CYCLEMAX™ CCR™ UNIT

General Operating Manual

February 2000
Revision 5

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I. INTRODUCTION TO CCR

The Catalyst Regeneration Section of a UOP Platforming Unit gives refiners the flexibility to operate the reaction section at high-severity conditions. At high-severity conditions in the reaction section, reforming catalyst deactivates more rapidly because coke lays down on the catalyst at a faster rate. Without a Catalyst Regeneration Section, the reaction section would have to be shut down more often for regeneration to burn off this coke and to restore the catalyst's activity and selectivity. With a Catalyst Regeneration Section, however, the refiner is able to operate the Platforming reaction section without having to shut down for catalyst regeneration. This is done by regenerating the catalyst continuously in the Catalyst Regeneration Section while the Platforming reaction section continues to operate.

The Catalyst Regeneration Section consists of a system of integrated equipment that is separate from, but still connected to, the reaction section. It performs two principal functions – catalyst circulation and catalyst regeneration – in a continuous circuit. First, spent catalyst from the last Platforming reactor is circulated to the Catalyst Regeneration Section. In the Catalyst Regeneration Section, the spent catalyst is regenerated in four steps: 1) Coke Burning; 2) Oxychlorination – for dispersing the catalyst metals and adjusting the catalyst chloride content; 3) Catalyst Drying; 4) Reduction – for changing the catalyst metals to the reduced state. Finally, the regenerated catalyst is circulated back to the first Platforming reactor. The logic and sequence of this circuit are controlled by the Catalyst Regeneration Control System.

In this manner, freshly-regenerated catalyst is continuously circulated through the Platforming reactors. This ensures that the Platforming reactor section operates economically with optimum catalyst performance at high-severity conditions and for long on-stream periods of operation.

In this manual, all aspects of the operating procedures of a Catalyst Regeneration Section are covered in some detail. It must be understood that this is a general manual and is not meant to strictly apply to one particular unit. The purpose in preparing this general manual is to assist the refiner in developing a more detailed manual for his particular unit.

II. PROCESS PRINCIPLES

A. CATALYST

The UOP Platforming catalyst consists of metals impregnated on an alumina base. A wide variety of metals can be used, but platinum is the chief metal. The alumina base acts as a support for the metal. The alumina is also a support for chloride.

In the Platforming reactors, both the metal and the chlorided base help catalyze desirable reactions. In short, the catalyst has two functions. The metal catalyzes hydrogenation and dehydrogenation reactions. The chlorided alumina acid function catalyzes isomerization and cracking reactions.

Optimum catalyst performance requires a proper balance of these two catalytic functions. Too much or too little of one or the other will upset the selectivity and activity of the catalyst. As a result, the performance of the catalyst in the Platforming reactors will suffer.

The operation of the Catalyst Regeneration Section has a great effect on the proper balance of the metal and chloride functions. Each of the four steps of catalyst regeneration must be done well to ensure the proper balance is maintained. Proper operation of the Catalyst Regeneration Section will help ensure optimum performance of the catalyst and long catalyst life.

In addition to its optimum catalytic properties, the catalyst also has strong physical properties. It is specially made to be resistant to attrition. Proper construction and operation of the Catalyst Regeneration Section will help preserve the good mechanical strength of the catalyst and minimize attrition.

B. CHEMISTRY

The Catalyst Regeneration process is a four-step process where the desirable regeneration reactions are completed on the catalyst. The operating conditions for each step are designed to favor certain chemical reactions. Each step is important in its own right, and all four steps must be performed correctly. The goal is to restore the catalyst to a condition that is as close to that of fresh catalyst as possible. The basic regeneration chemistry is the same for all regeneration sections.

1. Coke Burning

The first step burns coke off the catalyst. Coke burning takes place with oxygen by the combustion reaction. It makes carbon dioxide and water and gives off heat (exothermic):

$$\text{Coke} + O_2 \longrightarrow CO_2 + H_2O + \text{Heat}$$

This reaction is necessary and desirable to remove coke, but it can easily damage the catalyst. It results in a temperature rise on the catalyst, and high temperature greatly increases the risk of permanent damage to the catalyst. So the burning must be controlled. This is done by controlling the oxygen content during the burn. High oxygen makes the burn temperatures high. But low oxygen makes the burning too slow. During normal operation, the oxygen content is kept between 0.5 and 1.0 mol% oxygen. This is an optimum range to maximize the coke burning rate while minimizing the coke burning temperature.

2. Oxychlorination

The second step adjusts the chloride content and oxidizes and disperses the metals (i.e., platinum) on the catalyst. These reactions take place by complex reactions with oxygen and an organic chloride compound. These reactions need both oxygen and chloride. The chloride adjustment reactions can be summarized as follows:

(1) $\text{Chloride Compound} + O_2 \longrightarrow HCl + CO_2 + H_2O$

(2) $HCl + O_2 \rightleftharpoons Cl_2 + H_2O$ (Deacon Equilibrium)

(3) $Base\text{-}OH + HCl \rightleftharpoons Base\text{-}Cl + H_2O$

Chloride is needed on the catalyst to keep the proper activity of the acid function. But too much or too little chloride will have undesirable effects in the Platforming reactors. So the amount of chloride on the catalyst must be controlled. This is done by controlling the injection rate of the chloride compound. During normal operation, the chloride content of the oxidized catalyst is kept between 1.1-1.3 wt-% chloride, depending on the catalyst series. This is an optimum range for the acid function of the catalyst.

Table II-1: Properties of Organic Chloride Compounds

Compound	Molecular Weight	Freezing Point, °C (°F)	Boiling Point, °C (°F)	Specific Gravity @ 20°C (68°F)	Chloride content, wt%	Heat of Combustion, kJ/kg
Perchloroethylene (PERC)	165.8	-23 (-9.4)	120.6 (249)	1.63	85.5	4840
Methyl Chloroform (Trichloroethane)	133.41	-37 (-34.6)	74 (135.2)	1.33	79.7	7346

The oxidation and redispersion reactions can be summarized as follows:

$$\text{Metal} + O_2 \xrightarrow{Cl_2} \text{Oxidized Metal (dispersed)}$$

More evenly distributed metal on the catalyst surface results in better metal function of the catalyst. The conditions that promote proper oxidation and re-dispersion of the metal are high oxygen concentration, adequate residence time, correct temperature, and correct chloride concentration.

3. Drying

The third step dries excess moisture from the catalyst. Excess moisture is present from the coke burning step. Drying occurs when a hot, dry gas flows across the catalyst, removing water from the catalyst base:

$$\text{Base-}H_2O + \text{Dry Gas} \longrightarrow \text{Base} + \text{Gas} + H_2O$$

The drier the catalyst is before it re-enters the Platforming reactors, the better its overall performance will be. This drying step is favored by high temperature, adequate drying time, and adequate drying gas flow rates.

4. Reduction

The fourth step converts the metals from an oxidized state to a reduced state. This must be done after the oxychlorination step to return the metals to a state that is optimum before returning the Platforming reactors. The reduction reaction takes place with hydrogen by the following reaction:

$$\text{Oxidized Metal} + H_2 \longrightarrow \text{Reduced Metal} + H_2O$$

The more complete the reduction, the better the metal will perform in the Platforming reactors. The conditions that favor this reaction are high hydrogen purity, sufficient Reduction Zone temperatures and reduction gas flow rates adequate to ensure good gas distribution.

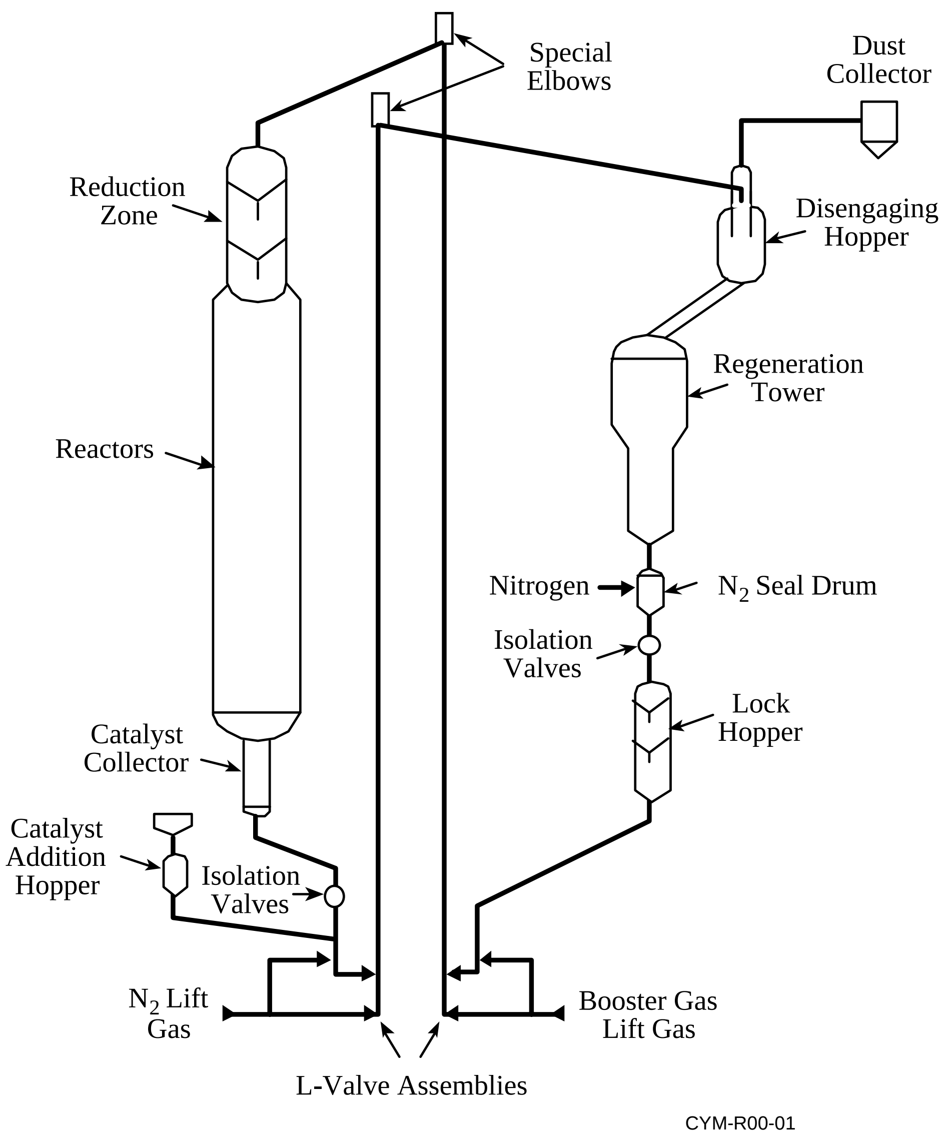
C. CATALYST REGENERATION PRINCIPLES

Figure II-1 is a flow diagram of the UOP CycleMax Catalyst Regeneration Section. The Catalyst Regeneration Section performs two functions: catalyst regeneration and catalyst circulation.

1. Catalyst Regeneration

Catalyst regeneration consists of four steps. The first three steps – coke burning, oxychlorination, and drying – occur in the Regeneration Tower. The fourth step, reduction, occurs in the Reduction Zone atop the Reactor Stack. A fifth step, catalyst cooling, is not part of the regeneration but is required for proper catalyst transfer. This step occurs in the Regeneration Tower.

Figure II-1
Simplified Flow Diagram of UOP Continuous Platforming CycleMax Regeneration Section



(a) Burn Zone/Reheat Zone (Figure II-2)

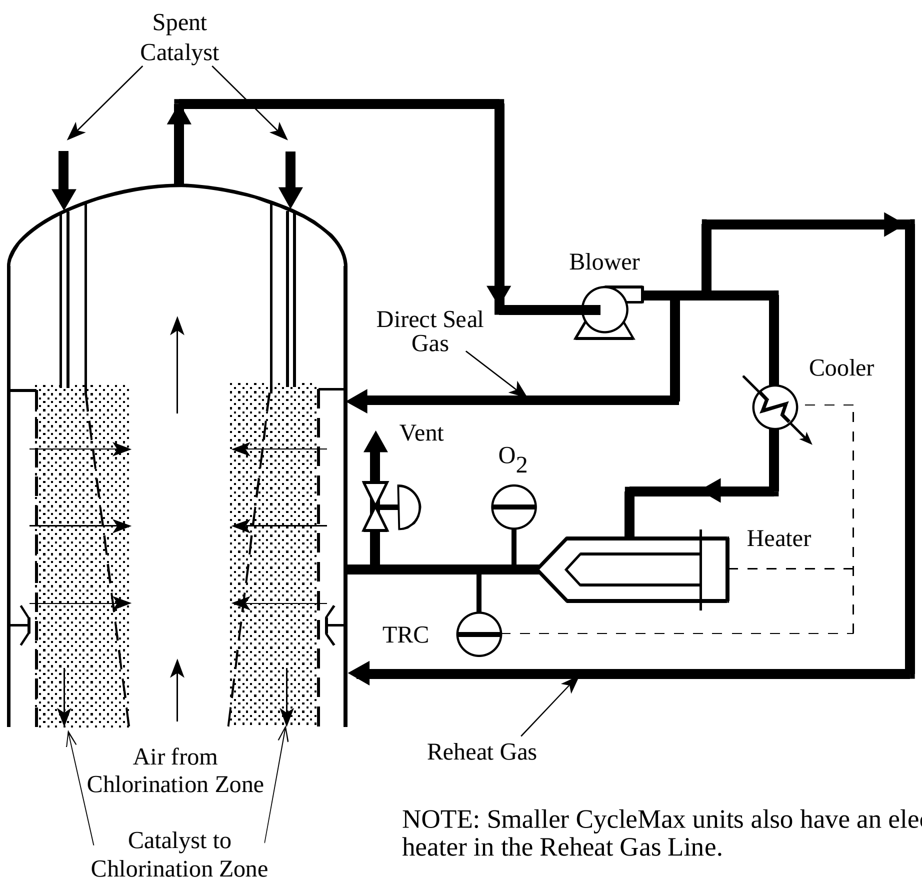
The burning of coke from the catalyst occurs in the Burn Zone at the top of the Regeneration Tower. Catalyst enters and flows downward between a vertical, cylindrical outer screen and a tapered inner screen. Hot regeneration gas, containing a low concentration of oxygen, flows radially from the outside to the inside of the catalyst bed. Coke burning occurs as the catalyst moves down in the bed. The coke burning should be complete when the catalyst exits the Burn Zone. The purpose of the tapered center screen is two-fold:

(1) To minimize the residence time of the catalyst behind the burn front. This catalyst is exposed to oxygen-deficient gas that is high in temperature and moisture. These are the conditions that promote catalyst surface area loss.
(2) To concentrate the flow of regeneration gas at the top of the bed where coke burning is oxygen supply limited. In the lower section, where the coke burning is oxygen diffusion limited, a slower flow of gas is acceptable and catalyst residence time is of greater importance.

The hot combustion gas mixes with the gas flowing up from the Chlorination Zone. The oxygen-rich chlorination gas supplies the oxygen for burning coke. The combined gas flows back to the Regeneration Blower. The Blower recycles the gas through the Burn Zone piping loop. A small portion of the circulating gas is directed from the Blower discharge to the top of the Burn Zone as direct seal gas. The seal gas preheats the catalyst before it reaches the top of the Burn Zone. The Regeneration Cooler removes the heat generated by the coke burning. The Regeneration Heater heats the gas to the proper zone inlet temperature during start-up or if heat loss in the piping is greater than the heat of combustion. The oxygen analyzer controls the oxygen content to the Burn Zone inlet. The products of combustion are vented from the Regeneration Tower inlet to provide a constant temperature vent gas to the downstream chloride scrubbing equipment.

After catalyst exits the Burn Zone it enters the Reheat Zone. In this zone the catalyst is heated further with hot combustion gas directly from the Regeneration Blower discharge. Units with small Regeneration sections may include a Reheat Gas electric heater to raise the reheat gas temperature above the normal blower discharge temperature. The purpose of this zone is to raise the temperature of the catalyst before it enters the Chlorination Zone. The Reheat Zone also provides additional residence time for oxygen diffusion limited coke combustion to prevent coke breakthrough.

Figure II-2
CycleMax Regeneration Tower
Burn Zone



NOTE: Smaller CycleMax units also have an electric heater in the Reheat Gas Line.

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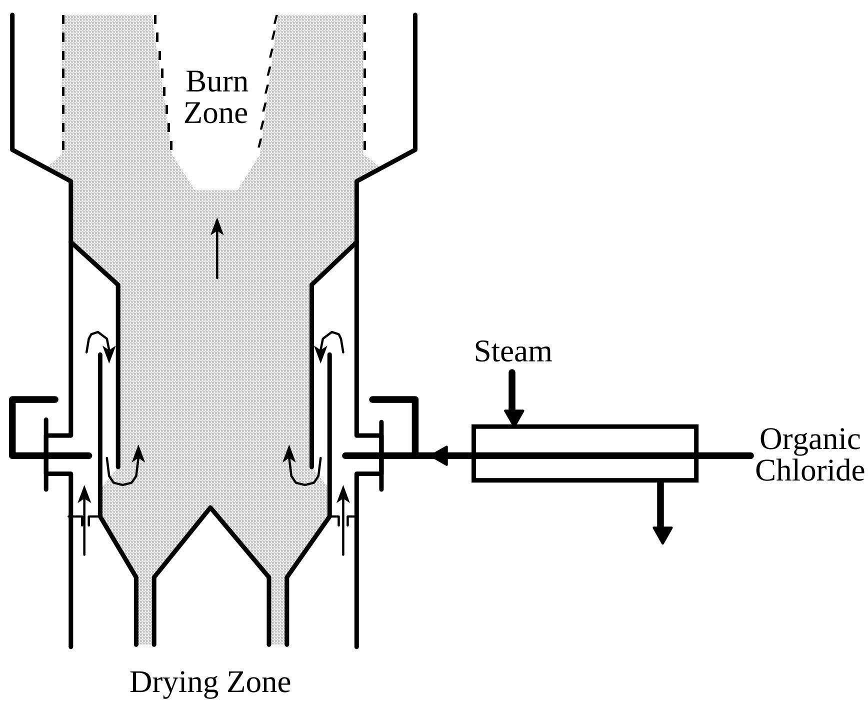
(b) Chlorination Zone (Figure II-3)

The catalyst metals are dispersed and the catalyst chloride content is adjusted in the Chlorination Zone. The Chlorination Zone is located below the Reheat Zone. Catalyst enters and flows downward in a cylindrical bed bound by an annular baffle. Hot air from the Drying Zone flows upward into the region behind the annular baffle where vaporized organic chloride is introduced to the gas through distributors. The resulting chlorination gas then flows upward through the catalyst bed and exits into the Burn Zone.

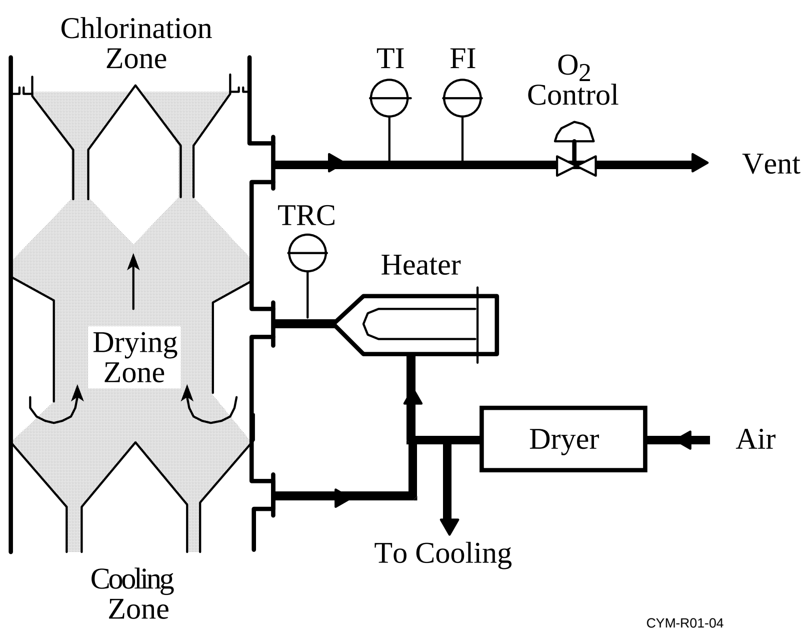
Figure II-3
CycleMax Regeneration Tower
Chlorination Zone



(c) Drying Zone (Figure II-4)

Catalyst drying occurs in the Drying Zone. The Drying Zone is below the Chlorination Zone. Catalyst enters and flows down through a cylindrical bed. Hot drying gas flows upward through the catalyst bed. The drying gas is a combination of air from the Cooling Zone and from the instrument air header. The air is dried to a very low moisture content in the Air Dryer before entering the Regeneration Tower. The Air Heater heats the gas to the proper inlet temperature. The gas from the Cooling Zone is hot, as it has been preheated by exchange with hot catalyst in that zone. This preheat reduces the net duty on the Air Heater. From the Drying Zone the drying air splits into two streams: one enters the Chlorination Zone behind the annular baffle and one exits the Regeneration Tower. The split depends on the amount of air needed for coke burning in the Burn Zone. The amount of air that is needed for coke burning enters into the Chlorination Zone. Any excess air vents directly from the Regeneration Tower on oxygen control. The excess air is needed in the Drying Zone for more complete moisture removal in that zone.

Figure II-4
CycleMax Regeneration Tower
Drying Zone



(d) Cooling Zone (Figure II-5)

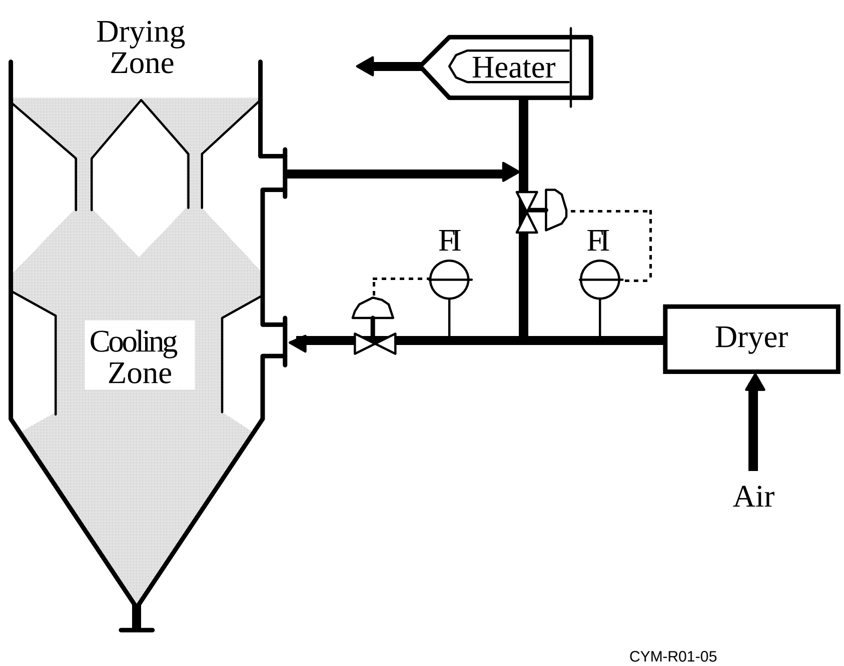
The Cooling Zone serves two functions, cooling the catalyst for downstream handling, and preheating a portion of the air to the Drying Zone. Cooling the catalyst reduces the metallurgy requirement for the downstream catalyst transfer equipment and facilitates catalyst transfer. Preheating the Drying Zone air lowers the duty required for the Air Heater thus reducing capital and operating costs.

