154
Chlorine	=	71
Hydrogen Chloride	=	36.5
Aroclor	=	254.1 to 395.6

The second process step is soaking and aeration. The material is held at a high temperature, 150 to 200°C for 24 hours. It is then blown with dry air in an aeration tank to remove trace amounts of Hcl gas and other gaseous impurities.

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The third process step is a flash distillation. This is carried out under vacuum conditions with a vacuum controller preset to give 40 mm Hg absolute at the still pot. Heat for distillation is supplied by an external source. The distillation must be carried out in the presence of lime. The residue product which contains lime, ferric chloride, and tars is generally drawn off to drums for discard or for sale as "Montars".

The fourth process step is stabilization. The distilled Aroclor is treated with Porocel, an activated bauxite (aluminum oxide product). Porocel absorbs moisture and chloride ions to improve the electrical properties of the Aroclor.

The fifth process step is storage and blending. Aroclors are mixed with tri or tetrachlorbenzene to produce Pyranols and Interteens. They are also formulated with other materials to produce Pydrauls.

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Section II - Biphenyl Mix Tank (Item 403)

A. Start-up Operation

1. Design Consideration

a) $FeCl_3$ is mixed with biphenyl in an agitated tank in order to provide a method of continuous charging of catalyst to the continuous chlorinator system. The standard process requires a minimum catalyst concentration of 0.05% by weight or 1.6 lb./hr., for a biphenyl feed rate of 380 gals./hr. One mix will be made initially during each work shift containing 0.29% by weight $FeCl_3$. After the initial start-up period, this will be increased to 0.87% by weight in order to test the feasibility of making one mix per day.

b) $FeCl_3$ settles out of solution quickly, blocks transfer lines and is a difficult material to handle. Charge to the chlorinator will be made through a Hills-McCanna ball valve, 3/4" size, which is controlled by a timer mounted at the instrument panel. The valve will be set to pass 125 gallons/hour. This valve is located as a take-off on a circulating loop from the tank.

c) Charge valve setting will have to be determined by trial before start. For example, a setting of 15 seconds open and 125 seconds closed should provide a flow of 16.7 gallon/minute or 125 gallons/hour. This may vary depending on the pressure drop through the valve.

d) The pumping system is designed to provide a minimum velocity of 9.0 ft/sec. & sufficient back pressure past the intermittent flow valve to prevent HCl gas from flowing back to the biphenyl feed tank.

2. Biphenyl Mix Tank Operation

a) Check that steam is on the coil in the storage tank and the temperature controller is operational. Set at $100^{\circ}C$ in automatic.

b) Close valve under mix tank.

c) Add biphenyl to the set point of 1000 gallons. This will be 19" below the top bend line.

d) Start agitator.

e) Add 24 pounds of ferric chloride.

f) Check that steam is on the circulating lines from the biphenyl mix tank to pump and return.

g) Align valves for circulating.

h) Start pump and check that mixture is circulating.

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B. Routine Operations

1. When charging to the chlorinator, check that the feeding rate is 125 gallons/hour. This can be done by observing draw down rate of level recorder, LRA-6. Some adjustment may be required in the charge valve timer, KICA-38. The catalyst charge valve, KICA-38, is activated at the panel board.

2. After 1000 gallons have been charged to the chlorinator, recharge the biphenyl mix tank and add ferric chloride as described in Section II, A-2.

3. Throttle biphenyl charge valve so that the pressure gauge in the line to the chlorinator indicates 5 psig. This will insure uninterrupted biphenyl flow to the chlorinator.

C. Safety Features

1. A level recorder instrument is located on the instrument panel to record flow of mix to the chlorinator. If the level is not changing, then some part of the system is blocked.

2. A low level alarm on the level recorder instrument will sound when the biphenyl mix tank needs recharging. Approximately 45 minutes will be available before the tank is completely empty.

3. If the loading valve to the chlorinator assumes an intermediate position between closed and open, an alarm will sound after this unit has been in this position a length of time set by the time delay relay on this valve.

4. A three inch overflow line, with return to the intermediate biphenyl storage tank, is located six inches down from the top bend line of the biphenyl mix tank to protect against overfilling.

5. A temperature controller will prevent the temperature of the biphenyl from exceeding its flash point. Set point is $100^{o}C$.

6. A steam jacketed vent is installed on the tank and is equipped with a flame arrester.

7. The biphenyl feed transfer pump will activate an alarm if it is shut down.

8. The agitator will activate an alarm if it is shut down.

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D. Emergency Shutdown

1. Shut off steam to mix tank coil.

2. Shut down agitator.

3. Shut down circulating pump.

E. Control Loops, Interlocks and Alarms

1. There are 3 major control loops in this system.

a) Biphenyl Mix Tank Temperature Control - TIC-5

The function of this loop is to provide temperature control for the biphenyl in the mix tank to prevent heating above the flash point of biphenyl (C.C.C. - 112°C). This is accomplished by measurement of the temperature and controlling the heat input by throttling a control valve in the steam line to the coil in the mix tank. Set point for the controller is 100°C.

b) Biphenyl Mix Tank Level - LRA-6

The function of this loop is to provide a recorded record of the level of material in the biphenyl mix tank and to activate an alarm if the level is too low. This is accomplished by a diaphragm pressure transmitter. A 0-100% dial indicates tank level in the field and a 0-100% scale indicates tank level at the control panel.

c) Catalyst to Chlorinator Flow Control - KICA 38

The function of this loop is to insure proper catalyst addition to the chlorinators. This is accomplished by an intermittently operated ball valve allowing a high flow of material at intermittent times to prevent valve blockages. Initial setting of the timer will be open - 15 seconds, closed - 125 seconds. An alarm will sound if the valve stops in some intermediate position. This is accomplished by a time delay relay, set point - 15 seconds. If the valve does not assume its proper position in 15 seconds, either open or closed, the alarm will sound.

2. Interlocks

There are no interlocks in this system. 0193364

3. Alarms

The following alarms exist through the system:

a) Low level in the biphenyl mix tank, at the bottom bend line.

b) If the biphenyl mix tank agitator motor stops.

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c) If the biphenyl feed transfer pump motor stops.

d) If the charge valve does not assume its proper position after a set time of 15 seconds.

All of the above alarms show on the Annunciator Panel as "Biphenyl Addition System - Abnormal".

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Section III - Continuous Chlorinator Unit

A. Start-up Operation

1. Design Consideration

a) Based on the demonstrated continuous chlorinator system at Anniston, the WGK chlorinator was designed 1) at the same apparent vapor velocity of the Anniston unit at a demonstrated rate of 28.5 M lbs./year and 2) with a material level over the chlorine sparger at least equal to or higher than the material level over the sparger in the Anniston chlorinators. WGK chlorinators have a potential capacity in excess of 50 M lbs./year.

b) Allowance was made for a volume expansion of about 25% and a minimum of 24 inches for vapor disengaging.

c) Ferric chloride catalyst will be added continuously as a suspension in molten biphenyl. Additional biphenyl will be added continuously to provide the proper biphenyl feed.

d) The heat removal system is based on a heat evolution rate of 510 Btu/hour/pound of chlorine added. Normal evolution at the input rate of 1295 pounds/hour of chlorine (88½% available) is 585,000 Btu's/unit. Design rating of the external air cooled heat exchangers is 1,100,000 Btu/hour and are the same units as installed in all of the Aroclor plant chlorinators. A two-speed motor is provided to give a turndown ratio of at least 3 to 1. Batch circulation rate is 250 gallons/minute which allows for a complete turnover of 3.4 to 4.6 minutes.

A manual-automatic selector switch is installed on the panel board to control the fan and select the motor speed.

e) The flow of chlorine to the chlorinators is controlled by a flow controller which allows manual adjustment of chlorine feed rate with automatic control. The rate can be adjusted to conform with the production requirement.

f) Chlorination temperature is held constant by a temperature controller which controls the opening of a shutter assembly located above the air cooled exchanger.

g) Entrainment separators are installed at the top of each chlorinator to prevent Aroclor from being lost from the chlorinator. The Brinks-Monsanto unit will eliminate 99% of all particles 3 microns and smaller from the vapor stream and return the entrained liquid to the chlorinator.

h) Chlorine sparger design is based on a chlorine velocity of 50 feet per second, a chlorine rate of 1140 lbs./hour with a 1/4 inch hole size.

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2. Continuous Chlorinator Operation

The continuous chlorinator operation consists of four cascade flow chlorinators in series where specific levels of chlorination occur. Ferric chloride catalyst suspended in molten biphenyl is fed into the first chlorinator along with molten biphenyl from the intermediate storage tank where the material is chlorinated and overflows to the second unit. This continues until the final unit where the finished product is pumped continuously to an intermediate storage tank. The system can be reduced to three chlorinators in series in case problems occur with one unit. Normally 1142 is the only liquid Aroclor produced in the continuous system. It is feasible to produce 1148, 1154 and 1160 by changing the level of chlorination and retention time.

a) Four Stage Continuous Chlorinator Operation

1) Close manual chlorine valve at the distributor on the chlorinator to be charged.

2) Close vents on the chlorinators to the blow tank.

3) Align vent valves to the muriatic acid area, Dept. 218.

4) Close manual valve on bottom of chlorinators.

5) Align valves at coolers and pumps to circulate through the cooler. Check that bypass valves around coolers are closed. Check that cooler fans are off. Selector switch should be in slow or fast positions.

6) Set the temperature controllers for chlorinators Nos. 6, 7, 8 and 9 at 150°C.

7) Set the chlorine flow controllers in "auto" with the set points at 1295 lbs./hour.

NOTE: The scale of the chlorine feed indicator is 0 to 100. A reading of 100 is equal to 1700 lbs./hour.

8) Set the specific gravity recorder controller for No. 9 chlorinator in "auto" with set point at 1.350. The Densitrol controller will adjust the chlorine feed automatically to No. 9 chlorinator to maintain the indicated specific gravity.

9) Set the biphenyl feed controller in "auto" with the set point at 4.25 GPM.

NOTE: The scale of the biphenyl feed indicator is 0 to 100. A reading of 100 is equal to ~~6.0~~ 10 GPM.

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10) Align valves to overflow from No. 6 chlorinator to No. 7, from No. 7 to No. 8 and from No. 8 to No. 9. Bypass valves should be closed.

11) Charge each of the four chlorinators with molten biphenyl through the bypass valve around the biphenyl feed control valve. This is carried out by overflowing from chlorinator No. 6 to No. 7, from No. 7 to No. 8 and from No. 8 to No. 9.

12) Add 4 pounds of ferric chloride catalyst to each chlorinator.

13) Open the valves on the bottom of the chlorinators and start the circulating pumps.

14) Chlorinate to the following levels:

Stage	Chlorinator	Specific Gravity
First	6	1.078 - 1.104 @ 65°C
Second	7	1.170 - 1.196 @ 65°C
Third	8	1.254 - 1.280 @ 65°C
Fourth	9	1.336 - 1.362 @ 65°C

NOTE: The chlorine control valves will remain closed until the circulating pumps are started and the chlorine reset button is activated.

15) Close valve on the chlorine distributor on each chlorinator when the correct specific gravity level has been reached. Hold this chlorinator until all four are ready. It may be necessary to put steam on the chlorinator to keep the temperature at 120°C.

16) Check the biphenyl mix tank to be sure the mix has been charged and the agitator is running.

17) Align valves at the biphenyl mix tank to No. 6 chlorinator. Activate catalyst feed valve by putting selector switch in "on" position.

18) Align valves at the biphenyl intermediate storage tank to No. 6 chlorinator. Activate feed valve by starting pump on biphenyl intermediate storage tank.

19) Start the chlorine feed to each chlorinator (1295 lbs./hour on each). Open manual valves at each chlorinator distributor. Chlorine feed is adjusted at the automatic flow controllers in the control room to maintain the required specific gravity level.

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Normally, chlorine feed to No. 6 chlorinator is lower than the other three chlorinators. This is to keep biphenyl carryover into the HCl line at a low level.

20) Samples will be taken and specific gravity run on chlorinators No. 6, 7 and 8 every two hours (8, 10, 12, etc.). A sample will be run on No. 9 chlorinator every four hours (8, 12, 4, etc.).

21) The following items should be checked during the operation:

(a) Temperatures on the individual chlorinators on the automatic temperature controllers.

(b) Chlorine flow on the chlorine flow controllers.

(c) Discharge pressure of the circulating pumps for each chlorinator.

(d) Temperature on the multipoint temperature recorder for the chlorinator batch temperature for each unit.