The Cooling Zone is below the Drying Zone. Catalyst enters and flows downward in a cylindrical bed before exiting the Regeneration Tower. The cooling gas is air from the Air Dryer. The gas exits the zone and mixes with instrument air from the Air Dryer then enters the Air Heater before going to the Drying Zone. The split between air going to the Cooling Zone and air going directly to the Drying Zone determines the temperature of the catalyst exiting the Regeneration Tower.

Figure II-5

CycleMax Regeneration Tower

Cooling Zone

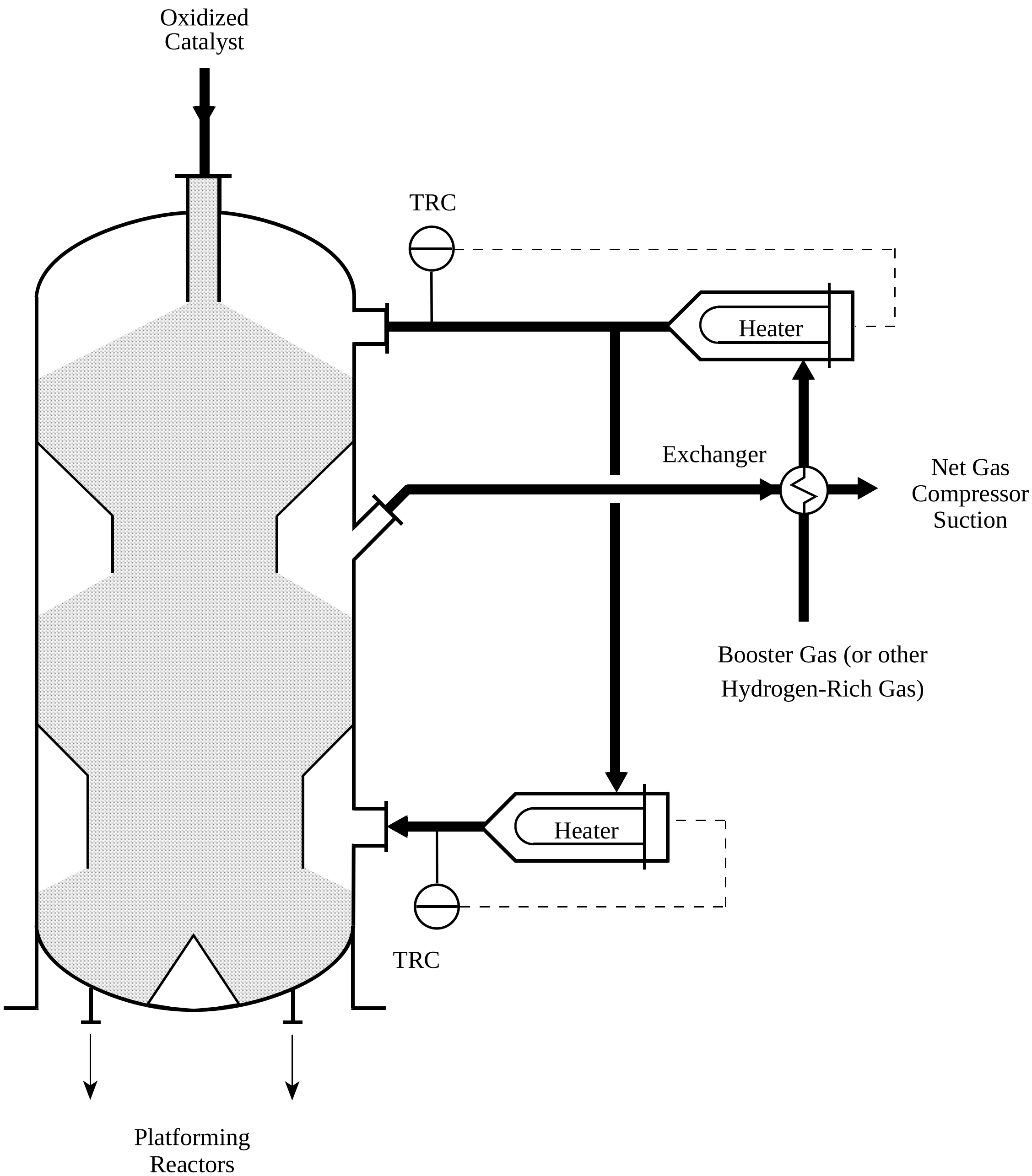


(e) Reduction Zone (Figure II-6)

Reduction of the metals on the catalyst occurs in the Reduction Zone. The Reduction Zone is at the top of the Reactor Stack. Oxidized catalyst enters the top of the zone via the regenerated catalyst lift line. The catalyst flows downward through two cylindrical beds with a gas disengaging area between them. The catalyst exits the zone and enters the first Platforming reactor. Reduction gas of intermediate temperature is supplied to the upper cylindrical bed and flows co-current with the catalyst. Reduction gas of higher temperature is supplied to the lower cylindrical bed and flows counter-current to the catalyst flow. Both gases exit from the Reduction Zone via the gas disengaging area. For most units, the reduction gas is hydrogen-rich gas from the Platforming Unit recontact or chiller section. Some units may require a small hydrogen purification unit to obtain suitable hydrogen-rich gas for reduction. The Reduction Heaters heat the gas to the proper inlet temperatures for each bed in the zone.

The purpose of the dual zone reduction is to affect optimum and independently controlled reduction conditions for the proper performance of the catalyst. A low temperature reduction is performed in the upper bed and a high temperature reduction is performed in the lower zone.

Figure II-6
Reactor Stack
CycleMax Reduction Zone



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2. Catalyst Circulation

Catalyst circulation consists of transferring catalyst from the Platforming reactors to the Regeneration Section and back again.

(a) Spent Catalyst Transfer

The catalyst circulation control scheme is shown in Figure II-7. Spent catalyst flows by gravity from the bottom of the last reactor to the Catalyst Collector. Catalyst flows downward into the Spent Catalyst L-Valve Assembly against an upward flow of nitrogen. At the L-Valve Assembly, circulating nitrogen from the Lift Gas Blower engages the catalyst and lifts it through the catalyst lift line to the Disengaging Hopper. In the Disengaging Hopper, additional circulating nitrogen from the Fines Removal Blower separates catalyst chips and fines from the whole catalyst and carries them out the top with the gas. The chips and fines are removed in the Dust Collector and the nitrogen circulates back to the suction of the Fines Removal Blower and the Lift Gas Blower. The whole catalyst drops to the bottom of the Disengaging Hopper, and flows by gravity into the Regeneration Tower. The catalyst flows through and out of the Regeneration Tower by gravity.

(b) Regenerated Catalyst Transfer

From the Regeneration Tower, the catalyst flows by gravity into the Nitrogen Seal Drum against a flow of nitrogen. From the Nitrogen Seal Drum the catalyst flows into the Lock Hopper. The Lock Hopper moves small batches of catalyst from the vessels above to the Regenerated Catalyst L-Valve Assembly. At the L-Valve assembly, hydrogen-rich gas from the recontact or chiller section of the Platforming Unit engages the catalyst and lifts it through the catalyst lift line to the Reduction Zone above the first Platforming reactor. The catalyst flows through the Reduction Zone to the top of the first reactor by gravity. The catalyst flows through and out each reactor by gravity until it reaches the catalyst collector. Catalyst flows between the reactors through equally-spaced transfer lines designed to ensure even catalyst flow from all sides of each reactor. This completes the transfer circuit.

(c) Catalyst Circulation Control

The catalyst circulation control scheme is shown in Figure II-7. The catalyst circulation rate for the entire system is set by the Catalyst Regeneration Control System (CRCS) by directly controlling the regenerated catalyst lift rate. The desired catalyst circulation rate is entered into the CRCS and it generates an output signal that adjusts the catalyst circulation as described below. The lift line pressure drop is used as a control parameter because it varies directly with catalyst flux (catalyst flow rate) in the lift line. The rate of catalyst lifting, as performed by the L-Valve assembly, is controlled by splitting a constant lift gas flow between the primary and secondary addition points. In practice, this is achieved by keeping the total lift gas flow constant and varying only the secondary lift gas rate.

The CRCS output signal is determined from the desired catalyst flow setpoint (circulation rate) entered. The CRCS sets the PDRC setpoint to a value stored in the CRCS memory commensurate with the catalyst flowrate setpoint entered. The output signal from the regenerated catalyst lift line PDRC resets the regenerated catalyst secondary lift gas FRC (Flow Recorder Controller) setpoint. The flow of secondary lift gas, as set by the FRC, controls the catalyst lifting to the Reduction Zone. As lifted catalyst is replaced by catalyst from the Lock Hopper Surge Zone, the level in that zone decreases. Once a low level is reached, the CRCS initiates the transfer of one batch of catalyst from the Regeneration Tower to the Lock Hopper Surge Zone by cycling the Lock Hopper Zone pressure. The Lock Hopper Zone load size is a known weight of catalyst, calibrated during the initial startup of the unit. The actual circulation rate is determined by the CRCS based on a running average of the frequency of Lock Hopper loads transferred. The regenerated catalyst lift line PDRC setpoint is then adjusted by the CRCS to match the actual circulation rate with the circulation rate entered into CRCS.

In addition to the above, the rate of change of the catalyst lift rate must be slow and controlled to maintain the stability of the process environment isolation systems utilized in the CycleMax design. Large or rapid changes in catalyst lift rate could result in the contamination of the oxygen atmosphere in the Regeneration Tower by hydrogen gas or interruption of catalyst flow to the L-Valve assemblies.

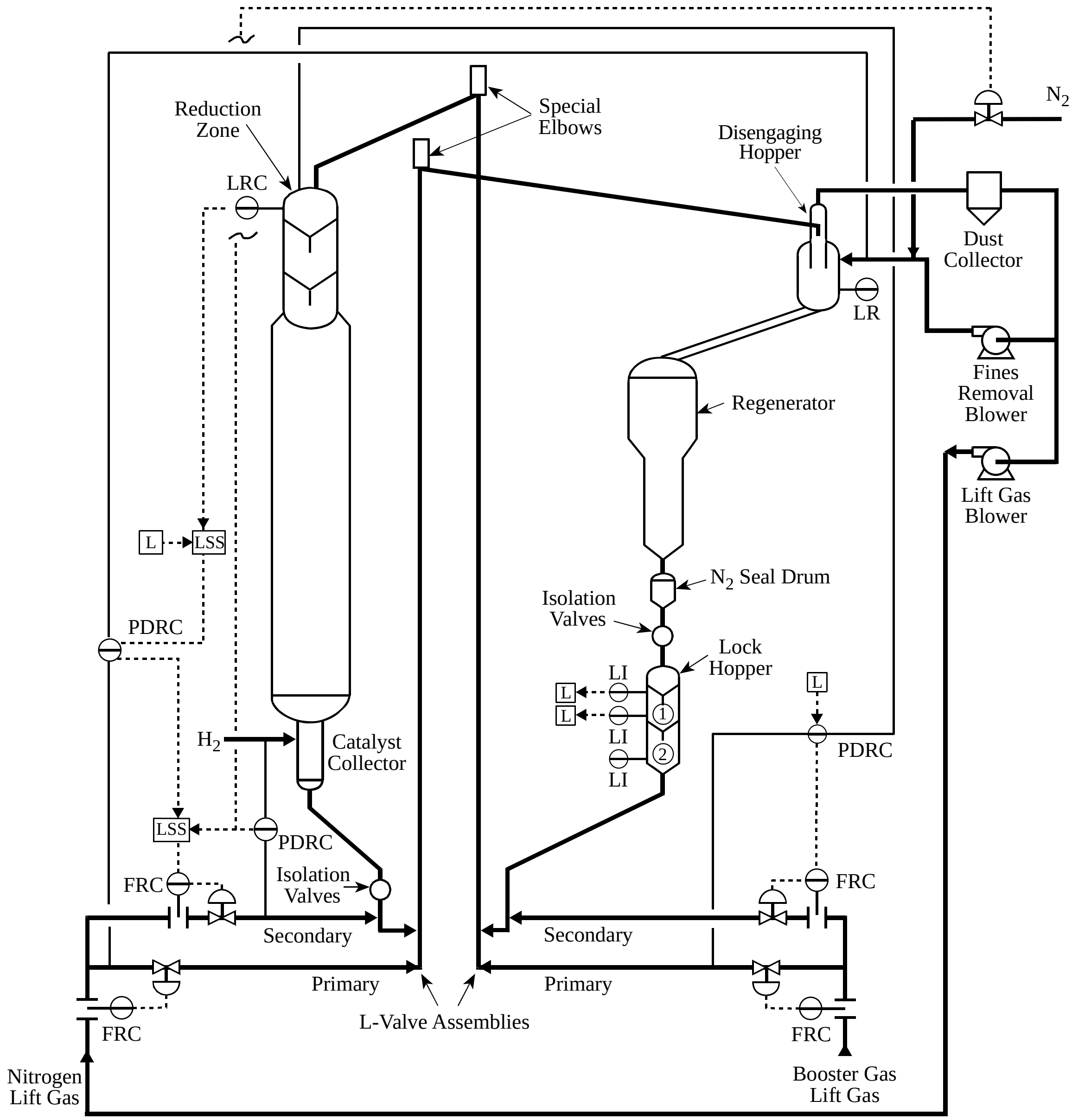
Since regenerated catalyst is being lifted to the Reduction Zone, spent catalyst is removed from the Platforming Reactors so as to maintain a controlled level in the upper bed of the Reduction Zone atop the reactor stack. The LRC (Level Recorder Controller) at the Reduction Zone sends a signal resetting the spent catalyst lift line PDRC (Pressure Differential Recorder Controller) setpoint via a signal selector. The signal selector also receives a signal from the CRCS. The output signal from the spent catalyst lift line PDRC resets the spent catalyst secondary lift gas FRC setpoint via a signal selector. The selector also receives an output signal from the Reactor/Spent Catalyst Lift Line PDRC. The flow of secondary lift gas as set by the FRC controls the catalyst lifting rate via the L-Valve Assembly to the Disengaging Hopper.

The signal selectors, and the secondary inputs they incorporate, are required to maintain the stability of the process environment isolation systems utilized in the CycleMax design. A large or rapid increase in catalyst lift rate could interrupt catalyst flow from the Reactor due to a rise in pressure at the L-Valve Assembly. The low signal selector receiving input from the Reduction Zone LRC also receives a signal from the CRCS. The latter signal is an adjustable ramping function designed to slowly increase the catalyst flow rate from 0% to 100% of the design catalyst circulation rate. This ramping is used by the Catalyst Flow Control in the CRCS only when catalyst circulation is initiated after a shutdown. At some point during the catalyst circulation ramp, the signal from the LRC will be less than that of the ramp function. At that point, the low signal selector will use the LRC signal as its output signal to the spent catalyst lift line PDRC.

The signal selector that receives input from the lift line PDRC also receives a signal from the Spent Catalyst Lift Line / Reactor (SCLL/R) PDRC. The latter signal serves to limit the magnitude and speed of catalyst lift rate changes for system stability. If the catalyst lift rate increases rapidly, the differential pressure between the lift pipe and the Reactor will increase (the bottom of the lift line being maintained at a higher pressure than the reactor) and the high upward flow of gas will impede catalyst flow downwards to the L assembly. Once the pressure differential increases to near that which will impede catalyst flow, the SCLL/R PDRC output will limit the catalyst lift rate by limiting the secondary lift gas flow.

Figure II-7

Catalyst Circulation Control Scheme UOP Continuous Platforming CycleMax Regeneration Section



Legend

FRC = Flow Recorder Controller
PDRC = Pressure Differential Recorder Controller
LR = Level Recorder
LRC = Level Recorder Controller
LI = Level Indicator

L = Logic Input
SS = Signal Selector
1 = Lock Hopper Zone
2 = Surge Zone

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(d) Process Pressures and Environments

There are several inherent hazards to overcome in order to transfer catalyst safely between the reaction section and the Regeneration Section. This is because the two sections operate at different pressures and under different environments, as shown in Figures II-8 and II-9. First, the low pressure equipment in the Regeneration Section must at all times be kept safe from the higher pressure environment in the Platforming section. Second, the hydrogen / hydrocarbon environment of the reaction section must at all times be kept separated from the oxygen-containing environment of the Regeneration Section. Through the design of the equipment and through the programmed sequences of the CRCS, the Regeneration Section accomplishes these tasks.

The hydrogen/hydrocarbon and oxygen atmospheres are separated by the use of "nitrogen bubbles". A nitrogen bubble is a region between hydrogen containing equipment and oxygen containing equipment maintained as a pure N_2 atmosphere. This is accomplished by keeping the pure N_2 region at a higher pressure than the equipment on either side of it. Nitrogen bubbles are maintained in the Regeneration Section just below the Reactors (i.e., the spent catalyst transfer system and the Disengaging Hopper) and just below the Regeneration Tower (i.e., the Nitrogen Seal Drum). The Reactor and Regenerator pressures are kept separate by allowing a pressure gradient to exist across a standpipe filled with catalyst. The pressure drop is maintained by the flow of gas from high to low pressure through the catalyst. Such pressure gradients are maintained between the Disengaging Hopper and the Regeneration Tower, and between different zones within the Lock Hopper.

Figure II-8
Process Pressures
Simplified Flow Diagram of UOP Continuous Platforming CycleMax Regeneration Section

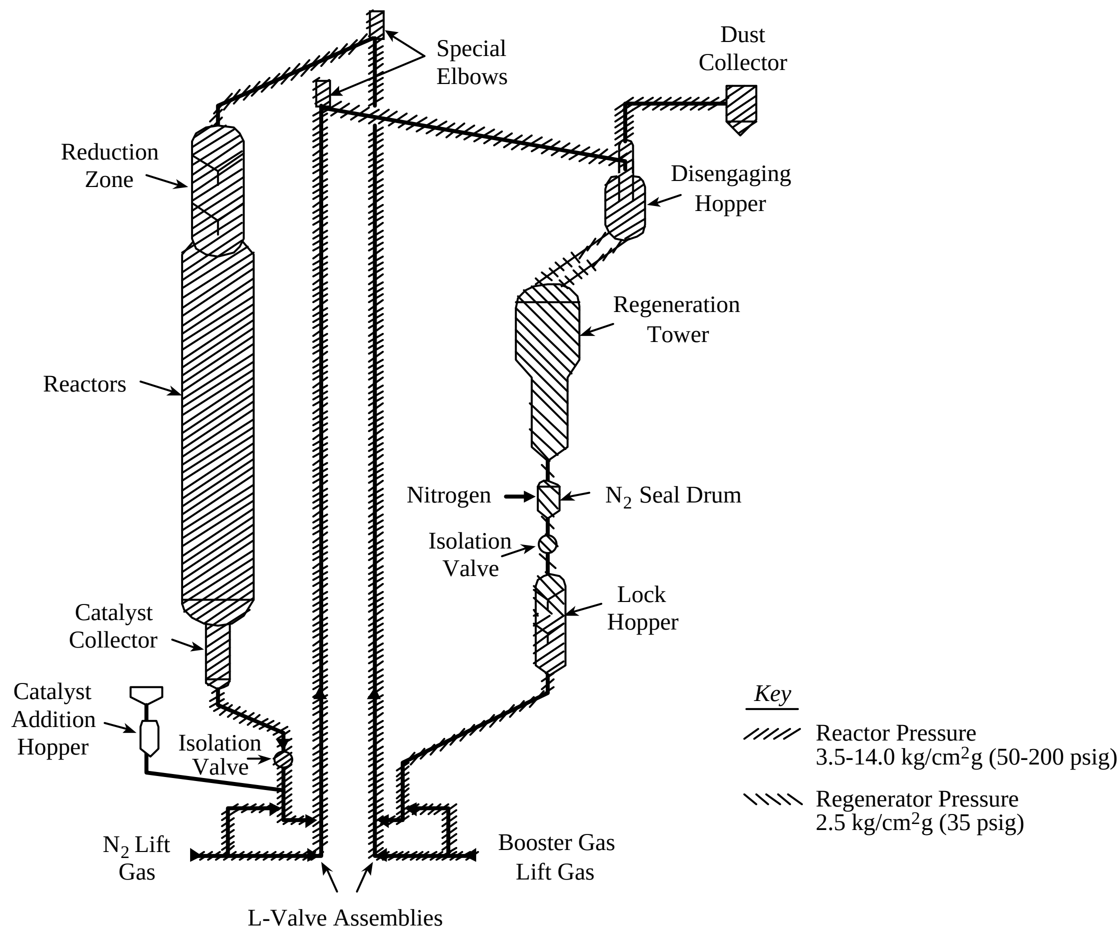

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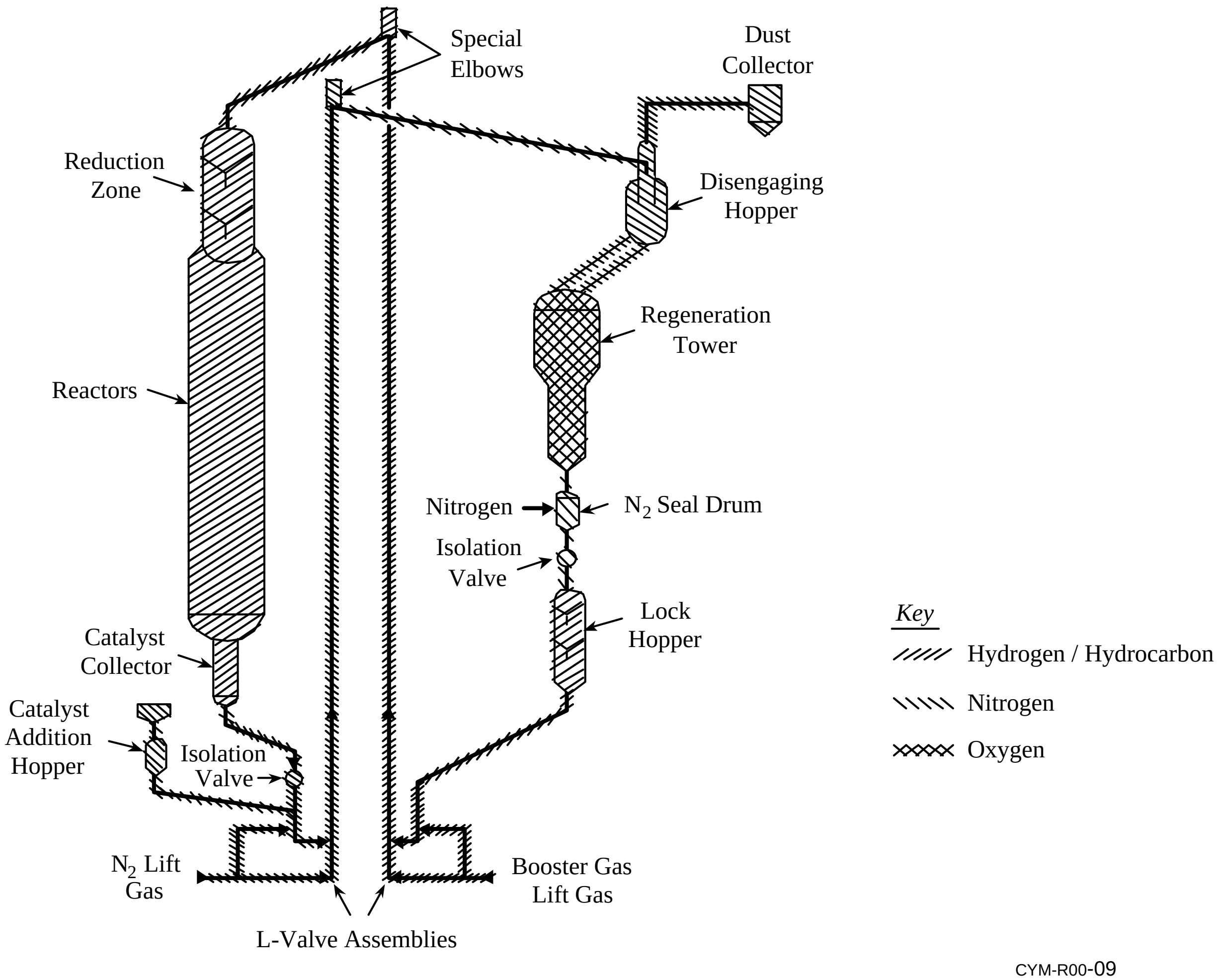
Figure II-9

Process Environments UOP Continuous Platforming CycleMax Regeneration Section



III. PROCESS VARIABLES

Good operation of the Regeneration Section depends on the proper selection and control of the processing conditions. The operating variables are of utmost importance to the performance of the Regeneration Section. This section includes general operating guidelines that should be followed to maintain the operating variables within acceptable limits.