(e) Specific gravity of No. 9 chlorinator.

b) Three Chlorinator System

1) Switch valves on the overflow lines from one chlorinator to another to allow by-passing a particular chlorinator.

2) Shut off the biphenyl feeds to the first stage chlorinator and chlorinate the material to the following levels:

Stage	Chlorinator *	
First	6	1.108 - 1.124 @ 65°C
Second	8	1.124 - 1.240 @ 65°C
Third	9	1.345 - 1.355 @ 65°C

* Indicates No. 7 Chlorinator is out of system.

3) Start chlorine and biphenyl feeds in the same manner as for four stage continuous operation.

4) The chlorinator removed from service should be chlorinated to a finished Aroclor and pumped out.

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B. Routine Operations

1. Chlorine flow will be in "auto" control with the flow indicated on the flow recorder controller for the individual chlorinators, No. 6, 7, 8 and 9.

2. Temperature will be controlled by the temperature recorder controller for the individual chlorinators. Normally, the controller will be in "auto" with the set point at 150°C.

3. The chlorinator circulating pumps will be in operation with the discharge pressure at 65 psig. Normal pump flow is 250 GPM.

4. Fan control switch will be in the "slow" or "fast" position.

5. The temperature of the individual chlorinators can be observed on the multipoint temperature recorder.

6. Biphenyl feed to the first stage of the continuous chlorinators can be observed on the biphenyl feed control instrument. Normally, this instrument is in "auto" with set point at 4.25 GPM.

7. The Densitrol specific gravity instrument for the No. 9 chlorinator will be indicating the specific gravity for the material in No. 9 chlorinator. The controller will be set in "auto" with the control point at 1.350 specific gravity units.

8. The level in the biphenyl mix tank will be indicated on the biphenyl mix tank level recorder.

9. The HCl header off gas pressure will normally be 3.0 to 5.0 psig.

C. Safety Features

1. A level recording instrument on the control panel to indicate when a new charge is needed in the biphenyl mix tank.

2. A high temperature alarm is set at 190°C on the individual chlorinators to prevent excessive carryover of material into the HCl off-gas header. Temperatures above this will cause excessive carryover of biphenyl or crude Aroclor.

3. If the chlorinator temperature drops to 120°C an alarm will sound and the chlorinator cooler fan will shut off. The fan will not cut on until the chlorinator temperature is 150°C.

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4. A push button is available at the panel to shut the fan off in case of emergencies. It normally operates automatically, starting at 150°C and shutting off at 130°C.

5. The chlorine feed valve will shut off when the circulating pump is shut down. It can be activated when the pump is started and the reset push button is activated at the panel.

6. The chlorine feed valve will shut off if the temperature at the bottom of the chlorinator reaches 190°C. The chlorine flow valve cannot be activated until the reset push button is activated at the panel.

7. The circulating pumps will activate an alarm if they are shut down.

8. The biphenyl feed pump to the biphenyl feed controller will activate an alarm if it stops.

9. A temperature of 190°C in the off-gas system will activate an alarm.

10. A sight glass has been placed in the HCl off-gas line of each chlorinator to allow observation of the gas flow for possible entrainment.

11. Rupture discs are installed in each chlorinator to protect against over pressurization but not failures which may result from explosions.

12. If the biphenyl flow drops too low an alarm will sound. This will show on the annunciator panel at "Biphenyl Addition System - Abnormal".

13. If the level in No. 9 chlorinator is too low or too high, an alarm will be activated.

D. Emergency Shutdown

1. Shut off biphenyl mix tank feed using automatic controller and biphenyl feed to the chlorinators. Close block valves.

2. Close block valves to the chlorine distributor on chlorinators No. 6, 7, 8 and 9. Reset chlorine feed control valves to 0 with instrument in "auto".

3. In event of a prolonged shutdown, greater than two hours, put steam on circulating lines or tracing around the chlorinators to maintain 120°C minimum temperature.

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E. Control Loops, Interlocks and Alarms

1. There are eleven major control loops in this system.

a) Chlorinator Temperature Controls - TRCA-12, TRCA-13, TRCA-14 and TRCA-15

The function of this loop is to provide temperature control for the chlorination batch in the chlorinator. This is done by measuring the temperature in the crude Aroclor circulating line at the discharge of the air cooled heat exchanger and controlling the damper position on the coolers and automatically starting or stopping the fan for the coolers by temperature. The temperature control for the fans can be operated in the manual position. The temperature system has a low temperature alarm at 120°C. The fan for the coolers is a two-speed fan. For summer operation, the fan will be in the "fast" position. For winter operation, the fan will be in the "slow" position.

b) Chlorinator Chlorine Flow Control - FRC-8, FRC-9, FRC-10 and FRC-11

The function of this loop is to control the chlorine flow to the chlorinator and regulate the rate of chlorination. This is done by measuring the chlorine flow with an orifice and controlling this flow with a control valve in the chlorine feed line. This system can be operated manually or automatically. The chlorine flow valve will shut if the temperature in the chlorinator reaches 190°C or the circulation pump is shut down.

c) Chlorinator Biphenyl Feed Control - FRCA-7

The function of this loop is to control the biphenyl flow to chlorinator No. 6. This is done by measuring the biphenyl flow with an orifice and controlling this flow with a control valve in the biphenyl feed line. This system can be operated manually or automatically. Flow indicator gauges are installed at the biphenyl mix tank and intermediate biphenyl storage tank. If the flow decreases below a set point, an alarm will sound.

d) Density Control, No. 9 Chlorinator - DRCA-39

The function of this loop is to control the gravity of the material leaving No. 9 chlorinator. This is done by measuring gravity in a density cell and controlling the chlorine flow to the chlorinator with a control valve in the chlorine feed line. Alarm will sound for out-of-specification material.

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e) No. 9 Chlorinator Level Control - LCA-16

The function of this loop is to control the level of material in No. 9 chlorinator and to activate an alarm if the level is too high or too low. This is done by sensing level with a float and controlling the pump away with a control valve in the discharge line.

2. Interlocks

a) If the temperature in the chlorinator at the sparge ring reaches 190°C the chlorine control valve will close and an alarm will sound.

b) If the chlorinator circulating pump motor shuts off, the chlorine control valve will close and an alarm will sound.