The four most important operating variables of the Burn Zone are:

1. Catalyst circulation rate
2. Burn zone oxygen content
3. Spent catalyst coke content
4. Burn zone gas rate.

These four operating variables are interrelated. That means, each has limits on its acceptable operating range that are set by the other three variables. The operator must select all four variables with one goal in mind: To ensure that essentially all coke burning occurs in the Burn Zone. If coke burning occurs below the Burn Zone, such as in either the Chlorination Zone or the Drying Zone, then there will be serious damage to both catalyst and equipment.

There is a general operating guideline that helps the operator achieve this goal. It is called the General Operating Curve (Figure III-1). It shows how these four operating variables are interrelated to ensure that essentially all coke burning occurs in the Burn Zone. The operator should always operate the Regeneration Tower in accordance with the General Operating Curve.

In practice, the operator has direct control over only two of the variables in Figure III-1:

1) the catalyst circulation rate, and
2) the Burn Zone oxygen.

The other two – the spent catalyst coke and the Burn Zone gas rate – are not under the operator's direct control. This fact does not limit the operator's options, and the operator will find the General Operating Curve is useful in several ways, as the examples that follow will show.

CAUTION: The operator should keep in mind that the General Operating Curve (Figure III-1) is an operating *guideline*. This chart is considered to be conservative. That means, for a given spent catalyst coke, Burn Zone oxygen, and Burn Zone gas flow, the maximum permissible catalyst rate shown by Figure III-1 is probably less than the true maximum catalyst rate. So, Figure III-1 should provide a safety margin between an actual operating point and the point where coke burning is not completed in the Burn Zone.

The operator can periodically confirm that the Regeneration Tower operates in accordance with the General Operating Curve by using it during Black Burn operation when restarting the unit following a shutdown. Depending on the spent catalyst coke and the Burn Zone gas flow at the time, the operator should choose the catalyst circulation rate and the Burn Zone oxygen that correspond to a point on the General Operating Curve. After circulating the full catalyst inventory of the R.T. under the conditions, the regenerated catalyst leaving the Regeneration Tower should be 0.1 wt-% coke or less, have coke-free centers, and contain essentially no whole black spheres.

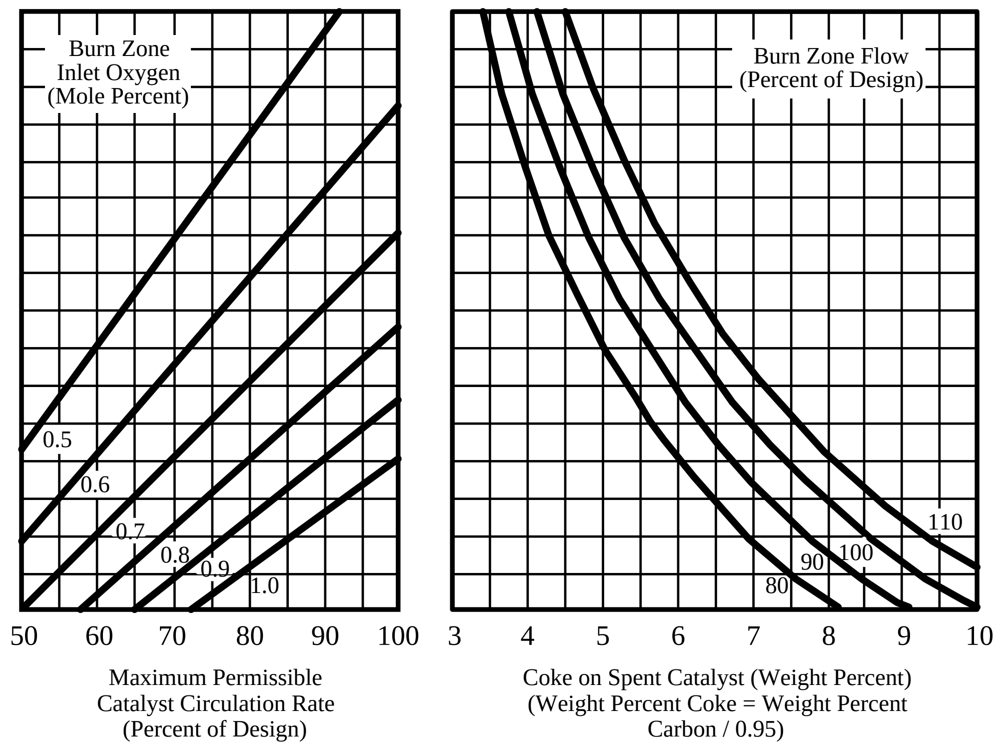
If desirable, the refinery may make a specific operating curve that represents the full coke-burning potential of its specific Regeneration Tower. In order to do this, a series of Coke Burn Tests must be done on the unit. The Coke Burn Test Procedure is discussed in Chapter VII, section B.

Figure III-1

Continuous Platforming CycleMax Regeneration Section

General Operating Curve

Basis:
477°C (890°F) Burn Zone Inlet



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A. CATALYST CIRCULATION RATE

1. Principle

The operator controls the catalyst circulation rate using the Catalyst Flow Setpoint in the Catalyst Regeneration Control System (CRCS). This setpoint sets the regenerated catalyst lift rate that in turn sets the catalyst circulation rate for the entire system.

The recommended operating range for the catalyst circulation rate is 25-100% of design. The catalyst circulation rate should not be operated above 100% of design.

There are limits on the acceptable operating range of the catalyst circulation rate. These limits are set by the Burn Zone oxygen content, the spent catalyst coke content, and the Burn Zone gas rate. The maximum permissible catalyst circulation rate is determined using the General Operating Curve as shown in the following example:

Example III-1: Maximum Permissible Catalyst Circulation Rate

If the current Regeneration Section operations is:

Spent catalyst coke content	5 wt-%
Burn Zone flow	90% of design
Burn Zone inlet oxygen	0.6 mole-%

then from Figure III-1:

Maximum permissible catalyst rate	82% of design

Using the General Operating Curve, start at 5 wt-% on the coke axis. Move vertically to the 90% Burn Zone flow curve. Move horizontally to the left to the 0.6% oxygen line. Then move vertically down to the circulation rate axis. Read 82% of design.

As a result, if the actual catalyst circulation rate is greater than 82% of design, then it should be reduced. If the actual rate is less than 82% of design, then it can be increased gradually if desired.

NOTE: Certain combinations of values for spent catalyst coke, Burn Zone gas flow, and Burn Zone oxygen may give a maximum permissible catalyst circulation rate from Figure III-1 that is greater than 100% of design. However, for various technical reasons, the catalyst circulation rate should not be increased above 100% of design. When a catalyst rate is obtained from Figure III-1 that is greater than 100% of design, it is usually because the chosen value of the Burn Zone inlet oxygen content is too high for the spent catalyst coke level. In the interest of minimizing the oxygen concentration without sacrificing complete combustion in the Burn Zone, the oxygen content should be reduced in accordance with the General Operating Curve. However, the Burn Zone inlet oxygen content should NOT be operated outside the range of 0.5-1.0 mole percent.

2. Computation

The operator computes the catalyst circulation rate using two methods: by the cycling of the Lock Hopper and by the combustion air usage.

a. Lock Hopper

To compute the catalyst circulation rate by the Lock Hopper, use the final calibration of the Lock Hopper Zone size.

$$\text{CCR} = \frac{(\text{number of L.H. cycles}) \times (\text{L.H. Zone size, wt})}{(\text{time, hrs})}$$

b. Combustion Air Usage

To compute the catalyst circulation rate by air usage, use the following formula:

$$\text{CCR (Kg/hr)} = (0.488) \times \left(\frac{100}{X} - 1\right) \times A_T \times (0.21 - Y)$$

or

$$\text{CCR (lb/hr)} = (0.0288) \times \left(\frac{100}{X} - 1\right) \times A_T \times (0.21 - Y)$$

where:

X = spent catalyst coke content, wt-%

$$= \frac{\text{Carbon, wt-\% (by lab)}}{0.95}$$

CCR = catalyst circulation rate, Kg/hr (lb/hr)

Y = Burn Zone inlet oxygen concentration, mole fraction

A_T = total combustion air, Nm^3/hr (SCFH)

NOTE: For white burn conditions (lower air injection only), use:

$$A_T = A_L - V_L$$

where:

A_L = air to Drying Zone, Nm^3/hr (SCFH)

V_L = excess air vent, Nm^3/hr (SCFH)

For black burn conditions (upper air injection only), use:

$$A_T = A_U$$

where:

A_U = air to Burn Zone, Nm^3/hr (SCFH)

This formula can be put in chart form for easier use. An example of a typical chart for a 3000 pph CycleMax Regeneration Tower is shown in Figure III-2.

Example III-2

If the current Regeneration is:

Total combustion air = 670 Nm^3/hr (25000 SCFH)
Spent catalyst coke content = 5.0 wt-%

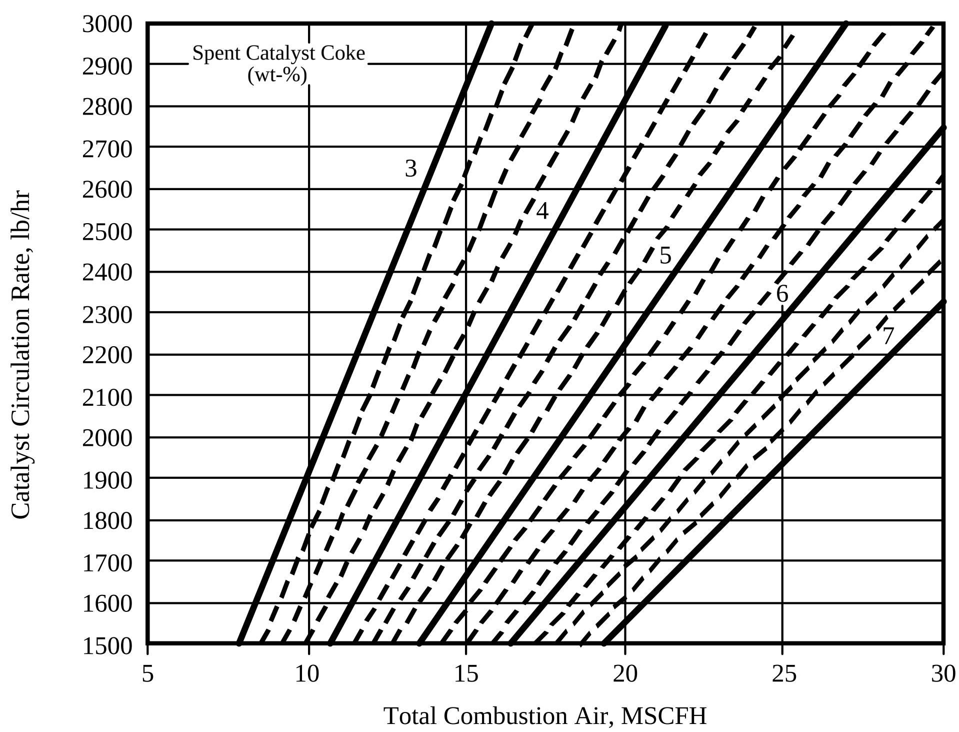
then from Figure III-2

Catalyst circulation rate = 1264 Kg/hr (2784 pph)

Figure III-2

Catalyst Flow Rate and Catalyst Coke by Air Demand

(3000 lbs/hr Unit)



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B. BURN ZONE OXYGEN

The operator controls the Burn Zone oxygen content using the oxygen analyzer. During normal operation, the oxygen analyzer controls how much excess air is vented from the Regeneration Tower: as less excess air is vented, more enters the Burn Zone, and the oxygen content becomes higher.

The recommended range for the Burn Zone oxygen is 0.5-1.0 mole-% oxygen. Higher oxygen causes higher burn temperatures that could cause damage to the catalyst, primarily in the form of surface area loss. Lower oxygen causes slower coke burning that might not finish completely in the Burn Zone. If coke burning occurs in the Chlorination Zone, extremely high temperatures will occur that will cause serious damage to catalyst (i.e., alumina phase change) and equipment in the Chlorination Zone.

In order to minimize the negative effects of high temperature burning on catalyst performance, it is recommended that the Burn Zone oxygen be minimized, provided that coke burning is completed in the Burn Zone.

There are limits on the acceptable operating range of the oxygen content. These limits are set by the catalyst circulation rate, the spent catalyst coke content, and the Burn Zone gas rate. The minimum allowable oxygen content is determined using the General Operating Curve as shown in the following example:

Example III-3: Minimum Allowable Burn Zone Inlet Oxygen Content

If the current Regeneration Section operation is:

Spent catalyst coke content	5.5 wt-%
Burn Zone flow	110% of design
Catalyst circulation rate	90% of design

then from Figure III-1:

Minimum allowable Burn Zone oxygen 0.6 mole-%

Using the General Operating Curve, start at 5.5 wt-% on the coke axis. Move vertically to the 110% Burn Zone flow curve. Move horizontally to the left to the vertical line extending up from 90% on the circulation axis. Read 0.6 mole-% on the oxygen line.

As a result, if the actual Burn Zone inlet oxygen content is greater than 0.6 mole-%, then it could be gradually reduced. If the actual oxygen content is less than 0.6 mole-%, then it should be increased.

C. SPENT CATALYST COKE

1. Principle

The operating conditions in the reaction section control the coke on the spent catalyst from the last Platforming reactor. The coke content is a function of charge rate, product octane, charge quality, reactor pressure, recycle rate, and catalyst circulation rate.

The recommended operating range for the spent catalyst coke is 3-7 wt-% coke. Within this range, catalyst performance and catalyst life are optimum.

There are limits on the acceptable operating range of the spent catalyst coke content. These limits are set by the Burn Zone oxygen content, the catalyst circulation rate, and the Burn Zone gas rate. The maximum allowable spent catalyst coke content is determined using the General Operating Curve as shown in the following example:

Example III-4: Maximum Allowable Spent Catalyst Coke Content

If the current Regeneration Section operation is:

Catalyst circulation rate	100% of design
Burn Zone inlet oxygen	0.8 mole-%
Burn Zone flow	90% of design

then from Figure III-1:

Maximum allowable spent catalyst coke 5.4 wt-%

Using the General Operating Curve, start at 100% on the circulation rate axis. Move vertically to the 0.8% oxygen line. Move horizontally to the right to the 90% Burn Zone flow curve. Then move vertically down to the coke axis. Read 5.4 wt-%.

As a result, if the actual spent catalyst coke content is greater than 5.4 wt-%, then the current Regeneration Section operation should be adjusted. For example, if the actual spent catalyst coke content is 6 wt-%, then one possible adjustment would be to increase the Burn Zone oxygen content. Burn Zone inlet oxygen of 0.85 would be sufficient to combust all the coke in the Burn Zone.

NOTE: The operator should keep the spent catalyst coke content under control. The spent catalyst coke is laid down on the catalyst in the Platforming reactors. The reactor conditions that increase the laydown rate are:

Increasing feed rate
Increasing product octane
Increasing feed endpoint
Decreasing feed naphthene content
Decreasing feed aromatic content
Decreasing reactor pressure
Decreasing recycle rate (H_2/HC)
Increases in water or sulfur in the feed

The spent catalyst coke is burned off in the Regeneration Tower. The regeneration conditions that increase the burnoff rate are:

Increasing Burn Zone oxygen
Increasing Burn Zone gas rate

To keep the spent catalyst coke content under control, the operator should always balance the coke laydown rate and the coke burnoff rate. That means, if a change in reactor conditions increases (or decreases) the coke laydown rate, then the operator must compensate with a change in regeneration conditions that increases (or decreases) the coke burnoff rate. But the change in the regeneration conditions may not need to be made immediately. It may take several days for a change in reactor conditions to show its effect on the spent catalyst coke content. The important point is that the reactor section change eventually shows its effect and then the operator must adjust the regeneration conditions in accordance with the General Operating Curve.

2. Computation

The operator computes the spent catalyst coke content using two methods: by combustion air usage and by laboratory analysis. The two results should not be different by more than 0.1-0.2 wt-% coke.

a. Combustion Air Usage

To compute the coke content by air usage, use the following formula:

$$X = \frac{100}{1 + \frac{\text{CCR (Kg/hr)}}{0.488 \times A_T \times (0.21 - Y)}}$$

or

$$X = \frac{100}{1 + \frac{\text{CCR (lb/hr)}}{0.0288 \times A_T \times (0.21 - Y)}}$$

where:

X	=	spent catalyst coke content, wt-%
CCR	=	catalyst circulation rate, Kg/hr (lb/hr)
Y	=	Burn Zone inlet oxygen concentration, mole fraction
A_T	=	total combustion air, Nm^3/hr (SCFH)

NOTE: For white burn conditions (lower air injection only), use:

$$A_T = A_L - V_L$$

where:

A_L	=	air to Drying Zone, Nm^3/hr (SCFH)
V_L	=	excess air vent, Nm^3/hr (SCFH)

For black burn conditions (upper air injection only); use:

$$A_T = A_U$$

where:

A_U	=	air to Burn Zone, Nm^3/hr (SCFH)

This formula can be put in chart form for easier use. An example of a typical chart for a 3000 pph Pressurized Regeneration Tower is shown in Figure III-2.

Example III-5

If the current Regeneration Section operation is:

Total combustion air	670 Nm^3/hr (25000 SCFH)
Catalyst circulation rate	1361 Kg/hr (3000 pph)

then from Figure III-2:

Spent catalyst coke content 4.7 wt-%

b. Laboratory Analysis

To compute the coke content from the spent catalyst carbon analysis, use the following formula:

$$\text{Coke, wt-\%} = \frac{\text{Carbon, wt-\% (by lab)}}{0.95}$$

NOTE: Coke is about 95% carbon.

D. BURN ZONE GAS FLOW

1. Principle

The flow of Burn Zone gas is not controlled. The flow rate is the maximum flow rate capable by the Regeneration Blower. The rate is a function of the capacity of the Blower and the pressure drop through the Burn Zone loop.

The Burn Zone gas flow rate should be at least 100% of design when the Regenerator screen is clean. Gradually over successive regenerations, the Burn Zone screen plugs with catalyst chips. This decreases the Burn Zone gas flow and the coke burning potential of the Burn Zone. When the Burn Zone gas flow drops to 90% of the rate when the Burn Zone screen is clean, then the screen should be cleaned.

There are limits on the acceptable operating range of the Burn Zone gas rate. These limits are set by the catalyst circulation rate, the Burn Zone oxygen content, and the spent catalyst coke content. The minimum allowable Burn Zone gas rate is determined using the General Operating Curve as shown in the following example:

Example III-6: Minimum Allowable Burn Zone Gas Rate

If the current Regeneration Section operation is:

Catalyst circulation rate	95% of design
Burn Zone inlet oxygen	0.6 mole-%
Spent catalyst coke content	4.5 wt-%

then from Figure III-1:

Minimum allowable Burn Zone gas rate	93% of design

Using the General Operating Curve, start at 95% on the circulation rate axis. Move vertically to the 0.6% oxygen line. Move horizontally to the right to the vertical line extending up from 4.5% on the coke axis. Read 93% on the Burn Zone flow curves.

As a result, if the actual Burn Zone gas rate is less than 93% of design, then the current Regeneration Section operation should be adjusted. For example, if the actual Burn Zone gas rate is 90% of design, then one possible adjustment would be to decrease the catalyst circulation rate to the maximum permissible circulation rate than corresponds to 4.5 wt-% coke, 90% of design Burn Zone flow, and 0.6 mole-% oxygen. This maximum permissible circulation rate is 92% of design. So, the catalyst circulation rate could be decreased from 95% to 92% of design.

2. Computation

The operator computes the Burn Zone gas flow rate using two methods: by pressure drop across the Regeneration Cooler and by oxygen measurements.

a. Regeneration Cooler

The Regeneration Cooler causes a pressure drop when Burn Zone gas flows through it. A differential pressure instrument measures this pressure drop. The higher the pressure drop, the greater is the Burn Zone gas flow rate.