3. Alarms

The following alarms exist through the system:

a) High temperature at the chlorine sparge ring, 190°C.

b) High temperature at the top of the chlorination mass, 190°C.

c) If the chlorinator circulating pump motor stops.

d) High temperature in the HCl off-gas line at the top of the chlorinators, 200°C.

e) Low temperature of crude material in the line at the air cooler discharge, 120°C.

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Section IV - Intermediate Storage and Continuous Blow Tank

A. Start-up Operation

1. Design Consideration

a) Intermediate storage is provided for storage between chlorination and distillation. It also provides aging time for the chlorinated Aroclors. By keeping the level at 90% full, at the maximum discharge rate of 8½ GPM from No. 9 chlorinator, an aging or retention time of 25 hours is attainable.

b) The continuous blow tank is sized on the basis of a batch blow of 60 minutes. Retention time at a feed rate of 6 GPM from the intermediate storage tank provides a retention time of 1.7 hours.

2. Intermediate Storage Tank Operation

a) Check that steam is on the plate coils on the storage tank and that the temperature control system is operational.

b) Close manual valve on the bottom of the tank.

c) Check that HCl scrubber is operating properly. The water pressure gauge at the scrubber should be at 40 to 50 psig.

d) Align valves from No. 9 chlorinator circulating line to intermediate storage tank.

e) Align circulating line on the intermediate storage tank.

3. Continuous Blow Tank

a) When the level in the intermediate storage tank reaches a predetermined value (50 to 90% full) align valves to allow transfer from the intermediate storage tank to the continuous blow tank to still No. 3 or No. 4.

b) The level in the continuous blow tank will be maintained automatically.

c) Align valves from the air blower to the blow tank.

B. Routine Operation

1. Intermediate Storage Tank

a) Check that pressure control system to the plate coil is operating satisfactorily to maintain a temperature of 150 - 180°C.

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b) When the existing biphenyl charge tank is filled from this tank it will be necessary to throttle charge valve at the charge tank so that the gauge at the pump indicates at least 30 psig. This will insure uninterrupted flow to the continuous blow tank and stills.

2. Continuous Blow Tank

a) When the continuous blow tank level is 50% of normal, start air blower and regulate outlet pressure to 8 psig.

b) Regulate air pressure to each of the blow tank compartments to 2 psig.

c) Align circulating valve on the blow tank.

d) Start blow tank transfer pump.

e) When charging a still pot, the blow tank will be bypassed until the still pot is charged.

C. Safety Features

a) The intermediate storage tank transfer pump will activate an alarm if it is shut down.

b) The blow tank transfer pump will activate an alarm if it is shut down.

c) A level controller controls the flow from the intermediate storage tank into the continuous blow tank. If the level in this tank is too low, set at 12 inches, an alarm will sound. If the level is too high, set at 36 inches, an alarm will sound.

d) The air blower will activate an alarm if it is shut down.

e) A combination vacuum-pressure relief vent is installed on the tank. A pressure of 6 oz. (10" w.c.) will open the vent. A vacuum of 4 oz. (7" w.c.) will open the vent. (Inter. stg. tank)

f) If the level is too high in this tank, an alarm will be activated. (Intermediate stg. tank)

D. Emergency Shutdown

1. Shut off steam to intermediate storage tank plate coil.

2. Shut down intermediate storage tank transfer pump.

3. Shut down blow tank transfer pump.

4. Shut down air blower.

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E. Control Loops, Interlocks and Alarms

1. There are 2 major control loops in the system.

a) Intermediate Storage Tank Level Indicator and Alarm - LIA-18.1

The function of this loop is to provide an indication of the level of material in the intermediate storage tank and sound an alarm on high level. This is accomplished by a diaphragm pressure transmitter. A 0-100% dial indicates tank level in the field and a 0-100% scale indicates tank level at the control panel.

b) Blow Tank Level Control and Alarm - LCA-17

The function of this loop is to control the level of material in the continuous blow tank and to activate an alarm if the level is too high or if the level is too low. This is accomplished by a level displacer which controls the level in the tank by throttling a control valve in the feed line to the blow tank. Set point for low level is 12 inches, high level is 36 inches, control is 20 inches.

2. Interlocks

There are no interlocks in this system.

3. Alarms

The following alarms exist through the system:

a) If the intermediate storage tank transfer pump motor stops.

b) If the blow tank transfer pump motor stops.

c) Low level in the blow tank.

d) High level in the blow tank.

Items b), c), d) above are listed on the Annunciator Panel as "Hi or Lo Level, Air Blow Off, Blow Tank".

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Section V - Off-Gas Purification

A. Start-up Operations

1. Design Considerations

a) HCl gas from the batch and continuous chlorinators will be cooled from 150°C to a temperature of 40°C in a gas-cooler. Entrained biphenyl and Aroclor, condensed by the gas-cooler, will be stored in an off-gas storage tank. The cooled gas will pass through a Brink mist eliminator and then transferred through a transfer line to the HCl purification plant, Dept. 218.

b) HCl gas can also be turned into the drowning jet without passing through the clean-up system.

2. Off-Gas Storage Tank Operation

a) Check that steam is on the plate coil on the storage tank and the temperature controller is operational. Set at 50°C in automatic.

b) Close valve under tank.

c) Align valves to circulate water through the cooler.

d) Adjust TIC-19 to allow water into pump suction.

e) Set the tempered water controller in automatic with the set point at 40°C.

f) Start the tempered water circulating pump.

g) Open the manual steam valve to the water mixer. As soon as water temperature is 40°C, close this valve.

h) Align valves to direct HCl gas from the chlorinator headers into the off-gas condenser.

i) Align valves to direct HCl gas to Dept. 218.

B. Routine Operations

a) Check that temperature controller is operating satisfactorily to maintain a material temperature of 50°C.

b) Check that circulating water temperature controller is operating satisfactorily to maintain a water temperature of 40°C.

c) Check level in the off-gas storage tank. This material will be used in the batch chlorinators No. 1 through No. 5 to make non-electrical grade Aroclors. The material can be pumped to the existing biphenyl charge tank by aligning valves and starting pump. The tank will hold 3000 gallons of material.

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d) Check level in the sample surge tank and at periodic intervals pump this tank to the off-gas storage tank. Do not shut off transfer pump until the sample surge tank is isolated from the off-gas surge tank since the latter contains HCl gas at 5 psig pressure.

C. Safety Features

1. A level instrument is located at the tank to indicate level of material in the tank.

2. A differential pressure gauge is located across the Brink demister to indicate pressure drop and is used to determine pluggage.