From the dimensions of the Cooler on the vendor's drawings, a calibration chart can be drawn up for computing the flow rate of Burn Zone gas through the Cooler from the measured pressure drop. A chart showing a typical Regeneration Cooler is shown in Figure III-3. The actual Burn Zone gas flow rate can then be calculated using this flow and the following formula:

$$\text{Burn Zone Gas, Nm}^3\text{/hr} = \text{Cooler Flow} - \text{Vent Gas Flow}$$

where:

Cooler Flow = by direct measurement of Cooler pressure drop and calibration curve, Nm^3/hr (SCFH)

Vent Gas Flow = approximated by Chlorination Gas Flow, Nm^3/hr (SCFH)

b. Oxygen Measurements

To compute the Burn Zone gas flow by oxygen measurements, use the following formula:

$$\text{Burn Zone Gas, Nm}^3\text{/hr (SCFH)} = \frac{21 - Z}{Y - Z} \times A_U$$

where:

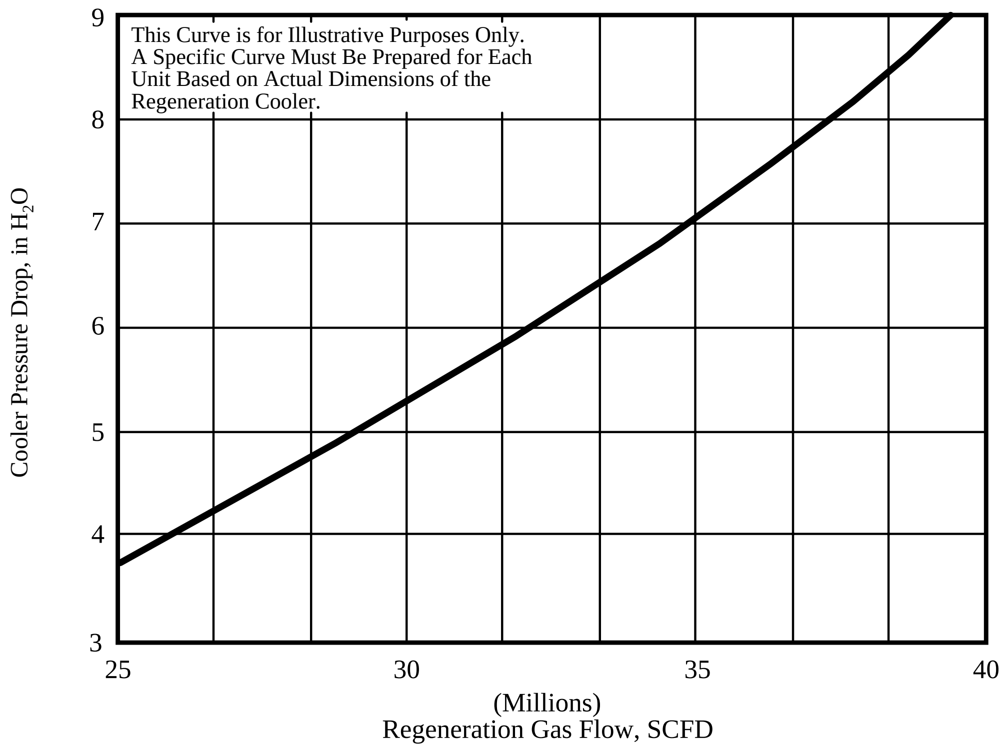
Y = measured Burn Zone inlet oxygen content, mole-%
Z = measured Burn Zone outlet oxygen content, mole-%
A_U = upper combustion air, Nm^3/hr (SCFH)

NOTE: The Regeneration Tower must be in the black burn condition (upper air injection only to apply this formula).

Figure III-3

Regeneration Cooler

Pressure Drop



Basis: Design Flowing Conditions

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E. BURN ZONE BED/REHEAT ZONE BED TEMPERATURES

The operating conditions in the regeneration section affect the “bed” temperatures in the Burn Zone. The “bed” temperatures give a very good indication of the coke burning in the Burn Zone and should be recorded regularly. From top to bottom in the Burn Zone, the “bed” temperatures form a profile. There are three rules concerning the bed profile. First, the peak temperature should be located about 40% down from the top of the Burn Zone, where the rate of coke burning is greatest. Second, the two Reheat Zone “bed” temperatures should be the same (i.e., a “flat” profile) because coke burning is essentially complete at the bottom of the Burn Zone. Third, a change in profile alerts the operator to a change in Regeneration Tower operating parameters.

The “bed” temperatures are a function of the Burn Zone inlet oxygen concentration, the catalyst circulation rate, the spent catalyst coke, and the regeneration gas rate. The temperatures in the bed rise whenever or wherever the rate of coke burning increases. ***The recommended maximum peak “bed” temperature in the Burn Zone is 593°C (1100°F).*** Higher temperatures could cause damage to catalyst and equipment in the Burn Zone.

The operating conditions that increase the highest or peak bed temperature of the peak are:

Increasing Burn Zone oxygen concentration

The operating conditions that move the location of the peak to lower in the burn zone or that increase the temperatures at the bottom of the bed are:

Increasing catalyst circulation rate
Decreasing Burn Zone oxygen concentration
Increasing spent catalyst coke
Decreasing Burn Zone gas rate (by screen plugging)

In order to decrease the rate of surface area decline, it is recommended that the Burn Zone "bed" temperatures be minimized, provided that coke burning is completed in the Burn Zone in accordance with the General Operating Curve. In practice, this means that the Operator should not use an unnecessarily high O_2 content.

A WORD OF CAUTION: Although the "bed" temperatures are useful, they are ***not*** a substitute for the Burn Zone oxygen analyzer. When the oxygen analyzer is out-of-service or not calibrated properly, the operator should initiate a Hot Shutdown immediately. The operator should not attempt to resume coke burning until the analyzer is working properly again.

The "bed" temperatures are also not a substitute for the General Operating Curve. The operator should operate the Regeneration Tower in accordance with the General Operating Curve.

DO NOT CONTROL THE REGENERATION TOWER USING THE "BED" TEMPERATURES ALONE.

F. REGENERATION TOWER PRESSURE

The operator controls the Regeneration Tower pressure using the pressure controller of another vessel. That vessel is either the Product Separator or the Fuel Gas Drum, depending on the design. In either case, it is the vessel where the gases vent from the Lock Hopper's Disengaging Zone. A differential pressure controller keeps the Regeneration Tower at the same pressure as the Lock Hopper Disengaging Zone.

The recommended operating pressure for the Regeneration Tower is 2.5 kg/cm^{2}g (35 psig). Low pressure decreases the coke burning capacity of the Burn Zone. High pressure decreases the water removal of the Drying Zone.

G. CHLORINATION GAS FLOW

The oxygen analyzer controls the chlorination gas flow indirectly by controlling the excess air vent flow from the Drying Zone. The remainder of the air from the Drying Zone becomes the chlorination gas. The chlorination gas promotes the chlorination/oxidation step, but it is also the air required for coke burning. This means the chlorination gas flow rate depends on the catalyst circulation rate and the spent catalyst coke. The greater the rate of coke burning, the higher the chlorination gas flow will be.

The recommended operating range for the chlorination gas flow is 25-150% of design.

The chlorination gas flow rate is not measured directly. Instead it is calculated by a function block in the DCS. The block subtracts the excess air flow rate from the drying air rate. It displays this value as the chlorination gas flow rate.

H. REGENERATED CATALYST CHLORIDE

The operator controls the regenerated catalyst chloride content using the Organic Chloride Injection Pump. The pump injects an organic chloride compound into the Chlorination Zone. The greater the injection rate, the higher the regenerated catalyst chloride will be.

The recommended operating range for the regenerated catalyst chloride is 1.1-1.3 wt-% chloride, depending on the catalyst type. Within this range, the catalyst's activity and selectivity are optimum.

The organic chloride injection rate can be measured by two methods: by the chloride flow meter and by the injection sight glass. The flow meter only indicates the presence of chloride injection on the control panel due to the pulsating nature of the flow from the injection pump. The injection rate should be double-checked daily at the pump using the sight glass on the organic chloride drum for an accurate flow measurement.

When the catalyst is new, the amount of chloride injection required in the Regenerator can be estimated as follows:

$$= 1.25 * (Cl_R^T - Cl_S^A) / 100 * CCR$$

where:

Cl_R^T - Target Regenerated Catalyst Chloride, wt-%

Cl_S^A - Actual Spent Catalyst Chloride, wt-%

To determine the required organic chloride injection rate, calculate as in the following example:

Example III-7: Chloride Makeup Rate

Spent catalyst chloride content (lab result)	= 1.20 wt-%
Target Regenerated Catalyst Chloride	= 1.30 wt-% for R-134
Catalyst Circulation Rate	= 2000 lbs/hr of R-134 per hour

⇒ 1.25 * (1.30 wt-% - 1.20 wt-%) /100 * 2000 lbs/hr
= **2.5 lbs/hr** of chloride

If the organic chloride being used is PERC
wt-% chloride = 85.5
specific gravity = 1.63

⇒ PERC density = 8.34 lbs/gal of water * 1.63/1.00 = 13.59 lbs/gal

⇒ Chloride density in PERC = 13.59 lbs/gal * 0.855 = **11.62 lb/gal**

so, the amount of PERC injection required:

⇒ 2.5 lbs/hr chloride required / 11.62 lbs/gal PERC
= **0.215 gal/hr of PERC**

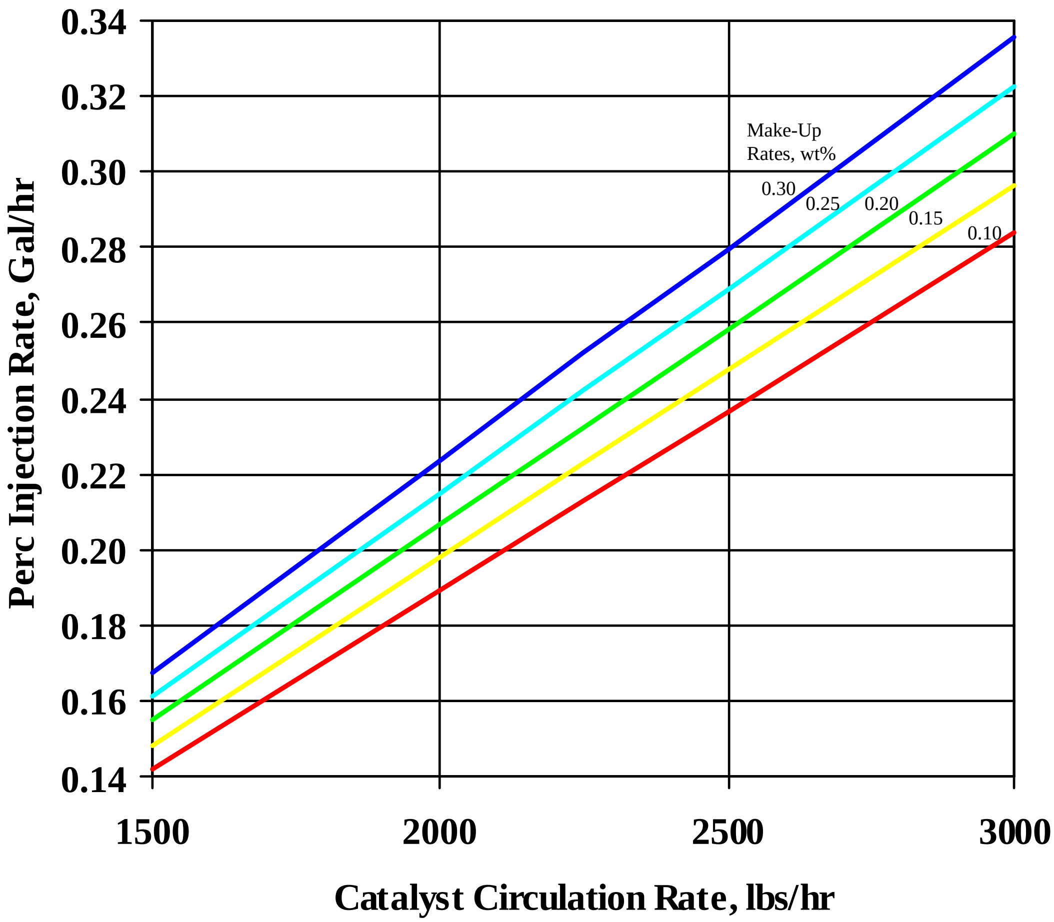
Based on the site glass calibration, this can be translated into an injection rate measured in inches per minute.

The factor 1.25 in the equation above is approximately accurate for new catalyst with a surface area >180 m^2/g. As the surface area declines, the factor must be increased. For low surface area catalyst (< 130 m^2/g) the factor may be as high as 8.00. Remember, the factor can only be estimated since other variables also influence the chloride pick-up in the chlorination zone, especially the water concentration in this zone.

This example can be put in chart form for easier use. An example of a typical chart for a 3000 pph CycleMax Regeneration Section using Perchloroethylene is shown in Figure III-4. To repeat the above example using Figure III-4, start at 2000 pph on the circulation rate axis. Move vertically to the 0.25% makeup line. Move horizontally to the left to the injection rate axis. Read 0.215 Gal/hr.

Note: As the catalyst ages and experiences surface area decline, the chloride injection required to maintain the chloride level on the catalyst will increase. The calculational method indicated above, while valid, is best understood as a minimum chloride injection rate, and used as a starting point for setting the injection rate.

Figure III-4
CycleMax Chlorination Zone Organic Chloride Injection Example



Notes:

1. Perchloroethylene is used as the chloriding agent.
2. Actual Spent catalyst chloride = 1.20 wt%.
3. Target Regenerated catalyst chloride = 1.30 wt%.

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I. DRYING AIR FLOW

The operator controls the total drying air rate on flow control using the drying air control valve. Dry air strips water from the catalyst base. The drier the catalyst is before it re-enters the Platforming reactors, the better its overall performance will be.

The recommended drying air rate is 100% of the design rate. The drying air can be varied with the catalyst circulation rate. See Normal Operations, Chapter VIII.

The drying air itself must be dry in order to dry the catalyst. The moisture content of the dried air must be checked regularly. There is a sample tap on the Air Dryer outlet for connecting a moisture analyzer or a dew point analyzer, the recommended moisture content of the air is less than 5 ppmv. This corresponds to a dew point of -65°C (-85°F).

J. COOLING AIR FLOW

A portion of the air flow from the Air Dryer is split off to the Cooling Zone. The operator controls the cooling gas flow rate on flow control using the cooling gas control valve.

The recommended cooling air rate is that which is required to maintain the catalyst in the Nitrogen Seal Drum at the design temperature, typically, 150°C (300°F). This temperature should equal the temperature of the booster gas supplied to the Lock Hopper and the L-Valve Assembly.

K. REDUCTION GAS FLOW

The operator controls the reduction gas flow rates (upper and lower reduction gas) by adjusting hand operated control valves or flow controllers for each flow. The total and lower reduction gas flows are measured directly with the upper reduction gas flow determined by subtraction.

The recommended reduction gas rate is 100% of the design rate. The reduction gas should be kept constant at this rate at all times during normal operation.

L. ZONE INLET TEMPERATURES

The operator controls the zone inlet temperatures using temperature controllers.

The recommended zone inlet temperatures are:

Burn Zone	477°C	(890°F)
Chlorination Zone	510°C	(950°F)
Drying Zone	565°C	(1050°F)
Upper Reduction Zone	377°C	(710°F)
Lower Reduction Zone	482°C	(900°F)
Lock Hopper Surge Zone	150°C	(300°F)

M. LIFT GAS FLOW

1. Total Lift Gas

The operator controls the total lift gas rate to each L-Valve Assembly on flow control using the primary lift gas control valve.

The recommended total lift gas rate is that required to give 100% of the design lift line superficial velocity. The lift gas rate should be kept constant at this rate regardless of the catalyst circulation rate. The superficial velocity is calculated as follows:

$$V_L = \frac{V_B P_B T_L}{T_B P_L}$$

where:

V_B = Corrected volumetric flow rate to lift line at base conditions, SCFH (Nm^3/h)

P_B = Base absolute pressure, 14.696 psia (1.033 kg/cm^2a)

T_B = Base temperature, 520°R (273 K)

V_L = Volumetric flow rate in lift line at lifting conditions, ft^3/h (m^3/h)

P_L = Absolute pressure in lift line during lifting (average of top and bottom), psia (kg/cm^2a)

T_L = Temperature in lift line during lifting (average of top and bottom), °R (K)

The lift line volumetric flow rate (V_L) is then divided by the cross-sectional area of the lift line, and a conversion factor to determine the superficial velocity of the gas in the lift line is determined according to the following formula:

$$VEL = \frac{V_L}{3600A}$$

where:

VEL = Superficial velocity of gas in the lift line, ft/s (m/s)

A = Cross-sectional area of lift line, ft^2 (m^2)

High total lift gas rate causes pipe erosion and makes catalyst fines. Low total lift gas rate may stop lifting and plug the lift line.

The total lift gas flow splits into two streams – a primary stream and a secondary stream. The primary lift gas stream enters at the bottom of the L-Valve Assembly and the secondary lift gas stream enters through the side of the catalyst transfer pipe leading to the lift line.

2. Primary Lift Gas

The total lift gas flow controller controls the primary lift gas control valve to keep the total lift gas flow constant. The controller automatically adjusts the primary lift gas when the secondary lift gas changes.

3. Secondary Lift Gas

The pressure drop in the lift line above the L-Valve Assembly controls the secondary lift gas flow on cascade using the secondary lift gas control valve. The recommended operating range of the secondary lift gas flow is 0-20% of the design total lift gas flow. The secondary lift gas controls the catalyst lifting rate. When the secondary lift gas rate increases, then the rate of catalyst lifting increases. When it decreases, lifting decreases.

N. L-VALVE ASSEMBLY INLET DIFFERENTIAL PRESSURE

A differential pressure controller controls the pressure drop across the catalyst inlet line into each L-Valve Assembly. The pressure drop into each L-Valve Assembly inlet should be the design pressure drop.

1. Spent Catalyst L-Valve Assembly

The control valve on the nitrogen supply line to the Disengaging Hopper controls the pressure drop from the Spent Catalyst L-Valve Assembly to the Catalyst Collector. The L-Valve is maintained at a pressure higher than the Catalyst Collector. The upward flow of nitrogen that this provides purges hydrogen gas from the catalyst as it leaves the Catalyst Collector. Too high of a pressure drop slows the flow of catalyst into the L-Valve Assembly. Too low of a pressure drop may insufficiently purge the catalyst and allow hydrogen gas into the circulating nitrogen.

2. Regenerated Catalyst L-Valve Assembly

The control valve on the makeup gas line into the Lock Hopper Surge Zone controls the pressure drop between the Surge Zone and the Regenerated Catalyst L-Valve Assembly. The pressure drop is maintained near zero. Positive pressure drop (Surge Zone higher pressure) leaks gas into the L-Valve Assembly and lifts the catalyst too quickly. Negative pressure drop (L-Valve higher pressure) slows the flow of catalyst into the L-Valve. The operator should occasionally check this control valve during an entire Lock Hopper cycle. If the control valve goes wide open or completely shut (i.e., out of range), then the maintenance personnel should check the Makeup Valve. The Makeup Valve's programmed ramping should keep the control valve in range.

O. ELUTRIATION GAS FLOW

The operator controls the elutriation gas flow using the flow control valve. The elutriation gas flow should start at 100% of the design rate and be adjusted as required (see Chapter VIII).

The elutriation gas superficial velocity can be calculated in the same manner as the lift line superficial velocities. The elutriation gas flowrate is measured at the discharge of the Fines removal Blower.

Elutriation gas removes chips of catalyst and fines from the circulating catalyst. Low gas flow allows chips and fines to enter the Regeneration Tower and plug the screens. Fines also cause lifting problems. High gas flow carries out too many whole pills with the chips and fines.

Catalyst Fines Surveys should be done regularly. Catalyst Fines Surveys test the efficiency of fines removal and optimize the elutriation gas flow. The Catalyst Fines Survey Procedure is in the Special Procedures section (Section XIII).

IV. PROCESS FLOW AND CONTROL

This section outlines the logic requirements for the operation of the Lock Hopper Sequence, the Makeup Valve, the Isolation Systems, the Catalyst Flow Interrupt Systems, the Regeneration Systems, the Valve Verification System, and the Bypass Switches. This explanation has been simplified to include only those items that the operator can check for proper operation. For a complete explanation of the logic, refer to the UOP Process and Information Control Equipment and Instructions Databook, Chapter 2.

A. CATALYST FLOW CONTROL

1. Catalyst Flow Pushbutton

The Catalyst Flow Pushbutton starts and stops the transfer of regenerated catalyst from the Lock Hopper to the Reactors.

The Catalyst Flow Pushbutton has only two positions: ON and OFF. An indicator on the control panel shows the position of the pushbutton. The Catalyst Flow Pushbutton can be turned on or off using either the DCS or the Operator Interface. Initially, the Catalyst Flow Pushbutton is in the OFF mode.

a. Pushbutton "ON"

To start transferring catalyst, the following condition must be met:

- The Regenerator is not in Hot Shutdown mode.

When the operator depresses the Catalyst Flow Pushbutton, catalyst transfer starts. The indicator changes from OFF to ON and the Catalyst Regeneration Control System (CRCS) starts the following systems:

- Lock Hopper Cycle
- Makeup Valve Control
- Catalyst Flow Control
- Spent Catalyst Lift Rate Limiter

b. Pushbutton “OFF”

The Lock Hopper stops automatically when a Hot Shutdown occurs.

The operator can manually stop the catalyst transfer at any time in order to begin the Hot Shutdown Procedure. If the Catalyst Flow Pushbutton is depressed while catalyst is transferring, then the transfer stops. The indicator changes from ON to OFF and the systems listed above are all stopped.

2. Catalyst Circulation Rate Setpoint

The Catalyst Circulation Rate Setpoint is used by the CRCS to control the catalyst circulation rate. The operator sets the setpoint in three steps.

First, the operator decides on the desired catalyst circulation rate as required by the Reactor Section and Regeneration Section operating conditions. This catalyst circulation rate should not be above the design catalyst circulation rate.

Next, the operator computes the Catalyst Circulation Rate Setpoint as a percentage of design:

$$\text{Catalyst Circulation Rate, \%} = \frac{\begin{array}{c}\text{Desired Catalyst Circulation Rate}\\ \text{(pounds/hour)}\end{array}}{\begin{array}{c}\text{Design Catalyst Circulation Rate}\\ \text{(pounds/hour)}\end{array}}$$

The result should not be greater than 100%.