3. A rupture disc with a bursting pressure of 27 psig is located on the off-gas storage tank.

4. A relief vent, set to open at a vacuum of 0.75 psi, is located on the sample surge tank.

5. The tempered water circulating pump will activate an alarm if it is shut down.

D. Emergency Shutdown

1. Open manual valves to direct HCl gas to the drowning jet system.

2. Close manual valve to isolate HCl clean-up system from routine flow.

3. Stop the tempered water circulating pump.

4. Drain water out of the off-gas condenser and circulating lines to prevent freezing during cold weather.

E. Control Loops, Interlocks and Alarms

1. There are 3 major control loops in this system.

a) Off-Gas Storage Level Indication - LI-46

The function of this loop is to provide an indication of level of material in the off-gas storage tank. This is accomplished by a diaphragm pressure transmitter. A 0-100% dial indicates tank level in the field.

b) Off-Gas Storage Tank Temperature Control - TIC-20

The function of this loop is to provide temperature control for the material in the off-gas storage tank. This is accomplished by measurement of the temperature and controlling the heat input by throttling a control valve in the steam line to the plate coil on the storage tank. Set point for controller is 50°C.

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c) Off-Gas Condenser Temperature Control - TIC-19

The function of this loop is to control the temperature of the circulating water to the off-gas condenser. This is accomplished by measuring the water temperature and controlling this temperature by throttling a control valve in the city water line to the tempered water circulating system. Set point for the controller is 50°C.

Normal circulating water flow is 240 GPM. Inlet flow of city water will depend on the temperature of the city water and the quantity of heat removal required. Water flow will vary from 10 to 25 GPM.

2. Interlocks

There are no interlocks in this system.

3. Alarms

An alarm will be activated if the tempered water circulating pump motor stops.

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Section VI - Distillation

A. Start-up and Routine Operations

1. Design Considerations

a) Time Cycle Considerations

	For 1142	For 1154
Charge and Heat Up	1.2 hour	1.1 hour
Heat Up and Distill	13.7 "	14.7 "
Add Lime	0.5 "	0.5 "
Distill to Montar	13.7 "	14.7 "
Empty	0.5 "	0.5 "
Total	29.6 "	31.5 "
Actual Distilling Time	27.4 hrs.	29.4 hrs.
Distilling Rate	3700 lbs./hr. or 365 gal./hr.	3700 lbs./hr. or 340 gal./hr.

Capacity for 1242:

$$\frac{3700 \text{ lbs./hr.} \times 27.4 \text{ hrs.} \times 8750 \text{ hrs.} \times 90\%}{29.6 \text{ hrs.}} = 27.0 \ \overline{M} \text{ lbs./year}$$

Capacity for 1254:

$$\frac{3700 \text{ lbs./hr.} \times 29.4 \text{ hrs.} \times 8750 \text{ hrs.} \times 90\%}{31.5 \text{ hrs.}} = 27.2 \ \overline{M} \text{ lbs./year}$$

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b) Heat for distilling is provided in an external liquid-liquid heat exchanger. This unit is designed to exchange 688,000 Btu/hr. The batch will circulate through the tubes of the exchanger at 250 GPM and therminol FR-2 will circulate through the shell of the exchanger.

c) Distillation rate is controlled by a flow indicating controller mounted in the panel board. Increase in Therminol flow will result in larger boil-up, decrease in flow will result in slower boil-up.

d) Calculated loading for still vapor condenser is:

Desuper heat	20,350 Btu/hr.
Condense	407,000 Btu/hr.
Cool	215,600 Btu/hr.
Total	642,950 Btu/hr.

This is based on distilling Aroclor 1142 with an inlet temperature of 206°C and condensate temperature of 79°C and Aroclor 1154 with an inlet temperature of 240°C and condensate temperature of 84°C.

e) Heat removal from the condensers is accomplished with water in a high volume circulation system. This will allow better control over condensate temperatures and should prevent fouling of the tubes in the condenser.

f) The stills are designed to operate at a loading of 50% to decrease entrainment into the cyclone separator.

g) The still system is designed as a semi-continuous unit with lime present in the still pot at all times. Lime will be added at the start of the distillation and when 5000 gallons has been distilled. When 10,000 gallons of feed has been processed through the system, the residue will be pumped to still No. 2 for final boil-down and separation of Montar.

2. Still Operation

a) Align valves to charge from intermediate storage tank bypassing the continuous blow tank. The automatic level control valve and flow integrator will pass 30 gallon/minute.

b) Start intermediate storage tank pump and charge 1076 gallons into the still pot. This is equal to 48" in the still pot leaving 45" of Freeboard for disengaging height. Control valve will shut off when proper level is reached. Shut off valve to still and by-pass valve around blow pump. Shut off transfer pump.

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c) Add 125 pounds of lime directly to the still pot. Close still and still receiver.

d) Energize the steam ejector.

1) Close main valve in vacuum line to still just above receiver.

2) Start steam to first and second stages.

3) Open water valve to the after-condenser and adjust to point where no steam is escaping from the after-condenser vent.

4) Vacuum should pull down steadily to about 4 mm Hg. absolute and hold steady.

e) Align valves to still receiver from ejector to condenser.

f) Energize the water circulating system to the condenser.

1) Align valves to circulate water through the condensers and return.

2) Adjust TIC-37 to allow water into pump section.

3) Start the tempered water circulating pump. As soon as the water is circulating properly, set TIC-37 to the required temperature. Expected set point will be 150-160°F.

g) Align valves in still pump line to circulate through the external heat exchanger and back into the still. Start pump.

h) Set vacuum-recorders, PRC-24 or PRC-29, to maintain 40 mm Hg. absolute pressure at the still pot. Observe the schedule start of the stills to insure that operating vacuum is reached before boiling temperature is reached. If vacuum is lowered too quickly, the overheated Aroclor will flash and belch over crude material.

i) Slowly increase the flow of hot therminol to the external heat exchangers by adjusting the flow controllers, FRC-21 or FRC-26. This will be the control over the rate of distillation or forward flow.

The table below gives a range of adjustments possible with this control system:

GPM	Btu Input (Per Hr.)
99	343,000
132	458,000
165	571,000
200	687,000

Note: The scale of the therminol flow indicator is 0 to 100. The reading of 100 is equal to 200 GPM.

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j) When forward flow begins, start the intermediate storage tank transfer pump and blow tank transfer pump and open the block valve in the line to the still. Record reading on the input flow integrator, FQA-22 or FQA-27. The level controller will maintain a level in the still dependent on the amount of hot therminol flow to the external heat exchanger which controls the amount of condensate flowing to the still receiver.

k) When the still is under proper operating conditions the following data can be expected:

1. Temperature in still pot

Aroclor	1242	200°C
Aroclor	1248	215°C
Aroclor	1254	230°C

2. Vaccum 40 mm Hg. absolute at the still pot

3. Flow Rate 3700 lbs./hour

4. Batch Circulating Temperature

Therminol Flow to Exchanger GPM	Aroclor 1242		Aroclor 1254	
	Inlet	Outlet	Inlet	Outlet
99	410°F	416.6°F	464°F	470.6°F
132	410°F	418.7°F	464°F	472.8°F
165	410°F	420.9°F	464°F	475 °F
200	410°F	423.1°F	464°F	477.3°F

5. Still Condenser Forward flow temperature at 175°F for 1242, 183°F for 1254

6. Still Pump Output pressure at 50 PSIG

l) When the still receiver is full, align valves to pump to surge tanks.

m) Start receiver transfer pump. The level controller on the receiver tank will allow continuous pump-out without dead heading the pump.

n) When 5000 gallons of feed material has been distilled, shut off feed valve to still and valve in condensate flow line to still receiver. Shut off hot therminol flow to exchanger.

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o) Release vacuum and add 125 pounds of lime to the still pot.

p) Continue to distill into the still receiver until an additional 5000 gallons has been distilled. At this point, shut off still feed.

q) Align valves to transfer residue material to Still No. 2.

B. Safety Features

1. The still pot circulating pumps will activate an alarm, if they are shut down.

2. When the set amount of flow, 5000 gallons, has passed through the positive displacement meter, an alarm will be activated.

3. If the level in the still pots is too low or too high, an alarm will be activated.

4. If the level in the still receivers is too low or too high, an alarm will be activated.

5. A sight glass has been placed in the return leg from the cyclone. Some flow is necessary for satisfactory operation.

6. Rupture discs are installed on the still pots and still receivers to protect against over pressurization.

7. The intermediate and blow tank transfer pumps will activate an alarm, if they are shut down.

C. Emergency Shutdown

1. Shut off feed to the still pots.

2. Shut off therminol flow to the heat exchangers.

3. Shut off still pot circulating pumps.

4. Release vacuum by readjusting the vacuum controller to 760 mm Hg. absolute.

D. Control Loops, Interlocks and Alarms

1. There are five major control loops on each still pot system and one major control loop for both still condensers.

a) Still Pot Flow Totalization and Alarm - FQA-22, FQA-27

The function of this loop is to measure the amount of material added to the still pots. This is done by measuring flow with a positive displacement meter which sends impluses to a calibrated converter located on the panel board. An alarm is activated after a set amount has been added.

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b) Still Pot Level Control and Alarm - LICA-23, LICA-28

The function of this loop is to control the level of the material in the still pot and activate an alarm if the level is too high or too low. This is done by sensing level with a float and controlling the amount added with a control valve in the charge line.

High Level - 85" from bottom bend line

Low Level - 12" from bottom bend line

c) Therminol Flow Control to Heat Exchanger - FIC-21,FIC-26

The function of this loop is to control the flow of hot therminol to the external heat exchangers. This is done by measuring the therminol flow with an orifice and controlling this flow with a control valve in the therminol feed line.

d) Absolute Pressure Control - PIC-24, PIC-29

The function of this loop is to maintain a constant pressure in the still pot. This is done by measuring the vacuum in the still pot with an absolute pressure transmitter and throttling a control valve at the still ejector.

e) Still Receiver Level Control and Alarm - LICA-25, LICA-30

The function of this loop is to maintain a constant level in the still receiver and activate an alarm if the level is too high or too low. This is done by sensing level with a float and controlling the pump away with a control valve in the discharge line.

High Level - 55" from bottom bend line

Low Level - 12" from bottom bend line

f) Vapor Condenser Temperature Control - TIC-37

The function of this loop is to control the temperature of the circulating water to the vapor condenser. This is accomplished by measuring the water temperature and controlling this temperature by throttling a control valve in the city water line to the water circulating system. Set point for the controller is 65-70°C. Normal circulating water flow is 250 GPM (125 GPM for each condenser). Inlet flow of city water will depend on the temperature of the city water and the quantity of heat removal required. Water flow can vary from 15 to 50 GPM.

2. Interlocks

There are no interlocks in this system.

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3. Alarms

The following alarms exist through the system:

a) If the water circulating pump motor stops.

b) If the still level is too high or too low.

c) If the receiver level is too high or too low.

d) When the charge meter to the still reaches its set point.

e) If the still circulating pump motor stops.

Items b) and e) show on the Annunciator Panel as "Hi or Lo Level - Circulating Pump Off".

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Section VII - Absorbers

A. Start-up Operation

1. Design Considerations

a) Absorbers (Items 532, 539, 540, and 545)

1) Based on experience in the Anniston experimental column. This is covered in detail in Anniston R&D reports as follows:

Report No.	19	21
Job No.	370-322	
Date	9-14-67	2-16-68

2) Design flow through the absorber units

Aroclor	1242	1248	1254	1260
Flow - lbs/hr	3300	3300	3300	3300
Flow - gal/hr	318	282	272	264
Tank - ^{o}C	65	80	100	140
Visc. - cps	6.1	6.9	9.0	6.6
Density - lbs/gal	10.4	11.7	12.1	12.5

3) Other design parameters:

a) Design mass flow - 1 gpm/ft^2 of bed

b) Bed material - Poropel grade 20/60 which has an average particle size of 550 microns

c) Vibrators to pack the bed upon charging

d) Viscosity to remain constant at 40-45 SUS units

e) Height to diameter ratio - 3 to 1 minimum - allowed 5 to 1

f) Temperature of feed material is critical and has to remain constant for best absorption results

b) Surge Tanks (Items 530 and 537)

1) An agitated tank with cooling or heating coil is provided for control of temperature of the Aroclors.

2) The temperature of the goods into the surge tank should be at 100°C or less for best control.

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3) Other Design Parameters:

(a) Feed to surge tank - 3300 lbs./hr. at 100°C.