Finally, the operator enters the Catalyst Circulation Rate Setpoint into the CRCS. The operator enters the setpoint at the control panel. Even though the setpoint can be adjusted up to 100%, the operator should not enter a setpoint that results in a catalyst circulation rate above the allowable catalyst circulation rate. The General Operating Curve (see Figure III-1) may limit the circulation rate to less than 100%. And even though the desired setpoint may be less than 25% the setpoint should only be adjusted down to a minimum of 25%.

The CRCS utilizes the Catalyst Circulation Rate Setpoint to generate the setpoint for the Regenerated Catalyst Lift Line Differential Pressure Controller. When Catalyst Flow is turned ON, the Regenerated Catalyst Lift Line ∆P Controller setpoint is initially zero. The CRCS then ramps the setpoint to a value that is estimated to yield a circulation rate half that of the target catalyst circulation rate setpoint. If the Lock Hopper Surge Zone level was above 40% when Catalyst Flow was turned ON, the CRCS uses the Regenerated Catalyst Lift Line ∆P ramp rate entered on the Catalyst Flow Setup Screen. If the level was below 40%, the CRCS uses a 2% per minute ramp until the level rises above 40% for the first time.

The Regenerated Catalyst Lift Line ∆P Controller setpoint is held at the estimated value until sufficient Lock Hopper cycles occur for the calculation of the actual catalyst circulation rate. The CRCS then adjusts the setpoint, using the ramp rate from the Catalyst Flow Setup Screen, to achieve the target catalyst circulation rate.

The catalyst circulation rate is achieved by adjusting the lift line ∆P controller setpoint. The CRCS compares the Catalyst Circulation Rate Setpoint to the actual Averaged Catalyst Circulation Rate as determined by the Lock Hopper cycle time (see section on Lock Hopper System later in this chapter). The lift line ∆P controller setpoint is adjusted up or down by the CRCS until the setpoint and actual catalyst circulation are in agreement.

When catalyst circulation is started, the lift line ∆P controller setpoint is ramped upward from 0% at a rate determined by the Regenerated Catalyst Lift Line Differential Ramp Rate. This ramp rate is set so as to gradually increase the Reduction Zone catalyst level, and thus gradually increase the spent catalyst lift rate. The rate of increase of the spent catalyst lift rate must be slow so that the spent catalyst lift line ∆P generated does not cause the ∆P between the L-valve assembly and the Catalyst Collector to fall out of its control range. This ramp rate is also used during normal operations when the actual catalyst circulation rate differs by more than 10% from the setpoint. For initial operation of the unit this ramp rate should be set slow, 2-5% per minute, then adjusted higher with operating experience.

When the actual catalyst circulation rate and the catalyst circulation setpoint are within 10% of each other, the CRCS will make incremental changes in the lift line ΔP setpoint toward the desired circulation rate every time a Lock Hopper cycle is completed. The size of the lift line ΔP setpoint change will depend on the Catalyst Flow Rate Gain Constant.

3. Spent Catalyst Lift Rate Limiter

Whenever catalyst circulation is started, the CRCS slowly ramps up the spent catalyst lift rate from 0% to 100% at a rate given by the Spent Catalyst Lift Line Differential Ramp Rate that is entered in the Catalyst Flow Setup Screen. The ramp occurs at a rate set slow enough so that the lift line ΔP generated does not cause the ΔP between the L-valve assembly and the Catalyst Collector to become too high and prevent catalyst flow out of the reactor. When the limiter output becomes greater than the Reduction Zone level controller output, the signal from the Reduction Zone level controller will take control and reset the lift line ΔP controller. The limiter is also activated when the Reduction Zone level rises above 50% after a Spent Catalyst Flow Interrupt occurs.

The Limiter will complete its ramp and hold at a value of 100 unless the Spent Catalyst Ratio Limit Override Switch is ON. The Override limits the ability of the Reduction Zone level controller to set the Spent Catalyst Lift Line ΔP Controller setpoint to a higher value than that required for circulation at the target rate. The Override will be useful if high catalyst circulation rates through the Reduction Zone are causing high temperature excursions in the Reduction Zone. For a more detailed discussion of the Spent Catalyst Ratio Limit Override Switch, refer to the PIC Equipment and Instructions Databook, Section 2.13.

The ramp rate for both the regenerated and the spent catalyst lift lines should be set the same. For initial operation of the unit this ramp rate should be set slow, 2-5% per minute, then adjusted higher with greater operating experience.

4. Catalyst Flow Interrupt Systems

The catalyst flow from the Reactor and from the Lock Hopper Surge Zone can be interrupted to prevent low levels in those vessels.

The CRCS controls the operation of these systems and catalyst flow will be allowed or interrupted automatically when certain conditions exist.

During normal operation the interrupt systems have no effect on catalyst circulation. However, during shutdowns, the systems prohibit catalyst transfer in order to maintain catalyst inventory in the Reactor and the Lock Hopper.

a. Spent Catalyst Flow Interrupt

The catalyst flow from the Reactor will be interrupted in two ways depending on the level at the top of the Reactor. If the Reduction Zone LRC (Level Recorder Controller) indicates a low level (~10%), the CRCS resets the Spent Catalyst Lift Rate Limiter controller to zero via the low signal selector. At the same time, the secondary lift gas control valve (fail closed) is closed by de-energizing a solenoid in the instrument air line, shutting off the instrument air supply.

If the Reduction Zone level continues to drop below the low level indicator switch point and reaches 0%, the Spent Catalyst Isolation will trip. Tripping the isolation will cause the two isolation valves to close and the nitrogen pressure valve to open. This results in a Hot Shutdown.

(1) **CLOSED**

The following condition will cause a Spent Catalyst Flow Interrupt:

<u>The catalyst level in the Reduction Zone falls below 10%.</u>

Then, the indicator labeled SPENT CATALYST FLOW INTERRUPTED on the control panel lights up.

(2) **OPEN**

When the following condition is met, the Spent Catalyst Flow Interrupt will clear:

<u>The Reduction Zone level rises above 50%.</u>

Then, the indicator labeled SPENT CATALYST FLOW INTERRUPTED on the control panel turns off. Then the Spent Catalyst Secondary Lift Gas Valve's solenoid is energized (valve opens) and the Spent Catalyst Lift Rate Limiter begins ramping up, allowing lifting to resume.

b. Regenerated Catalyst Flow Interrupt

The catalyst flow from the Lock Hopper Surge Zone will be interrupted if the catalyst level in the Surge Zone falls below 10%. If a low-low level is indicated by the Surge Zone LR (Level Recorder) the CRCS resets the Regenerated Catalyst Lift Line ΔP controller to zero catalyst flow. At the same time, the secondary lift gas control valve (fail closed) is closed by de-energizing a solenoid in the instrument air line, shutting off the instrument air supply.

(1) **CLOSED**

The following condition will cause a Regenerated Catalyst Flow Interrupt:

<u>The catalyst level in the Surge Zone falls below 10%.</u>

Then, the indicator labeled REGENERATED CATALYST FLOW INTERRUPTED on the control panel lights up.

(2) OPEN

When the following condition is met, the Regenerated Catalyst Flow Interrupt will clear:

The catalyst level in the Surge Zone rises above 40%.

Then, the indicator labeled REGENERATED CATALYST FLOW INTERRUPTED on the control panel turns off. The Regenerated Secondary Catalyst Lift Gas solenoid is energized (valve opens) and the Regenerated Catalyst Lift Line ΔP Controller begins ramping up, allowing lifting to resume.

When there is a low-low level in the Lock Hopper Surge Zone (0%), only the Regenerated Catalyst Flow Interrupt is activated, this does not result in any shutdown or the closing of the Regenerated Catalyst Isolation System.

5. Regenerated Catalyst Lift Line Valve

The valve in the regenerated catalyst lift line at the top of the reactor serves to isolate the Platforming Unit reactors from the Regeneration Section under certain circumstances. It is also useful in preventing gases from the Reactor from flowing back into the lift line. The valve may be closed by the process operator from the control room, or it may be closed automatically by the CRCS.

There are two conditions that will automatically signal the CRCS to close the lift line valve:

1. The temperature of regenerated catalyst lift line, as measured by the lift line skin TC, is above the high-temperature monitor switch of the temperature indicator. This indicates a back flow of Reduction Zone gas or Reactor gas as a result of a lift line rupture.

2. The flow of gas to the Reduction Gas Heater No. 1 AND regenerated catalyst lift gas are below the low-level monitor switches of both flow indicators.

B. LOCK HOPPER SYSTEM

The Lock Hopper System regulates the catalyst circulation rate through the Lock Hopper and consequently throughout the entire Reactor and Regenerator system. A description of the catalyst flow control functionality is given in Chapter II "Process Principles".

The catalyst is transferred through the Lock Hopper Zone of the Lock Hopper in small batches. The cycle time of this batch operation is used to determine the catalyst circulation rate.

The Lock Hopper System has four main functions:

- Determines the actual catalyst circulation rate and adjusts the setpoint to the Regenerated Catalyst Lift Line Differential Pressure Controller (see "Catalyst Flow Control" later in this chapter)
- Enables the Spent Catalyst Lift Rate Limiter (see "Spent Catalyst Lift Rate Limiter" later in this chapter)
- Ramps the two equalization valves open and closed over a predetermined pattern (see "Lock Hopper Cycle" later in this chapter)
- Controls the makeup gas valve using Feedthrough, Ramp, or Adaption modes (see "Makeup Valve Control" later in this chapter)

The Lock Hopper transfers catalyst from the Regeneration Tower into the Regenerated Catalyst L-Valve Assembly. The catalyst is moved through the Lock Hopper Zone of the Lock Hopper in small batches. The CRCS controls the sequencing of this batch operation.

The cycle time of this batch operation indicates the catalyst circulation rate. The more often the Lock Hopper Zone cycles, the faster the catalyst circulation rate. In this way, the flow of catalyst through the Lock Hopper monitors the catalyst circulation rate throughout the entire Reactor and Regenerator system.

The Lock Hopper cycles through five basic steps in a sequence. Two of the steps, PRESSURE and DEPRESSURE, have two sub-steps. The five basic steps in one cycle of the Lock Hopper are:

STEP	DESCRIPTION
0. READY	Lock Hopper Zone, full of catalyst and at Disengaging Zone pressure, waits for signal to start the cycle.
1. PRESSURE	Lock Hopper Zone is pressured up in a programmed pattern to equalize the pressure between it and the Surge Zone.
2. UNLOAD	Catalyst is unloaded from the Lock Hopper Zone to the Surge Zone.
3. DEPRESSURE	Lock Hopper Zone is depressured in a programmed pattern to equalize the pressure between it and the Disengaging Zone.
4. LOAD	Catalyst is loaded into the Lock Hopper Zone from the Disengaging Zone.

At the end of the LOAD step, the Lock Hopper returns to the READY step. This cycle repeats over and over again, moving catalyst through the Lock Hopper.

Three logic-operated valves control the pressuring and depressuring of the Lock Hopper Zone: two Equalization Valves and one Makeup Valve. Valve (XV-25) is the Upper Equalization Valve between the Lock Hopper Zone and the Disengaging Zone. XV-26 is the Lower Equalization Valve between the Lock Hopper Zone and the Surge Zone. At no time during the cycle should both Equalization Valves be open at the same time. Valve XV-27 is the Makeup Valve to the Surge Zone for pressuring up the Lock Hopper Zone with booster gas. Excess gas from depressuring the Lock Hopper Zone is vented from the Disengaging Zone.

The Upper (XV-25) and Lower (XV-26) Equalization Valves, along with the Makeup Valve (XV-27) change position during the PRESSURE and DEPRESSURE steps. During the PRESSURE step, the Upper Valve closes completely, the Lower Valve opens fully, and the Makeup Valve opens slightly more and then closes partially. During the DEPRESSURE step, the Lower Valve closes completely, the Upper Valve opens fully, and the Makeup Valve closes slightly and then reopens partially. The opening and closing of these three valves is controlled by the Lock Hopper Control System in the CRCS.

For the Upper (XV-25) and Lower (XV-26) Equalization Valves, their programmed patterns for opening and closing are usually the same. These patterns are programmed in the CRCS and are rarely changed.

For the Makeup Valve (XV-27), however, its programmed pattern for opening and closing can change. The Makeup Valve can operate in any one of three different modes. All three modes have one goal: to supply makeup gas for pressuring the Lock Hopper Zone while keeping the differential pressure between the Lock Hopper and the Regenerated Catalyst L-Valve Assembly stable. The correct Makeup Valve mode at any one time depends on several conditions, including 1) whether or not the Lock Hopper is cycling normally, 2) how many times the Lock Hopper has cycled after it was last started, and 3) whether or not the operator chooses to change the programmed pattern for the Makeup Valve. The three modes of the Makeup Valve (XV-27) are described in more detail later in this section.

1. Lock Hopper Cycle Time

The Lock Hopper Cycle Time is the time from the start (i.e., the pressure step) of one Lock Hopper cycle until the start of the next cycle. The start of the cycle is initiated by a low level in the Lock Hopper Surge Zone. The CRCS computes the actual catalyst circulation rate from the measured Lock Hopper Cycle Time.

$$\text{Actual Catalyst Circulation (\%)} = \frac{\begin{array}{c}\text{Calibrated Lock Hopper Load Size}\\ \text{(lbs)}\end{array}}{\begin{array}{c}\text{Design Catalyst}\\ \text{Circulation}\\ \text{(lb/hr)}\end{array} \times \begin{array}{c}\text{Actual L.H.}\\ \text{Cycle Time}\\ \text{(sec)}\end{array}} \times 3600 \times 100$$

where:

The Calibrated Lock Hopper Load Size is measured according to the Startup Preparation and the Startup Procedures.

The actual catalyst circulation rate is reported as two values. The first is the instantaneous rate, updated at the end of each Lock Hopper cycle, equal to Actual Catalyst Circulation as shown above. The second is a running average of the last “n” (this number is adjustable) instantaneous rate calculations called the Averaged Catalyst Circulation Rate. The value for “n” is determined from the Number of Lock Hopper cycles for Average Catalyst Flow Rate.

2. Long Cycle Alarm

This alarm is activated if the Lock Hopper has not entered a new cycle before both the Lock Hopper Estimated Cycle Time and Long Cycle Delay Timers time out. The Lock Hopper Estimated Cycle Time (L.H.E.C.T.) is the estimated time between entering Step 1 (the Pressure step) in two sequential Lock Hopper Cycles.

$$\text{L.H.E.C.T.} = \frac{\text{Calibrated Lock Hopper Load Size (lbs)}}{\begin{matrix}\text{Design Catalyst} \\ \text{Circulation Rate (lbs/hr)}\end{matrix} \text{ x } \begin{matrix}\text{Actual Catalyst Circulation} \\ \text{Rate Setpoint (\%)}\end{matrix}} \text{ x } 3600 \text{ x } 100$$

The Long Cycle Delay Timer compensates for the Regenerated Lift Line Differential Pressure Controller Setpoint Ramping function. When the setpoint is ramping, the catalyst circulation rate may be slower, which can cause long Lock Hopper cycles. The Long Cycle Delay Timer range is 300 to 1800 seconds.

$$\text{Long Cycle Delay Time (sec)} = \text{LH Est. Cycle Time} \times \left(\frac{\text{Regen Lift Line Target SP}}{\text{Regen Lift Line Actual SP}} - 1 \right) + 300$$

If the level in the Lock Hopper Surge Zone is greater than 40% when Catalyst Flow is turned on, the Long Cycle alarm is disabled until the first time the level drops below 40%.

3. Short Cycle Alarm

The Short Cycle Alarm alerts the operator that not enough time has passed during the previous cycle when the Lock Hopper enters a new cycle. The Short Cycle Alarm is activated if the level in the Lock Hopper Surge Zone has decreased below 40% before the end of the Lock Hopper Cycle. If the level in the Lock Hopper Surge zone is less than 40% when catalyst flow is turned on, the alarm is disabled until the first time the level goes above 40%. If the short Cycle Alarm is activated in two consecutive cycles, a Hot Shutdown occurs. The shutdown alarm condition will last for one minute and then reset.

4. Abnormal Unload/Load Alarms

There are four alarms that alert the operator of a problem with the loading and unloading of the Lock Hopper. If any alarm sounds during two consecutive Lock Hopper cycles, then a Hot Shutdown occurs. Each of the four alarm timer settings can be adjusted from 0-120 sec using the Catalyst Flow Setup Screen.

a. Fast Unload Alarm

The Fast Unload Alarm alerts the operator that the Lock Hopper Zone is unloading too quickly. The alarm is activated by the Fast Unload Timer. The Fast Unload Timer starts to count down when entering the UNLOAD step. The alarm will sound if the Lock Hopper Zone unloads to below the low-level instrument before the Fast Unload Timer times out.

b. Slow Unload Alarm

The Slow Unload Alarm alerts the operator that the Lock Hopper Zone is unloading too slowly. The alarm is activated by the Slow Unload Timer. The Slow Unload Timer starts to count down when the Fast Unload Timer times out. The alarm will sound if the Lock Hopper Zone does not unload to below the low-level instrument before the Slow Unload Timer times out.

c. Fast Load Alarm

The Fast Load Alarm alerts the operator that the Lock Hopper Zone is loading too quickly. The alarm is activated by the Fast Load Timer. The Fast Load Timer starts to count down when entering the LOAD step. The alarm will sound if the Lock Hopper Zone loads up to the high-level instrument before the Fast Load Timer times out.

d. Slow Load Alarm

The Slow Load Alarm alerts the operator that the Lock Hopper Zone is loading too slowly. The alarm is activated by the Slow Load Timer. The Slow Load Timer starts to count down when the Fast Load Timer times out. The alarm will sound if the Lock Hopper Zone does not load up to the high-level instrument before the Slow Load Timer times out.

5. Lock Hopper Cycle Counter

The Lock Hopper Cycle Counter counts the total number of times the Lock Hopper Zone unloads a full load of catalyst. The counter advances one digit when the Lock Hopper Zone unloads to below the low-level instrument following a cycle in which the Lock Hopper Zone had loaded up to the high-level instrument. In this way, the Lock Hopper Cycle Counter advances only when the Lock Hopper Zone transfers a full load of catalyst.

6. Unload/Load Timers

There are two timers that time how long it takes for the Lock Hopper Zone to unload and load during each Lock Hopper cycle. The most recent unload time and the most recent load time are displayed on the control panel for troubleshooting purposes.

The Unload Timer starts to time when the Upper Equalization Valve begins to close at the start of the PRESSURE step. It stops timing and displays the elapsed time when any of the following conditions occur:

1. The Catalyst Flow Pushbutton indicator changes from RUN to STOP; or

2. The Lock Hopper Zone unloads to below the low-level instrument; or

3. The Slow Unload Timer times out.

The Load Timer starts to time when the Lower Equalization Valve begins to close at the start of the DEPRESSURE step. It stops timing and displays the elapsed time when any of the following conditions occur:

1. The Catalyst Flow Pushbutton indicator changes from RUN to STOP; or

2. The Lock Hopper Zone loads up to the high-level instrument; or

3. The Slow Load Timer times out.

7. Lock Hopper Level Switch Malfunction Alarm

The Lock Hopper Level Switch Malfunction Alarm alerts the operator of a level instrument malfunction. If the low-level instrument in the Lock Hopper Zone indicates a low level and the high-level instrument simultaneously indicates a high level for more than a prescribed period of time (normally two seconds), then the Level Switch Malfunction Alarm will sound. The alarm causes a Hot Shutdown.

8. Lock Hopper Equalization Valve Alarms

There are two alarms that alert the operator to a problem associated with the positions of the Lock Hopper Equalization Valves. Position switches on each valve indicate when that valve is closed.

a. Lock Hopper Equalization Valve Verification Alarm

The valves take a finite amount of time to actually move after they are commanded to do so. A timer (adjustable between 5 and 15 seconds) monitors the time it takes for the valve to travel. If a valve is commanded to close and it does not do so (as indicated by the position indicator) before the timer times out, the Lock Hopper Equalization Valve Verification Alarm will be activated.

b. Lock Hopper Equalization Valve Malfunction Alarm

Catalyst circulation and Regenerator operation would be disrupted if both equalization valves were open at the same time. If both valves are open (i.e., the position indicators do not indicate that they are closed) at the same time for more than 2 seconds, The Lock Hopper Equalization Valve Malfunction Alarm is activated. This alarm also triggers a hot shutdown.

9. Starting and Stopping the Sequence

The Lock Hopper cycle can be started as long as no Hot Shutdown conditions are present. Otherwise, pressing the Catalyst Flow ON button will start the cycle in the Depressure Stage.

The Lock Hopper cycle can be stopped at any time, either by an operator's action or either of the following conditions:

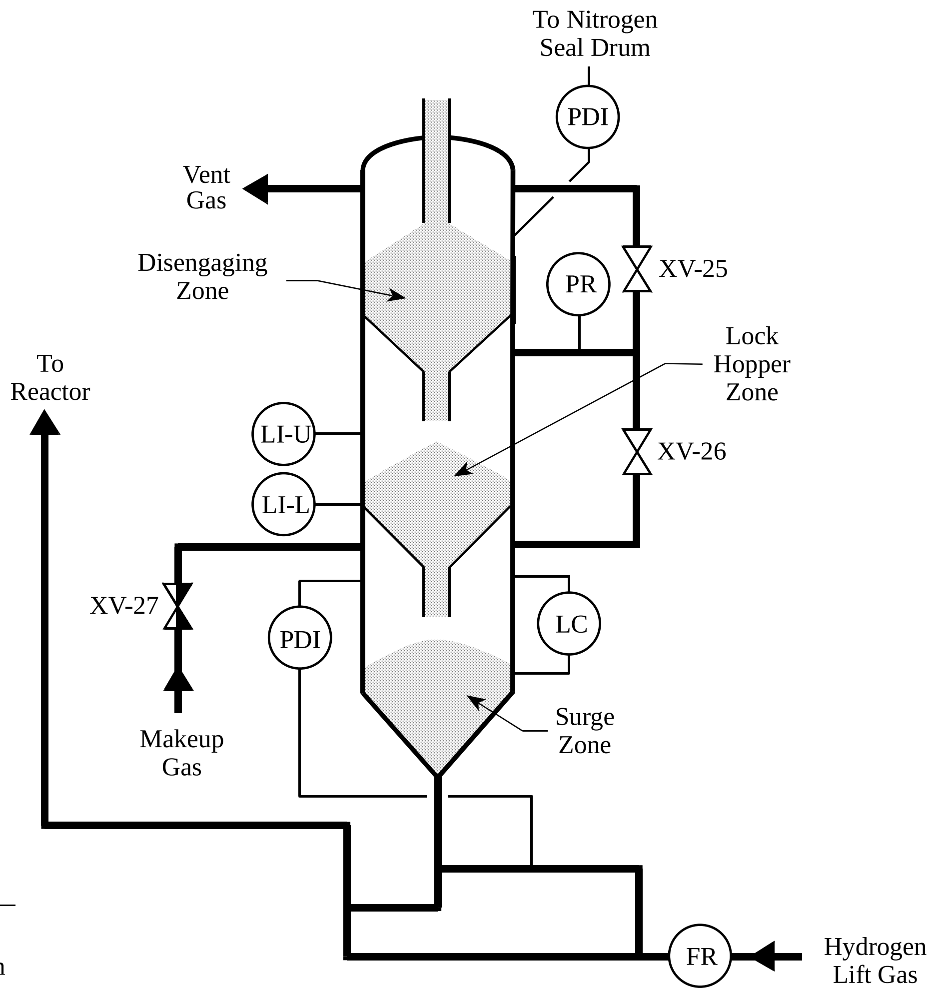
(i) Catalyst Flow Pushbutton is switched to OFF or
(ii) Hot Shutdown.

10. Initial Cycle Sequence

The Initial Cycle Sequence starts the Lock Hopper in a special way when the Lock Hopper is first started. This sequence compensates for the unpredictable conditions of pressure and catalyst level that exist in the Lock Hopper Zone, which depend on when the Lock Hopper was stopped. For these reasons, the Initial Cycle Sequence starts the Lock Hopper in the DEPRESSURE-1 step to depressure the Lock Hopper Zone.

The following sheets (Figures IV-1 through IV-8) are an outline of the logic steps. These sheets are in the order of a normal cycle sequence from the READY step until the LOAD step. The STOP step precedes the sheets for the normal cycle sequence.

Figure IV-1
Lock Hopper Controller



Definitions

Open
Closed
Part-Open
Changes Position

Step : STOP

Conditions to Proceed:

To Start the Lock Hopper Cycle Controller:

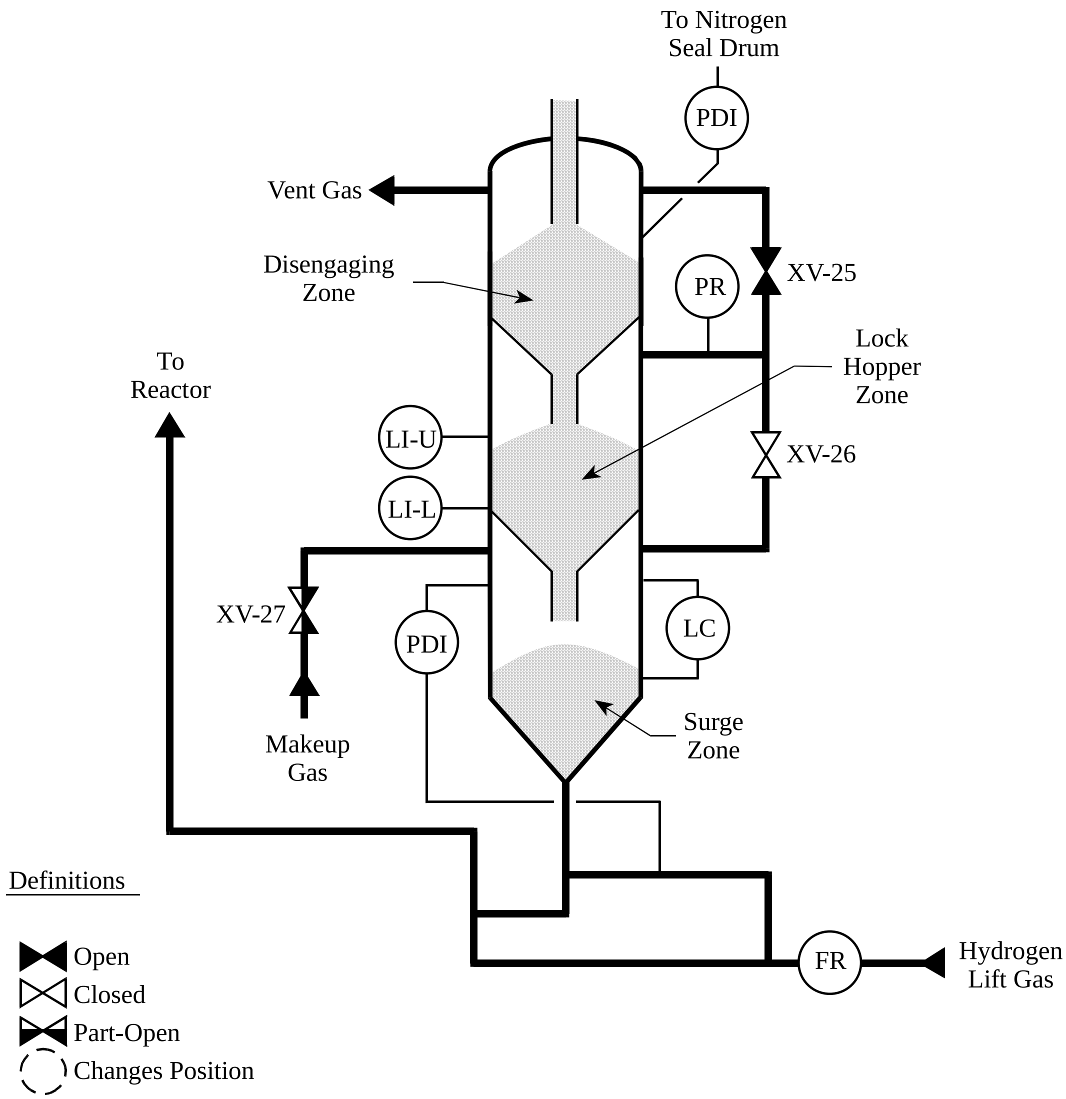
1. The Regenerator Must Not Be in a Hot Shutdown, Cold Shutdown, or a Contaminated Nitrogen Shutdown.

Remarks:

1. Start the Lock Hopper Cycle Controller by Pushing the Catalyst Flow ON Pushbutton. The Catalyst Flow Pushbutton Indicator Changes from OFF to ON.

PLT-R00-73
CYM-R02-11

Figure IV-2
Lock Hopper Controller



Step : READY (FROM "LOAD")

Initially the LH starts the sequence from the Depressure Stage. The normal sequence starts from the READY stage.

Conditions to Proceed:

1. The Lock Hopper Surge Zone LC Indicates a Low Level. The LH SZ falls below 40%.

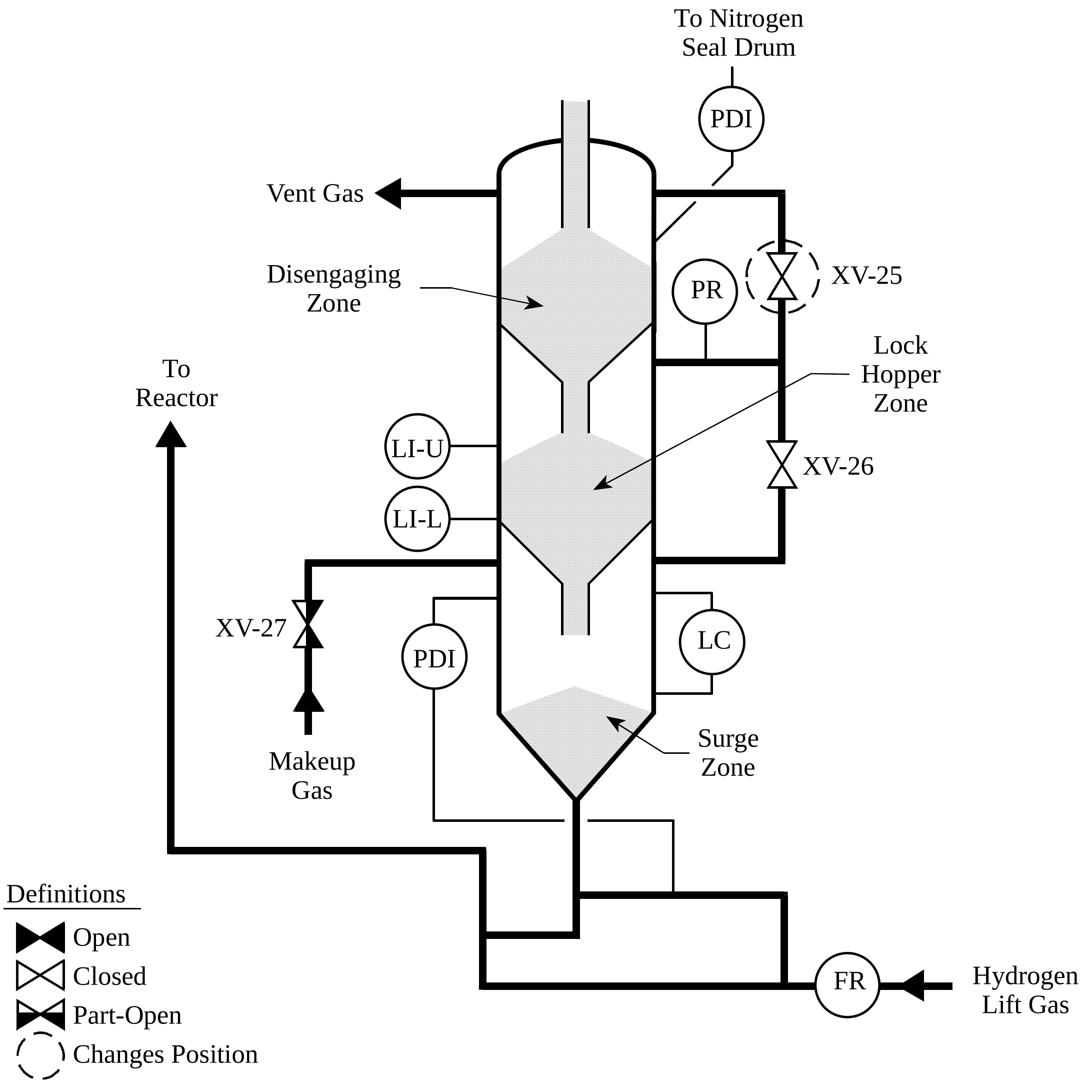
2. The LH SZ level has not risen above 40% since Catalyst Flow was switched ON and the LH Estimated Cycle Timer times out.

Remarks:

1. The READY Indication on the Control Board Comes On.

PLT-R00-77
CYM-R02-15

Figure IV-3
Lock Hopper Controller



Step : PRESSURE - 1

Conditions to Proceed:

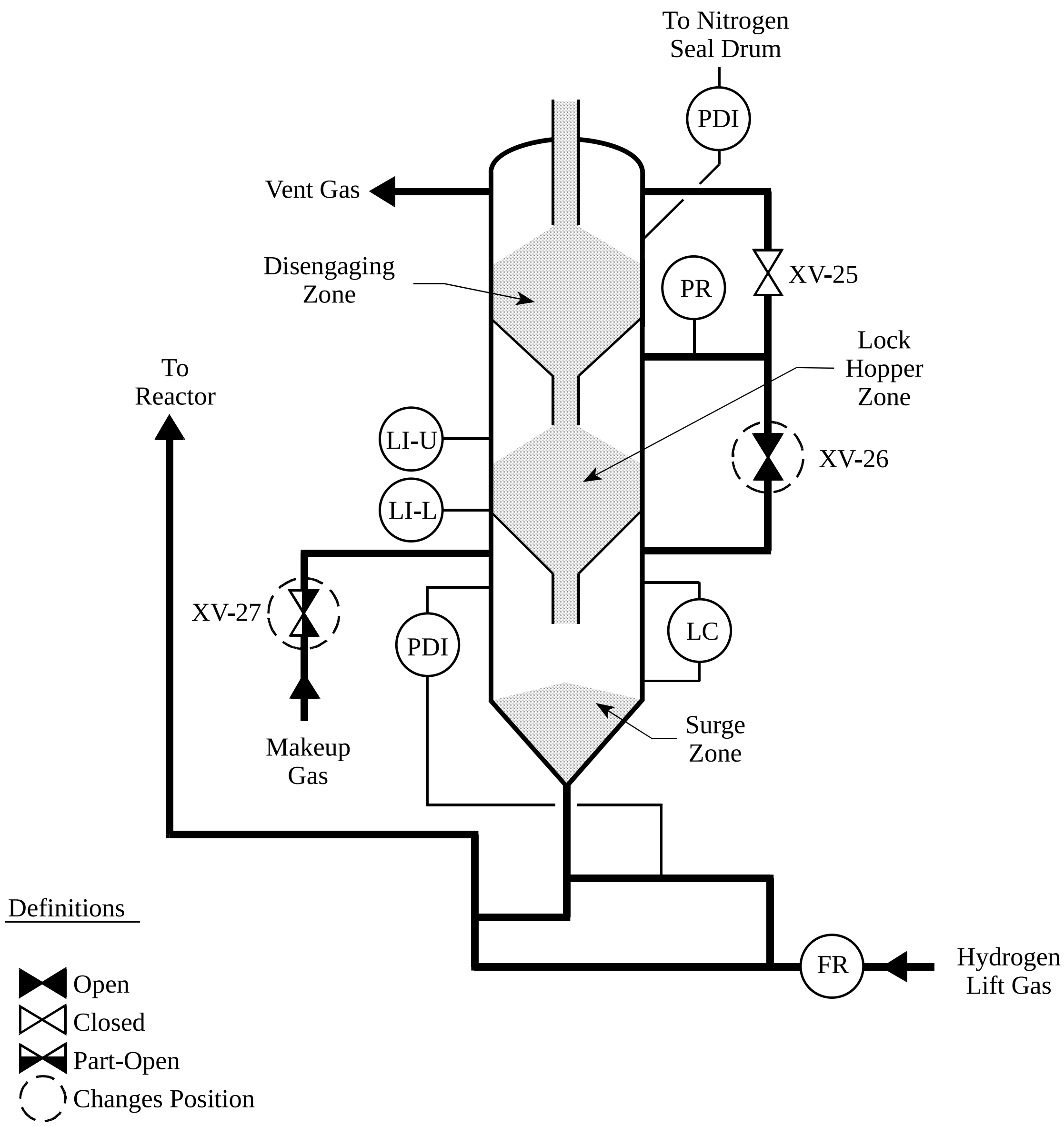
1. XV-25 Has Confirmed Closed.

Remarks:

1. The PRESSURE Indication on the Control Board Comes On.
2. The Lock Hopper Cycle Timer Restarts and the Catalyst Circulation Rate is Calculated from the Previous Value of the Lock Hopper Cycle Timer.
3. The Unload Timer Starts.
4. The Fast/Slow Unload Alarm resets if activated.

PLT-R00-78
CYM-R02-16

Figure IV-4
Lock Hopper Controller



Step : PRESSURE - 2

Conditions to Proceed:

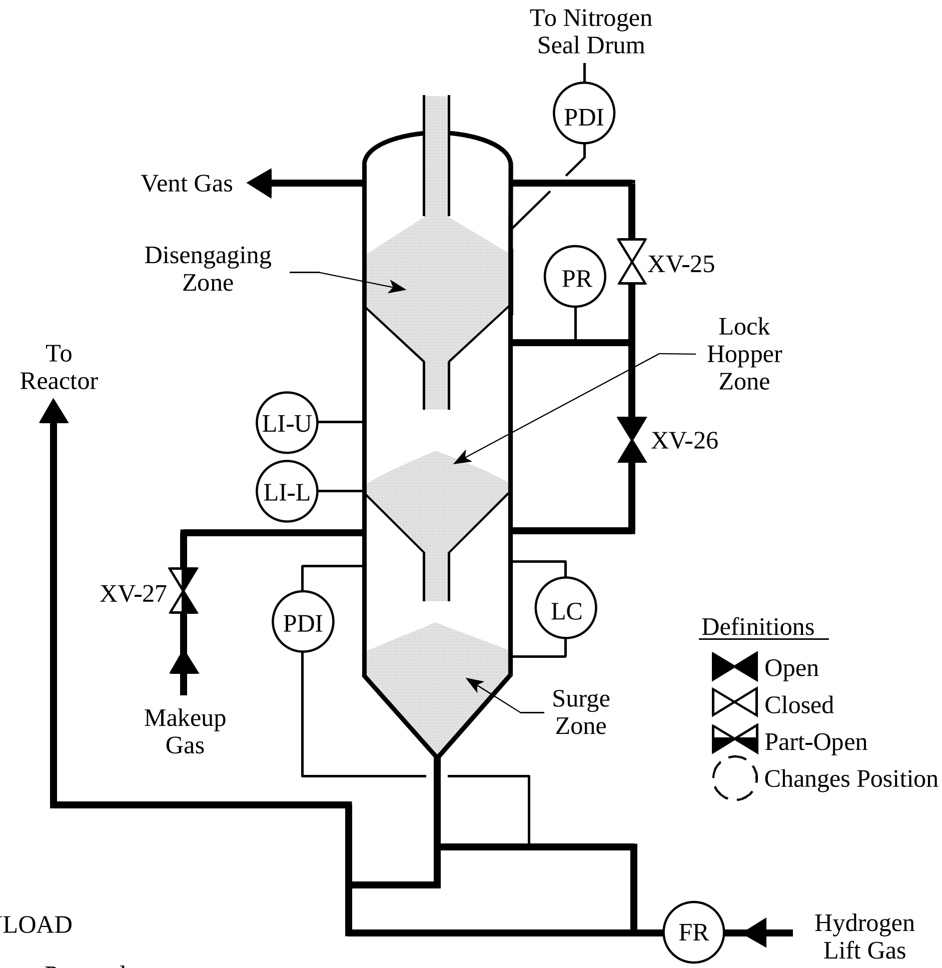
1. The Programmed Patterns for XV-25, XV-26, and XV-27 for Pressuring Have Completed.

Remarks:

1. If LI-L indicates a low level before the Step ends, the Fast Unload Alarm Sounds, then the Cycle Proceeds Immediately to the DEPRESSURE-1 Step.

PLT-R00-79
CYM-R02-17

Figure IV-5
Lock Hopper Controller



Step : UNLOAD

Conditions to Proceed:

1. Either LI-L Does Not Indicate a Level or the Slow Unload Timer Has Timed Out.

Remarks:

1. The UNLOAD Indication on the Control Board Comes On.

2. The Fast Unload Timer Starts as the Step is Entered. The Slow Unload Timer Starts when the Fast Unload Timer Times Out.

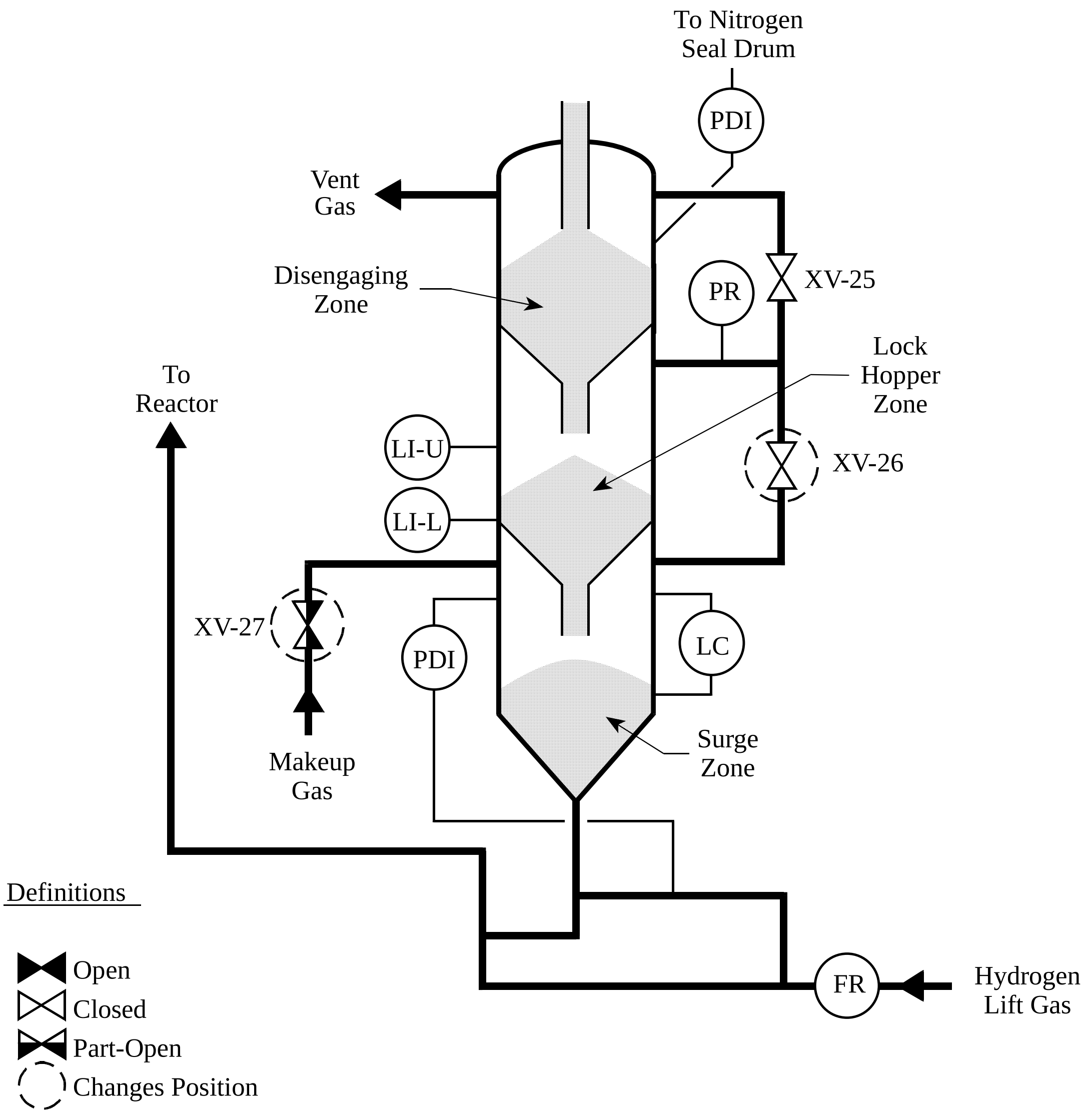
3. If LI-L Indicates No Level Before the Fast Unload Timer Times Out, then the Fast Unload Alarm Sounds and the Cycle Proceeds Immediately to the DEPRESSURE-1 Step. If the Fast Unload Alarm Sounds during Two Consecutive Cycles, then a Hot Shutdown Occurs.

4. If the Slow Unload Timer Has Timed Out Before LI-L Indicates No Level, then the Slow Unload Alarm Sounds (but the Cycle Continues). If the Slow Unload Alarm Sounds during Two Consecutive Cycles, then a Hot Shutdown Occurs.