(b) Heat release in surge tank - 62,000 Btu/hr.

(c) Water balance - 30 GPM with Δt of 4°F.

(d) Time required to cool stream from 100°C to 65°C - 16.5 minutes.

(e) Retention time - 2.5 hours.

c) Polish Filters (Items 533 and 540)

These units collect any porocel that passes through the support plate in the absorbers.

d) Finished Product Tank (Item 534 and 542)

These tanks collect finished product before pumping is made to the finished product storage tanks.

2. Surge Tank Operation

a) Activate cooling or heating system to the coil of the surge tank and check that the temperature controller is operational. If the material has to be cooled, activate the cooling system (Items 530 and 537). If the material has to be heated, activate the heating system (Items 537, 547 and 548).

b) Activate the nitrogen blanketing system.

c) Close manual valve on bottom of tank.

d) Align valves from still receiver and start receiver transfer pump.

3. Absorber Operation

a) Charge 5900 lbs. of dry porocel into each absorber with vibrators operating. Porocel must be dry before Aroclor treatment begins. The bed may have to be heated with the steam coil provided and blown with nitrogen to insure a moisture free bed.

b) Activate steam heating system for absorber and set control point at a temperature corresponding to the surge tank temperature.

4. Filter Operation

Align valves from absorber to filter and return to surge tank.

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B. Routine Operations

a) After aligning valves from surge tank through absorber and filter to return to surge tank, start transfer pump.

b) Set flow control to absorbers to correspond to the flow from the still condensers. Normally, this will be 4 to 6 GPM.

Note: Scale of the flow indicator is 0 to 100. A reading of 100 is equal to 10 GPM.

c) Observe flow through system back to surge tank. Check material for resistivity and if it is in specification, cut to the finished product tank.

C. Safety Features

1. Field mounted level instruments are located on the surge tanks. A high level or low level will activate an alarm at the panel.

2. A field mounted temperature controller regulates temperature through the absorbers.

3. A flow indicator controller controls the flow to the absorbers. In the event the flow stops, an alarm is activated.

4. A Monsanto power factor analyzer is located in the field with a recorder at the panel to continuously monitor product power factor. An alarm will sound if power factor is too high.

5. A combination vacuum-pressure relief valve is installed in the surge tanks and finished product tanks to prevent air contamination of product. A pressure of 6 oz. (10" w.c.) will open the vent. A vacuum 0.5 oz. (1" w.c.) will open the vent.

6. A rupture disc is installed on the absorbers to prevent over pressurization. Burst pressure is 104 psig.

7. The agitator in the surge tanks will activate an alarm, if they are shut down.

8. Field and panel mounted level instruments are located on the finished product tanks. A high level will activate an alarm at the panel.

D. Emergency Shutdown

1. Shut off feed transfer pump to surge tanks.
2. Shut off feed transfer pump to absorbers.
3. Shut down surge tank agitator.
4. Shut off water or steam to surge tank coils and drain coil.

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E. Control Loops, Interlocks and Alarms

1. There are 6 major control loops in this system.

a) No. 3 and No. 4 Surge Tank Temperature Control - TIC-31 and TIC-34

The function of this loop is to provide temperature control for the distilled Aroclors in the surge tanks. This is needed to regulate the viscosity of the Aroclor before being pumped to the absorbers. This is done by measuring the temperature and controlling the heat input or output by throttling a control valve in the steam line or water line to the surge tanks. Set points are determined by the Aroclor being processed.

b) No. 3 and No. 4 Surge Tank Level - LIA-40 and LIA-41

The function of this loop is to give a field indication of level of Aroclor in the surge tank and to activate an alarm if the level is too high or too low. This is done by a diaphragm pressure transmitter. A 0 - 100% dial indicates tank level in the field.

High Level - 65" From Bottom Bend Line

Low Level - 12" From Bottom Bend Line

c) Absorber Steam Tracing Temperature Control - TIC-33 and TIC-36

The function of this loop is to control the heat loss from the absorbers. This is accomplished by sensing the outlet Aroclor temperature from the absorbers and controlling the heat input by throtting a control valve in the steam tracer around the absorbers.

d) Absorber Inlet Flow Control - FICA-32 and FICA-35

The function of this loop is to control the flow of Aroclors to the absorbers. This is done by measuring the Aroclor flow with an orifice and controlling this flow with a control valve in the transfer line to the absorbers. This system can be operated manually or automatically.

e) Power Factor Analyzer - ARA-44 and ARA-45

The function of this loop is to continuously monitor the quality of the finished product by measuring the power factor. This is done by passing the finished product through a special resistance cell and continuously measuring this resistance in a power factor analyzer. This signal is recorded at the panel board.

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f) Finished Product Tank Level Indicator - LIA-42 and LIA-43

The function of this loop is to provide a recorded level of finished product in the finished product tanks and to activate an alarm if the level is too high. This is accomplished by a diaphragm pressure transmitter. A 0-100% dial indicates tank level in the field and a 0-100% scale indicates tank level at the control panel.

High Level - 65" From Bottom Bend Line

2. Interlocks

There are no interlocks in this system.

3. Alarms

The following alarms exist through the system:

a) Low and high level in the surge tanks.

b) No flow to the absorbers.

c) If the surge tank agitator motor stops.

d) A high power factor from the resistance cell

e) High level in the finished product tanks.

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SECTION VIII - THERMINOL HEATER

A. Start-up Operations

1. Design Considerations

a) Based on heat requirements at the still pots

Actual Requirement - 1,376,000 BTU/hr
Design - 1,500,000 "

b) Total flow through the heater - 310 GPM

c) Temperature profile

	Inlet	Outlet
Actual	537°F	560°F
Design	525°F	570°F

2. Charge System with Therminol FR-2 (Aroclor 1248)

a) Use temporary drum pump to charge Therminol surge tank.

b) Fill surge tank, Item 586, with 16 drums - approximately 885 gallons total.

c) Blow out Therminol lines through heater coil to atmosphere to make certain no water is present in the heater coil.

d) Evacuate system with vacuum. This can be done by attaching a temporary air hose to the shell side of one of the external heat exchangers (Items 504 or 526) and to one of the still ejectors (Items 509 or 516). Evacuate the entire system to 26-27 inches of mercury vacuum. Shut down ejector.

e) Open valve in line to surge tank to introduce Therminol slowly into the system.

f) When the system is completely filled, start main circulating pump (Item 587). It may be necessary to put heat on the coil of the surge tank to make the Therminol pumpable. Do not heat above 50°C.

g) Circulate Therminol through the system for about 3 to 4 hours to eliminate air pockets and to be sure the system is filled.