5. The Unload Timer Stops Timing and Displays Its Elapsed Time When LI-L Does Not Indicate a Level or the Slow Unload Timer Has Timed Out.

PLT-R00-80
CYM-R02-18

Figure IV-6
Lock Hopper Controller



Step : DEPRESSURE-1

Conditions to Proceed:

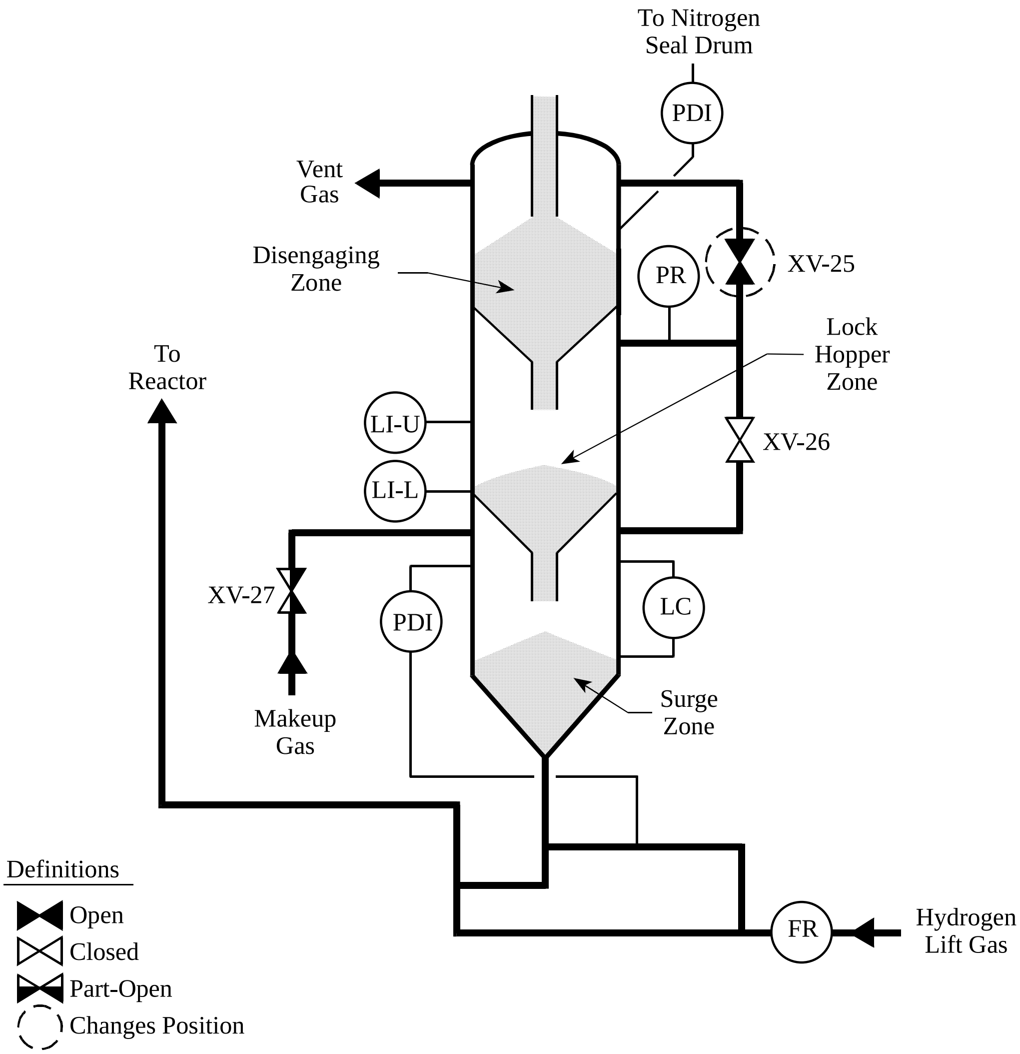
1. XV-26 Has Verified Closed.

Remarks:

1. The DEPRESSURE Indication on the Control Board Comes On.
2. The Load Timer Starts.
3. The Fast/Slow Load Alarm Resets if Activated.

PLT-R00-81
CYM-R02-19

Figure IV-7
Lock Hopper Controller



Step : DEPRESSURE-2

Conditions to Proceed:

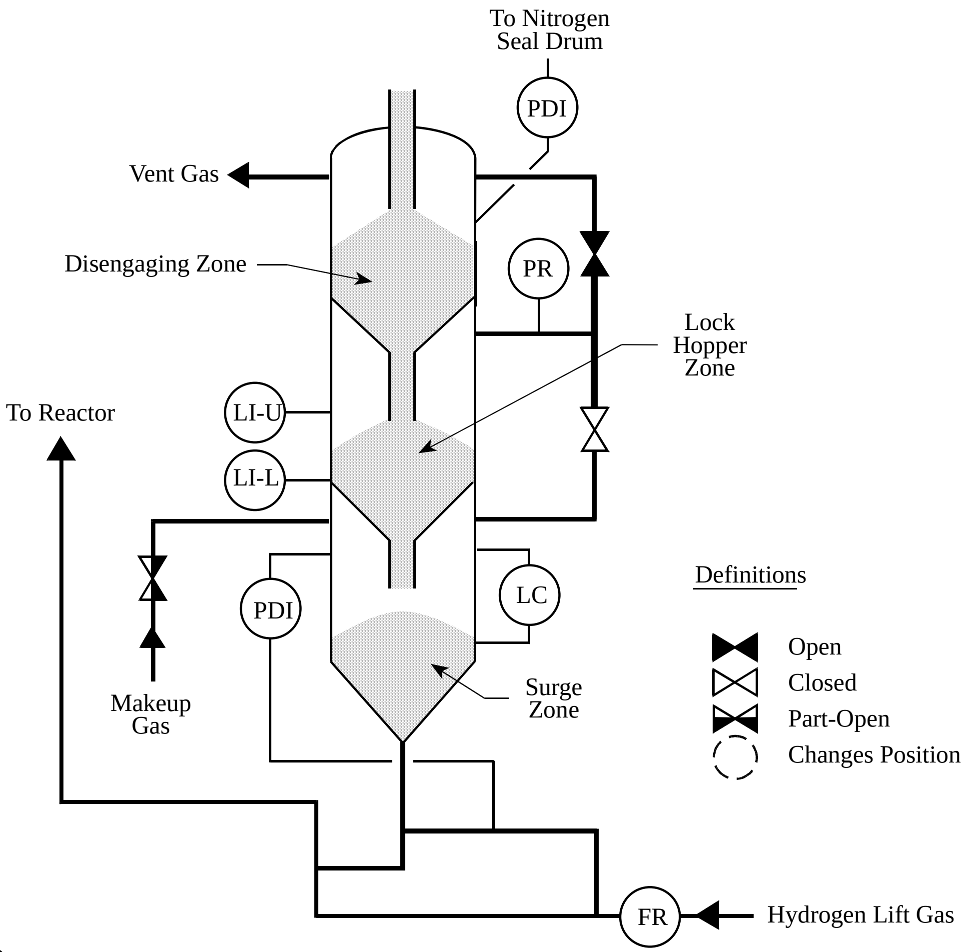
1. The Programmed Patterns for XV-25, XV-26, and XV-27 for Depressuring Have Completed.

Remarks:

1. The DEPRESSURE Indication on the Control Board Comes On (If It Is Not On Already).
2. If LI-U Indicates a Level during this Step, the Fast Load Alarm Sounds, then the Cycle Continues.

PLT-R00-82
CYM-R02-20

Figure IV-8
Lock Hopper Controller



***Step:* LOAD**

Conditions to Proceed:

1. LI-U indicates a level.

Remarks:

1. The LOAD step timer starts.
2. The LOAD indication on the control board comes on.
3. The fast load timer starts as the step is entered. The slow load timer starts when the fast load timer times out.
4. If LI-U indicates a high level before the fast load timer times out, then the fast load alarm sounds (but the cycle continues). If the fast load alarm sounds during two consecutive cycles, a hot shutdown occurs.
5. If the slow load timer has timed out before LI-U indicates a high level, then the slow load alarm sounds. If the slow load alarm sounds during two consecutive cycles, a hot shutdown occurs.
6. The timers stop timing and display the elapsed time when LI-U indicates a high level or the slow load

CYM-R02-21

C. MAKEUP VALVE

The Makeup Valve (XV-27) works in conjunction with the pressure differential control valve to supply booster gas to the Surge Zone of the Lock Hopper for pressuring the Lock Hopper Zone while keeping the differential pressure between the Lock Hopper and the Regenerated Catalyst Secondary Lift Gas Line stable. This will minimize disturbances in the Regenerated Catalyst Lift Rate. The Makeup Valve system reduces the pressure swings in the Lock Hopper Surge Zone caused by the opening and closing of the Equalization Valves. When the Lock Hopper is operating, the Makeup Valve can operate in three different modes, but at any time it can operate in only one mode. The three modes of the Makeup Valve are Feedthrough, Ramp Table and Adaption mode. Feedthrough and Ramp Table modes can be selected using either the DCS or Operator Interface, but Adaption can only be selected from the Operator Interface. Initially, Feedthrough mode is selected.

1. Mode No. 1: Feedthrough Mode (Closed Loop Control)

In Mode No. 1, the Makeup Valve (XV-27) operates like a differential pressure control valve. It opens and closes depending on the signal from the differential pressure instrument between the Lock Hopper and the Regenerated Catalyst Secondary Lift Gas Line. In this way, the differential pressure instrument controls not only its own control valve but also the Makeup Valve. Both valves operate together in parallel.

Mode No. 1 is used when the Lock Hopper is stopped in order to compensate for the unpredictable conditions that exist in the Lock Hopper from when it was stopped. Mode No. 1 is also intended to be used during the first several cycles when the Lock Hopper is restarted in order to compensate for the changing conditions that occur in the Lock Hopper until process conditions are once again constant from cycle to cycle. The Makeup Valve will operate in this mode until the process operator selects another mode after the catalyst flow is started.

2. Mode No. 2: Ramp Table Mode (Programmed Ramp)

Mode No. 2 is the normal operating mode. The Makeup Valve (XV-27) operates according to a programmed pattern. This programmed pattern remains the same from cycle to cycle.

The programmed pattern for the Makeup Valve in Mode No. 2 is either the default pattern or the learned pattern. The default pattern is permanently programmed in the CRCS and never changes. The learned pattern is a modified version of the default pattern after it has been changed by operation in Mode No. 3. The CRCS is capable of storing different programmed patterns off-line that can be read into the CRCS for future on-line use.

Mode No. 2 is useful when the programmed pattern for the Makeup Valve keeps the differential pressure between the Lock Hopper and the Regenerated Catalyst Secondary Lift Gas Line stable and the conditions in the Lock Hopper are constant from cycle to cycle.

3. Mode No. 3: Adaption Mode

In Mode No. 3, as in Mode No. 2, the Makeup Valve (XV-27) follows its programmed pattern. However, in Mode No. 3 the CRCS changes the programmed pattern of the Makeup Valve after each Lock Hopper cycle.

The Valve Ramping PLC “learns” what changes to make to the programmed pattern of the Makeup Valve by monitoring both the indication and the output of the differential pressure indicator/controller between the Lock Hopper and the Regenerated Catalyst Secondary Lift Gas Line. Then, the CRCS will change the Makeup Valve’s programmed pattern for the next Lock Hopper cycle using what it “learns” during the current Lock Hopper cycle.

At each moment in the Makeup Valve’s current cycle, the CRCS computes the changes in the Makeup Valve’s programmed pattern for the same moment in the next cycle using the information below:

- Pressure differential between the Lock Hopper Surge Zone and the Regenerated Catalyst Secondary Lift Gas Line.

- The controller output of the PDIC for the above

- Tuning constants

Mode No. 3 is useful when changes are needed to the programmed pattern for the Makeup Valve. This may be necessary when there are significant differences between the actual and design conditions in the Lock Hopper or when the process conditions in the Lock Hopper are changing significantly from cycle to cycle.

In Adaption mode, the CRCS generates new Makeup valve Ramp data points based on a correlation between the existing Makeup Valve Ramp Table data and the new data (Lock Hopper Surge Zone/Regenerated Catalyst Secondary Lift Gas ΔP pattern) collected over the current cycle. The learning algorithm works best if the PDIC controller is placed into Manual mode with its output set near 50%. The equation is:

$$MV_{new\ at\ t} = MV_{old\ at\ t} - K1 * (PDIC_{at\ t+n} - PDICSP)$$

Where:

$MV_{new\ at\ t}$	New makeup valve ramp controller output at time t.
$MV_{old\ at\ t}$	Previous (old) makeup valve ramp controller output at time t.
K1	Adjustable constant with a range of 0 to 32.767 in 0.001 increments
$PDIC_{at\ t+n}$	LH Surge Zone/Regen. Cat. Sec. Lift Gas ΔP at time (t+n)
n	Future time offset with a range of 0-30 sec in 0.1 sec increments for the differential pressure measurement signal.
PDICSP	Setpoint for PDIC with a range of 0-100% in 0.1% increments

The $PDIC_{at\ t+n}$ term of the equation uses the differential pressure measurement signal at an offset of **n** seconds after the current Makeup Valve position changes. In other words, the Makeup Valve position is changed based on a differential pressure measurement that occurs later in the cycle. When the corrections is applied in subsequent cycles, it allows the Makeup Valve to start making corrections in anticipation of differential pressure fluctuations later in the cycle. This is taking advantage of the fact that the Lock Hopper displays a predictable, cyclic pattern.

While in Adaption mode, the Control System alternates between “Observe” cycles and “Calculate” cycles. When the Control System is switched to Adaption mode and the value of the Adaption Mode Cycle Counter is greater than zero, the CRCS begins the first Observe cycle at the beginning of the next Lock Hopper cycle, i.e., when Lock Hopper Step 1 begins. An Observe cycle is a complete alarm-free Lock Hopper cycle. The following situations can cause problems during an Observe cycle:

- The Lock Hopper cycle is stopped and restarted.
- Any Lock Hopper alarms occur.
- The Catalyst Circulation Rate is not within 25% of the Catalyst Circulation Rate Setpoint.

The Lock Hopper cycle after one complete alarm-free Lock Hopper Observe cycle is called a Calculate cycle. The Calculate cycle performs the learning calculation on the Makeup Valve ramp table and loads this modified ramp table into the CRCS. After a Calculate cycle, the next complete cycle is an Observe cycle, followed by a Calculate cycle, and so on, until the Adaption Mode Cycle Counter reaches zero. The Modified Makeup Valve ramp created in a Calculate cycle will be utilized in the following Observe cycle. The Makeup Valve (XV-27) has the following features:

4. Feedthrough Mode Cycles Counter

The operator uses the Feedthrough Counter to set the number of Lock Hopper cycles that the Makeup Valve (XV-27) will operate in Mode No. 1 after either Ramp Table or Adaptation mode is selected. This helps prevent the CRCS from using what it “learned” shortly after the cycle has been restarted. The counter is adjustable from 0 to 5 cycles, usually it is set at 3 cycles.

5. Adaption Mode Cycles Counter

The operator uses the Adaptation Cycles Counter to set the number of Lock Hopper cycles for the Makeup Valve (XV-27) to be evaluated and changed by the Adaption mode learning algorithm. This is useful when the operator wishes to change the programmed pattern of the Makeup Valve, but only during a temporary time period. The counter is adjustable from 1 to 20 cycles.

D. REGENERATION TOWER SYSTEMS

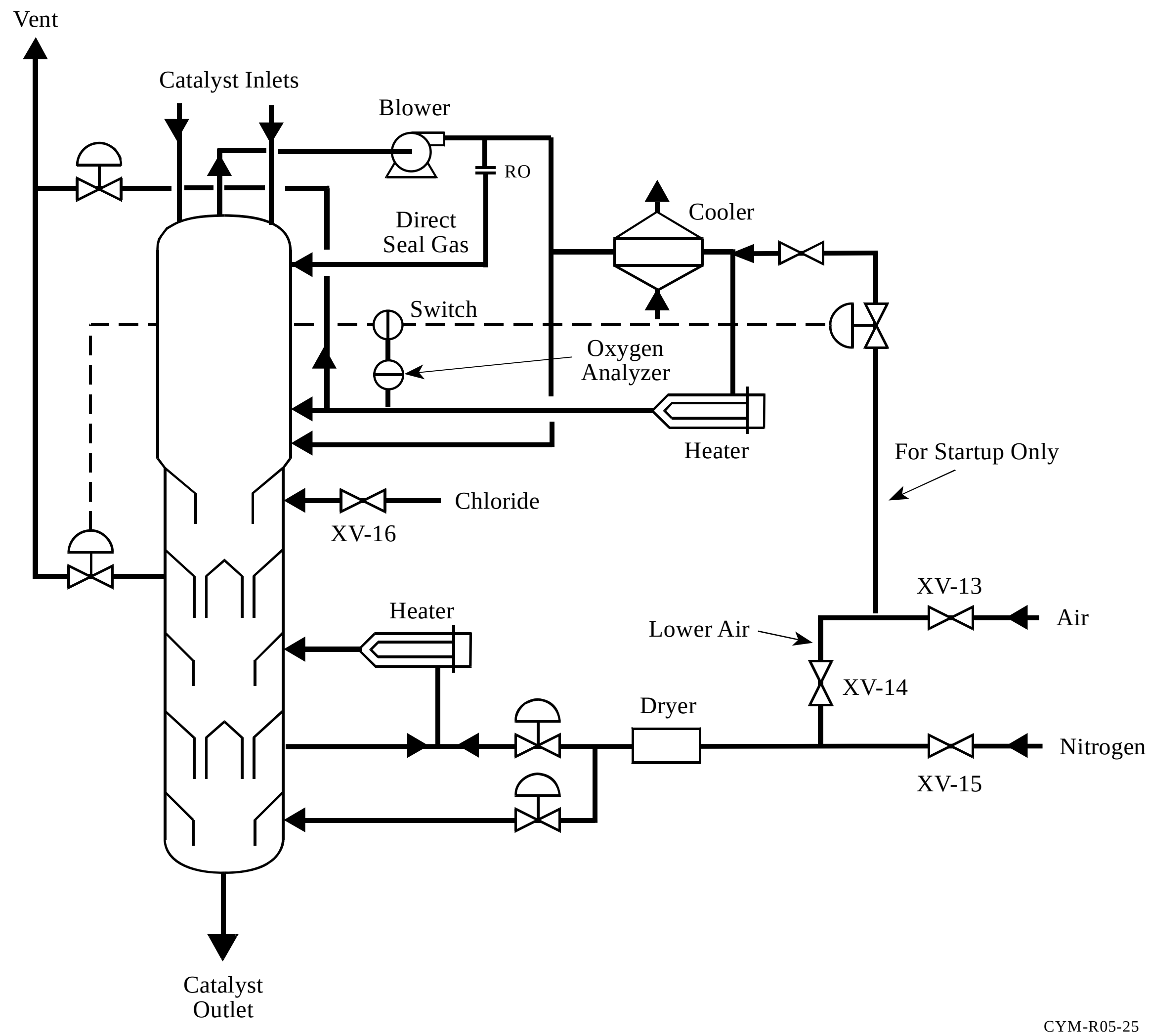
The Regeneration Systems control the catalyst regeneration. The goal of catalyst regeneration is to restore the catalyst to a condition that is as close as possible to fresh catalyst in a safe manner. The Regeneration Systems follow the logical requirements to achieve this goal. See Figure IV-9.

The operator starts and stops the Regeneration Systems using pushbuttons and switches. These pushbuttons and switches must be operated correctly to ensure the catalyst regeneration is done properly and safely. The Regeneration Systems help ensure that all of the process requirements are satisfied when a system is started or stopped. Depending on the actual conditions present, the Regeneration Systems can prevent a system from starting or it can automatically cause a system to stop.

The operator controls the Regeneration Systems using the following: the Regenerator Run-Stop Pushbutton, the Spent or Regenerated Catalyst Isolation Pushbutton, the Nitrogen Pushbutton, the Air Pushbutton, the Chloride Pushbutton, the Lower Air Supply Line Pushbutton, the Electric Heater Pushbuttons, and the Emergency Stop Switch.

Figure IV-9

CycleMax Regeneration Tower



1. Regenerator Run-Stop Pushbutton

The Regenerator Run-Stop Pushbutton starts and stops the entire Regeneration Section.

The Regenerator Run-Stop Pushbutton has only two positions: RUN and STOP. An indicator on the control panel shows the position of the pushbutton. The operator can place the Regenerator in RUN or STOP mode using either the DCS or the Operator Interface. Initially, the Regenerator RUN-STOP Pushbutton is in the STOP mode. The Pushbutton must be in the “RUN” position in order to start any of the Regeneration Section Systems controlled by the CRCS.

a. Regenerator “RUN”

To start the Regeneration Section, the following conditions must be met:

Item	Condition
1. Spent Catalyst Isolation System	Valves XV-5 and XV-7 confirm closed. Valve XV-6 confirms open.
2. Regenerated Catalyst Isolation System	Valves XV-24 and XV-22 confirm closed. Valve XV-23 confirms open.
3. CCR Nitrogen Header	Pressure not low.
4. CCR Nitrogen Analyzer	Contaminants not high.
5. Regenerator Inventory Switch	NORMAL position.
6. Emergency Stop Switch	RUN position.

Then, when the operator depresses the Regenerator Run-Stop Pushbutton, the Regeneration Section starts. The indicator changes from STOP to RUN.

All of the Regeneration Section conditions remain the same. Starting the Regeneration Section allows the Spent Catalyst and Regenerated Catalyst Isolation Systems to be opened, catalyst circulation to be started, nitrogen or air to be introduced to the Regeneration Tower (Burn or Drying Zone), chloride to be introduced to the Chlorination Zone and the Electric Heaters to be turned on. However, to start any of these systems, other conditions must be met and their respective pushbuttons must be depressed.

b. Regenerator "STOP"

The Regeneration Section stops automatically when any of the following conditions occur:

Item	Condition
1. Spent Catalyst Isolation System	Either Valve XV-5 or XV-7 does not confirm closed when they should be closed OR Valve XV-6 does not confirm open when it should be open.
2. Regenerated Catalyst Isolation System	Either Valve XV-24 or XV-22 does not confirm closed when they should be closed OR Valve XV-23 does not confirm open when it should be open.
3. CCR Nitrogen Header	Low pressure.
4. CCR Nitrogen Header	High contaminants.
5. Regenerator Run-Stop Pushbutton	"STOP" by manual operation.
6. Emergency Stop Switch	"STOP" by manual operation.

Then, the Regenerator Run-Stop indicator changes from RUN to STOP. If the condition is high contaminants in the CCR nitrogen header, a Contaminated Nitrogen Shutdown occurs. With any of the other conditions above, a Cold Shutdown occurs.