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3. Furnace Start-up for First Time

a) Open the damper in the furnace stack.

b) Open manual valves in the natural gas line to the furnace main and pilot gas lines. Pressure gauges should read as follows:

PG 84 & 76	25 psig	gas
PG 81	5 psig	gas
PG 94	6 psig	air

c) Turn on "Therm" Htr. Panel Switch at the motor control center panel and the switch on the field control box to "on."

d) Set the temperature shutdown control point on the Honeywell coil outlet temperature indicator located in the box at 325°C (617°F).

e) Gas test the atmosphere inside the heater. Use a 3 foot length of copper tubing on the end of a rubber hose. If the test shows dangerous, stop and correct the cause of the trouble before lighting the burner. When the heater is cold, there is no natural draft to carry away gas or fumes. After the unit gets hot, there will always be a natural draft.

f) Set the temperature controller, TIC 52, in "auto" with temperature at 38°C (100°F).

g) Align the Therminol circulating valves.

h) Start Therminol circulating pump (Item 587). The "red" light at the Honeywell Protecto glo unit will light up, provided gas pressure switches are set correctly.

i) Actuate red reset lever inside the Honeywell Protecto glo unit in the field control box. Open the door of the flame unit. This exposes the small red lever in the lower right-hand corner of the case. You must wait 10 seconds between settings of this lever in case it has to be redone.

j) The "green" light on the Protecto glo unit should come on within 10 minutes. This is established by the purge timer setting.

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k) Depress the ignition start button on the side of the field control box to actuate the pilot flame. Hold the button depressed for no more than 10 seconds. If all is well, the "white" light on the Protecto glo unit will come on and the "green" light will go out. When this occurs, pull your finger away. The pilot is now properly lit.

l) Establishment of the pilot flame closes the main gas vent valve, SV 88, and permits manual opening of the main gas shutoff valves, SV 86 and SV 87. This flame at first is the "Low Fire Start" flame. After the Low Fire Start timer, TDR 94, times out, the flame size is directed by controller. This is set at 15 minutes.

m) The furnace refractory must be dried out prior to heat up to final set point of 295°C (562°F). Drying temperature should not exceed 38°C (100°F) and should remain at this temperature for a minimum of 24 hours.

4. Routine Operations

a) After the heater refractory is dry, the heater temperature can be raised to its normal operating point. Fluid temperature and fluid flow in the heater loop are maintained automatically.

b) After the Honeywell Protecto glo unit completes its program, the following conditions are normal:

Display	Measurement	
PG 76	25 psig	Gas to pilot burner
PG 81	5 psig	Gas to pilot burner
PG 84	25 psig	Gas to main burner
PG 89	20 psig	Gas to main burner
TIS 74	325°C (617°F)	Therminol through heater coil
TIC 52	295°C (562°F)	Therminol out of heater coil
FIC 47	300 GPM	Therminol through heater coil

c) The following guide is provided for inspection of the Therminol system:

1) Daily

Check pump operation, liquid level in surge tank, Item 586, and operating conditions listed above in Section 4 (b).

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2) Monthly

(a) Test the interlock between the Combustion Safeguard system and the Low Therminol Flow Switch, FS 47, and the High Temperature Switch, TIS 74.

(b) Analyze Therminol for viscosity, % moisture and acid number. New fluid assay is

Moisture - 50 ppm
Acid No. - 0.01 mg KOH/gm max.
Viscosity - 75 cp at 100°F

B. Safety Features

1. The Honeywell Protecto glo unit has the following safety features:

a) Ignition period 10 second delay between actuation periods for warp switch to cool.

b) Heater coil high temperature shutdown, TIS 74, set at 325°C.

c) Natural gas high reduced pressure shutdown, PS 82, set at 30 psig.

d) Natural gas low reduced pressure shutdown, PS 85, set at 10 psig.

e) "Low Fire Start-up" timer, TDR 94, will prevent a fast heat-up of the furnace. Timer will be set at 15 minutes.

f) Circulating pump low flow rate shutdown, FS 47, set at 200 GPM.

g) Pilot flame must be burning to start up the unit indicated by _____ microamperes on current meter. Meter gives an alternating off-on reading.

C. Emergency Shutdown

1. Push ignition "stop" button on scale of field control panel to shut off pilot and main burner.

2. Push "stop" button for the circulating pump located at the pump. This is the least preferred of the above methods.

3. Close block valves in gas line to the burner.

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D. Control Loops, Interlocks and Alarms

1. There are two major control loops in this system:

a) Temperature Control and High Temperature Cut-off, Therminol System, TIS 74, TIC 52, TR 52

The function of the temperature control is to control and record the temperature of the heated Therminol to be used at the still heat exchangers (Items 504 and 526). This is done by measuring the temperature of the Therminol and throttling a control valve in the fuel gas line to the main burner. This temperature is recorded on a two-pen recorder on the burner panel. The function of the high temperature cut-off is to shut off the fuel gas to the burner in the event the temperature of the Therminol is too high.

b) Circulation Control - Therminol System, FIC 47

The function of this loop is to maintain a flow of Therminol through the Therminol system. This is done by measuring the Therminol flow with an orifice at the outlet of the coil. The control valve, located at the extremity of the loop, will throttle as needed to maintain the coil flow rate corresponding to the minimum tube velocity for sound design. This flow is 300 GPM. The heater will shut down upon low flow.

2. Interlocks

The following conditions will shut the furnace down:

a) High furnace coil outlet temperature, TIS 74, above 325°C

b) Low reduced natural gas pressure, PS 85, 10 psig

c) High reduced natural gas pressure, PS 82, 30 psig

d) Pilot flame failure, ZE 75 and ZS 75

e) Electric power failures, ZE 75 and ZS 75

f) Flow in Therminol circulating loop, FS 47, at 200 GPM or below

3. Alarms

The following alarms exist through the system:

a) Low furnace outlet temperature, TRA 48, PT 24

b) Low Therminol flow, FR 47

c) Any interruption to the flame failure system, ZS 75

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4. Field Installation and Instrument Checkouts

This information to be supplied by the Instrument Section of CED.

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