The operator can manually stop the Regeneration Section at any time in order to begin the Cold Shutdown Procedure. If the Regenerator Run-Stop Pushbutton is depressed while the Regeneration Section is running, then the Regeneration Section stops. The indicator changes from RUN to STOP and a Cold Shutdown occurs.

Table IV-1: System Control Modes While in Regenerator Stop Mode

System Control	Forced Position
Spent Catalyst Isolation System	Closed
Regenerated Catalyst Isolation System	Closed
Nitrogen	ON
Air	OFF
Chloride	OFF
Lower Air Supply Line	Closed
Catalyst Flow	OFF
Air Heater	STOP
Regeneration Heater	STOP

2. Nitrogen Pushbutton

The Nitrogen Pushbutton opens and closes the Nitrogen Valve (XV-15). The Nitrogen Valve is a fail-open valve that starts and stops the flow of nitrogen to the Cooling Zone and Drying Zone of the Regeneration Tower. Nitrogen flow must first be started in order to begin the Startup Procedures.

The Nitrogen Pushbutton has only two positions: ON and OFF. In the ON position, the Nitrogen Valve (XV-15) is open. In the OFF position, the Nitrogen Valve is closed. An indicator on the control panel shows the position of the pushbutton. Limit switches indicate the position of the valve.

a. Pushbutton "ON"

The Nitrogen Valve (XV-15) opens automatically when a Hot Shutdown or a Cold Shutdown occurs, unless these shutdowns are the result of a Contaminated Nitrogen Shutdown. The Nitrogen Valve also opens automatically when the Emergency Stop Switch is moved to the Stop position. This keeps the Regeneration Tower under a nitrogen environment when catalyst circulation and catalyst regeneration are stopped.

The operator can manually open the Nitrogen Valve (XV-15) without any preconditions when doing the Hot Shutdown Procedure. If the Nitrogen Pushbutton is depressed while the Nitrogen Valve is closed, then the Nitrogen Valve opens. The indicator changes from OFF to ON.

If the Nitrogen Pushbutton is depressed during a Contaminated Nitrogen Shutdown, the Nitrogen Valve does not open. In this way, contaminated nitrogen is prevented from entering the bottom of the Regeneration Tower.

b. Pushbutton "OFF"

Closing the Nitrogen Valve (XV-15) manually is an important step in the Startup Procedures. In the Shutdown Procedures, the Nitrogen Valve is open and it must remain open until the Startup Procedures are underway. This keeps the Regeneration Tower under a nitrogen environment. Even in the Startup Procedures, the Nitrogen Valve must continue to remain open until it is allowable, according to the Startup Procedures, to open the Lower Air Supply Line Valve (XV-14). The important point is that opening the Lower Air Supply Line Valve too early can cause serious damage to equipment and catalyst inside the Regeneration Tower.

When it is allowable, according to the Startup Procedures, to close the Nitrogen Valve, the operator depresses the Nitrogen Pushbutton. The Nitrogen Valve closes and the indicator changes from ON to OFF.

The Nitrogen Valve (XV-15) closes automatically when a Contaminated Nitrogen Shutdown occurs. In this way, contaminated nitrogen is prevented from entering the bottom of the Regeneration Tower.

3. Air Pushbutton

The Air Pushbutton opens and closes the Air Valve (XV-13). The Air Valve is a fail-close valve that starts and stops the flow of air to the Regeneration Tower. Air flow must be started during the Startup Procedures in order to begin coke burning.

The Air Pushbutton has only two positions: ON and OFF. In the ON position, the Air Valve (XV-13) is open. In the OFF position, the Air Valve is closed. An indicator on the control panel shows the position of the pushbutton. Limit switches indicate the position of the valve.

a. Pushbutton “ON”

Opening the Air Valve (XV-13) is an important step in the Startup Procedures that should not be taken lightly. In the Shutdown Procedures, the Air Valve is closed and it must remain closed until the Startup Procedures are underway. This keeps the Regeneration Tower under a nitrogen environment. Even in the Startup Procedures, the Air Valve must remain closed until it is allowable, according to the Startup Procedures, to begin coke burning. The important point is that opening the Air Valve too early can cause serious damage to equipment and catalyst inside the Regeneration Tower.

When it is allowable, according to the Startup Procedures, to open the Air Valve (XV-13), the operator depresses the Air Pushbutton. The Air Valve opens and the indicator changes from OFF to ON.

b. Pushbutton “OFF”

The Air Valve (XV-13) closes automatically when a Hot Shutdown, a Cold Shutdown, or a Contaminated Nitrogen Shutdown occurs or if the Emergency Stop Switch is moved to the Stop position. This keeps air out of the Regeneration Tower when catalyst circulation and catalyst regeneration are stopped during these shutdowns.

The operator can manually close the Air Valve (XV-13) without any preconditions when doing the Hot Shutdown Procedure. If the Air Pushbutton is depressed while the Air Valve is open, then the Air Valve closes. The indicator changes from ON to OFF.

4. Lower Air Supply Line Pushbutton

The Lower Air Supply Line Pushbutton opens and closes the Lower Air Supply Line Valve (XV-14). The Lower Air Supply Line Valve is a fail-closed valve that starts and stops the flow of air to the Cooling Zone and Drying Zone of the Regeneration Tower. Air flow must be started to the Cooling Zone and Drying Zone during the Startup Procedures in order to begin oxidizing and chloriding the catalyst.

The Lower Air Supply Line Pushbutton has only two positions: OPEN and CLOSED. In the OPEN position, the Lower Air Supply Line Valve (XV-14) is open. In the CLOSED position, the Lower Air Supply Line Valve in closed. An indicator on the control panel shows the position of the pushbutton. Limit switches indicate the position of the valve.

a. Pushbutton “OPEN”

Opening the Lower Air Supply Line Valve (XV-14) is an important step in the Startup Procedure that should not be taken lightly. In the Shutdown Procedures, the Lower Air Supply Line Valve is closed and it must remain closed until the Startup Procedures are underway. This keeps the Cooling Zone and Drying Zone under a nitrogen environment. Even in the Startup Procedures, the Lower Air Supply Line Valve must remain closed until it is allowable, according to the Startup Procedures, to begin oxidizing and chloriding the catalyst. The important point is that opening the Lower Air Supply Line Valve when there is coke below the Burn Zone can cause serious damage to equipment and catalyst inside the Regeneration Tower.

When it is allowable, according to the Startup Procedures, to open the Lower Air Supply Line Valve (XV-14), the operator depresses the Lower Air Supply Line Pushbutton. The Lower Air Supply Line Valve opens and the indicator changes from CLOSED to OPEN.

b. Pushbutton “CLOSED”

The Lower Air Supply Line Valve (XV-14) closes automatically when a Hot Shutdown, a Cold Shutdown occurs, or a Contaminated Nitrogen Shutdown occurs or when the Emergency Stop Switch is moved to the Stop position. This keeps air out of the Drying Zone when catalyst circulation and catalyst regeneration are stopped during these shutdowns.

The operator can manually close the Lower Air Supply Line Valve (XV-14) without any preconditions when doing the Hot Shutdown Procedure. If the Lower Air Supply Line Pushbutton is depressed while the Lower Air Supply Line Valve is open, then the Lower Air Supply Line Valve closes. The indicator changes from OPEN to CLOSED.

5. Chloride Pushbutton

The Chloride Pushbutton opens and closes the Chloride Valve (XV-16). The Chloride Valve is a fail-closed valve that opens and closes to supply an organic chloride into the Chlorination Zone. Chloride injection must be started during the Startup Procedures in order to begin redispersing the metals and chloriding the catalyst.

The Chloride Pushbutton has only two positions: ON and OFF. In the ON position, the Chloride Valve (XV-16) is open. In the OFF position, the Chloride Valve is closed. An indicator on the control panel shows the position of the pushbutton. Limit switches indicate the position of the valve.

a. Pushbutton “ON”

Opening the Chloride Valve (XV-16) can be done only after normal catalyst circulation and catalyst regeneration have been started. That means, gas flow rates to each zone are normal, operating temperatures of each zone are normal, and the gas flowing to the Cooling Zone and Drying Zone is air. These conditions help ensure that the organic chloride will decompose when it is injected. The Chloride Valve cannot be opened during a Hot Shutdown, Cold Shutdown, or a Contaminated Nitrogen Shutdown. To open the Chloride Valve (XV-16), the following conditions must be met:

Item	Condition
1. Nitrogen Valve	XV-15 is commanded closed and confirms closed.
2. Regeneration Gas Heater Outlet Temperature	Not low.
3. Air Heater Outlet Temperature	Not low.

When the operator depresses the Chloride Pushbutton, the Chloride Valve opens. The indicator changes from OFF to ON.

For the Organic Chloride Injection Pump to start, the following conditions must be met:

Item	Condition
1. Chloride Valve	XV-16 confirms opened.
2. Chloride Injection Pump Handswitch (local)	AUTO position.

Then, the Organic Chloride Injection Pump will start automatically.

The operator can adjust the organic chloride injection rate by using the stroke adjustment on the Injection Pump. A flow meter indicates the injection rate. If the flow rate is too low for a time longer than the Chloride Flow Alarm Timer (usually 15 seconds), then an alarm sounds and the Chloride valve closes. The operator should check the injection rate regularly using the sight glass on the organic chloride drum.

The operator can manually start the Organic Chloride Injection Pump in order to inventory the injection line. If the operator turns the local Pump Handswitch to the HAND position while the Emergency Stop Switch is in the RUN position, then the Injection Pump starts. The line should be inventoried up to the Chloride Valve (XV-16) before beginning the Startup Procedures. After inventorying, the local Pump Handswitch should be in the AUTO position for normal operation.

b. Pushbutton “OFF”

The Chloride Valve (XV-16) closes automatically when a Hot Shutdown, Cold Shutdown, or a Contaminated Nitrogen Shutdown occurs. The Chloride Valve closes automatically if any condition required to open the Chloride Valve and start the Injection Pump is not met while the Chloride Valve is open, that is:

Item		Condition
1.	Nitrogen Valve	XV-15 is not confirmed closed.
2.	Regeneration Gas Heater Outlet Temperature	Low.
3.	Air Heater Outlet Temperature	Low.
4.	Chloride Valve	XV-16 is not confirmed open.
5.	Chloride Flow	Low.
6.	Emergency Stop Switch	Stop position.

Then, the indicator changes from ON to OFF. If the Pump Handswitch is in the AUTO position, then the Injection Pump stops automatically too.

The operator can manually close the Chloride Valve (XV-16). If the Chloride Pushbutton is depressed when the Chloride Valve is open, then the Chloride Valve closes, the Injection Pump is disabled and the Chloride Injection Low Flow Alarm is disabled.

The operator can also manually stop the Injection Pump by turning the Pump Handswitch to the OFF position.

6. Electric Heater Controls

There are four electric heaters – Regeneration Gas, Air, Reduction Gas No. 1, and Reduction Gas No. 2. Each heater has an Electric Heater Pushbutton that starts and stops its electrical power. Each Electric Heater Pushbutton has only two positions: RESET and STOP. The RESET mode enables the heater's power control system while the STOP mode disables power. An indicator on the control panel shows the position of the pushbutton.

a. Reset

To start the Air and Regeneration Gas heaters, the following conditions must be met:

	Item	**Condition**
1.	Regenerator Run-Stop Pushbutton	RUN position.
2.	Process Gas Flow	Not low.
3.	Heater Element Skin Temperature	Not high.
4.	Ground Fault	None.
5.	Emergency Stop Switch	Not in Stop position.

When the operator depresses either the Air or Regeneration Gas Heater Pushbutton, then that electric heater starts. Its indicator changes from STOP to RESET.

NOTE: Some units with a small Regeneration Section may have a fifth electric heater; the Reheat Gas Heater. This heater operates in the same way as the Air and Regeneration Gas heaters discussed above.

To start the Reduction Gas heaters, the following conditions must be met:

Item		Condition
1.	Process Gas Flow	Not low.
2.	Heater Element Skin Temperature	Not high.
3.	Ground Fault	None.
4.	Emergency Stop Switch	Not in Stop position.
5.	Reduction Zone Bed Temperatures	Not high

When the operator depresses either Reduction Gas Heater Pushbutton, then that electric heater starts. Its indicator changes from STOP to RESET.

The operator controls each heater's output with its temperature controller on the DCS.

b. Stop

The Regeneration Gas and Air electric heaters stop automatically when a Cold Shutdown or a Contaminated Nitrogen Shutdown occurs. Hot, Cold and Contaminated Nitrogen Shutdowns do not shut off the Reduction Gas heaters. The Reduction Gas heaters are not affected by the Regenerator Run-Stop Pushbutton.

Each of the electric heaters can individually stop automatically. If any condition required for starting the heater is not met while the heater is on, then that heater alone stops. If the heater stops because of low process gas flow, high heater element skin temperature, or ground fault, the indicator changes from RESET to display neither RESET nor STOP.

The operator can manually stop each of the electric heaters. If the Electric Heater Pushbutton is depressed when the heater is on, then that electric heater stops. Its indicator changes from RESET to STOP.

7. Emergency Stop Switch

The Emergency Stop Switch controls power to all logic-operated valves and electric heaters in the Regeneration Section. The Emergency Stop Switch has two positions: RUN and STOP.

a. Stop

If the Emergency Stop Switch is turned to the STOP position, a Cold Shutdown occurs and each logic-operated valve immediately moves to its fail-safe position. In addition, the three Controller Failure Alarms sound, and the Valve I/O Failure Alarm, if present, clears. Turning the Emergency Stop Switch to the STOP position may be required as a last resort. But in normal operations this is not recommended. This is because all of the valves move at once and neither the operator nor the CRCS controls the sequence of the movement. Moving the switch to the STOP position stops the following systems and disables them from being started:

1. Regeneration System (Isolation Systems, Catalyst Lift Systems)
2. Catalyst Flow Interrupt Systems
3. Chemical Systems (Nitrogen, Air, Chloride)
4. Lock Hopper Control (Lock Hopper Cycle, Catalyst Flow Control, Makeup Valve Control)
5. Catalyst Addition Hoppers
6. Fines Collection Pot
7. Heaters (Air, Regeneration Gas, Reduction Gas)

b. Run

RUN is the position of the Emergency Stop Switch during normal operation. The Emergency Stop Switch must be in the RUN position in order for the operator to control CRCS instrumentation. The Emergency Stop Switch must be in the RUN position or else no other system, including the Regenerator, can be in the RUN condition.

When the Emergency Stop Switch is turned to the RUN position:

1. The three Controller Failure Alarms clear (this confirms that the Emergency Stop Switch is functioning normally),
2. Valve power is made available
3. The systems listed above can be restarted.

E. ISOLATION SYSTEMS

Isolation Systems keep the environment in the Regeneration Tower separate from hydrogen/hydrocarbon-containing environments present in the Reactor and Lock Hopper (See Figures IV-10, IV-11, and IV-12). The Regeneration Tower is an oxygen-containing environment. The isolation systems prevent a potentially hazardous mixture of oxygen and hydrogen/hydrocarbon environments between the Regeneration Tower and either the Disengaging Hopper or Lock Hopper.

There are two Isolation Systems. The Spent Catalyst Isolation System is at the catalyst outlet from the last reactor. It isolates the Reactor from the Spent Catalyst Lift System. The Regenerated Catalyst Isolation System is on the catalyst outlet from the Nitrogen Seal Drum. It isolates the Nitrogen Seal Drum from the Lock Hopper.

1. Principle

Both Isolation Systems are alike. Each has a “High Pressure Zone”, two Isolation Valves, a Pressure Valve, and a differential pressure control valve. There are two differential pressure controllers. The top one is between the “High Pressure Zone” and the vessel above it. The bottom one is between the “High Pressure Zone” and the vessel below it.

The Spent Catalyst system does not have the lower differential pressure controller. It is assumed in this case that the Disengaging Hopper will always be at a higher pressure than the Regeneration Tower.

These two differential pressures are the key indications that the Isolation System is keeping the environments above and below the Isolation System separate. Nitrogen purges into the “High Pressure Zone” on differential pressure control. The “High Pressure Zone” is at a slightly higher pressure than both the vessel above and below the Isolation System. This “nitrogen bubble” prevents gases in the vessel above from leaking downward and it prevents gases in the lower vessel from leaking upward. If either the top or bottom differential pressure becomes too low, the “nitrogen bubble” in the High Pressure Zone may be lost. On the other hand, if the top differential pressure becomes too high, the flow of catalyst downward may be halted. So, it is very important that these two differential pressures – top and bottom – are controlled, measured, and monitored accurately.

First, each differential pressure, top and bottom, is controlled by one dedicated differential pressure indicator-controller. One control valve, the nitrogen purge to the High Pressure Zone, controls both differential pressures by a signal selector.

Second, each differential pressure, top and bottom, is measured by a further two independent differential pressure instruments. These two instruments are devoted to the alarm and shutdown functions of the isolation systems.

Third, each differential pressure, top and bottom, is monitored by a two-of-two voting circuit. This voting circuit is located in the CRCS. The two independent differential pressure indications are inputs to this voting circuit. If one indication is higher than the low-differential trip setting then the voting circuit is satisfied. This is one of the requirements for opening the Isolation System. If both indications are lower than the low-differential trip setting, then the voting circuit is not satisfied. If this condition persists for longer than a set time, the Isolation System will close (if it was open). This voting circuit allows operation without the need for a shutdown in case one of the differential pressure instruments must be serviced.

2. Operation

The Spent Catalyst Isolation Open Pushbutton opens the Spent Catalyst Isolation System. The Regenerated Catalyst Isolation Open Pushbutton opens the

Regenerated Catalyst Isolation System. Both Isolation Systems must be open in order to circulate and regenerate catalyst.

Both Isolation Systems have only two conditions: OPEN and CLOSED. An indicator on the control panel shows the condition of each Isolation System. Limit switches indicate the positions of the Isolation Valves. Both Isolation Systems can be opened or closed using either the DCS or the Operator Interface. Initially, both Isolation systems are closed.

3. Isolation System Open

Opening an Isolation System means opening its two Isolation Valves and closing its Pressure Valve.

To open an Isolation System (either Spent or Regenerated Catalyst), the following conditions must be met:

1. The Regenerator Run-Stop pushbutton is in "RUN," and

2. <u>One</u> of the indicators for both the top and the bottom differential pressures is higher than the low-differential trip settings (two-of-two voting system).

3. (For Spent Catalyst Isolation only.) Reduction Zone above Low Level.

Then, when the operator depresses the Isolation Open Pushbutton, that Isolation System opens. First, its Pressure Valve is commanded closed and confirms closed. Then, its Isolation Valves are commanded open and confirm open. Its indicator changes from CLOSED to OPEN.

4. Isolation System "Closed"

Closing an Isolation System means closing its two Isolation Valves and opening its Pressure Valve. This pressures the pipe between the two Isolation Valves to nitrogen header pressure and prevents cross-mixing between the two vessels.

An Isolation System (either Spent or Regenerated Catalyst) closes automatically when:

1. A Cold Shutdown occurs (Regenerator Run/Stop to Stop)

2. Both of the indicators for the top and bottom differential pressures are lower than the low-differential trip settings (two-of-two voting system). The indicators must be low for a time longer than the set amount of time.

3. (For Spent Catalyst Isolation only.) Reduction Zone catalyst level is below the Low Level point.

4. Contaminated Nitrogen Shutdown occurs.

When an Isolation System closes, first, its Isolation Valves are commanded closed and confirm closed. Next, its Pressure Valve is commanded open and confirms open. Its indicator changes from OPEN to CLOSED. If its Isolation Valves do not confirm closed within the time period of its Purge Delay Timer (usually 10 seconds), a Cold Shutdown occurs and its Pressure Valve is commanded open anyway. In this way, a limit switch malfunction will not prevent the Pressure Valve from opening. If the Pressure Valve does not confirm open, a Cold Shutdown occurs.

Any time either isolation system is tripped closed, a Hot Shutdown will occur. The isolation system will continue to give this signal for one minute at the end of which the Regeneration System can be restarted. An exception to the above is when the Spent Catalyst Isolation is tripped by a low level in the Reduction Zone. In this case no Hot Shutdown shall occur so the level can be reestablished.

An Isolation System closes automatically when a Contaminated Nitrogen Shutdown occurs. Then, only the Spent Catalyst Isolation System closes as described above. The Regenerated Isolation System closes differently. Not only are its Isolation Valves commanded closed, but so is the Pressure Valve and the control valve for the nitrogen purge to the Nitrogen Seal Drum. In this way, contaminated nitrogen is prevented from contaminating the Nitrogen Surge Drum and possibly the

Regeneration Tower. The operator can manually close both Isolation Systems at any time by depressing the Isolation System CLOSE pushbutton, or if the operator resets the Regenerator Run-Stop Pushbutton, then a Cold Shutdown occurs. This closes the Isolation Systems.

5. Regenerator Inventory Switch

The Regenerator Inventory Switch bypasses the two logic requirements for opening the Regenerated Catalyst Isolation System. The two logic requirements are that one differential pressure indicator for each of the Nitrogen Seal Drum/Regeneration Tower and Nitrogen Seal Drum/Lock Hopper must be above the low-differential trip setpoint. This is useful before startup for loading catalyst into the Regeneration Section.

The Regenerator Inventory Switch has only two positions: INVENTORY and NORMAL. An indicator on the control panel indicates when the two logic requirements are bypassed. The Regenerator Inventory Switch should be in the NORMAL position during normal operation.

a. "Inventory"

To inventory the Regeneration Section, the following conditions must be met:

Item		**Condition**
1.	Emergency Stop Switch	RUN position.
2.	Regenerator Run-Stop Pushbutton	STOP position.

Then, when the operator turns the Regenerator Inventory Switch to the INVENTORY position, the two logic requirements for opening the Regenerated Catalyst Isolation System is bypassed. The indicator labeled REGENERATOR INVENTORY OPERATION on the control panel lights up. Then, when the operator depresses the Isolation Pushbutton, the Regenerated Catalyst Isolation System will open.

b. “Normal”

NORMAL is the position of the Regenerator Inventory Switch during normal operation.

c. Automatic Removal from Inventory Mode

Any of the following conditions will end inventorying of the Regeneration Section:

Item		Condition
1.	Emergency Stop Switch	STOP position.
2.	Regenerator Inventory Switch	NORMAL position.
3.	Regenerator Run-Stop Switch	RUN position.

Then, the two logic requirements for opening the Regenerator Catalyst Isolation System are no longer bypassed. The Regenerated Catalyst Isolation System closes. The indicator labeled REGENERATOR INVENTORY OPERATION on the control panel turns off.

Figure IV-10
CycleMax Regeneration Section
Isolation Systems

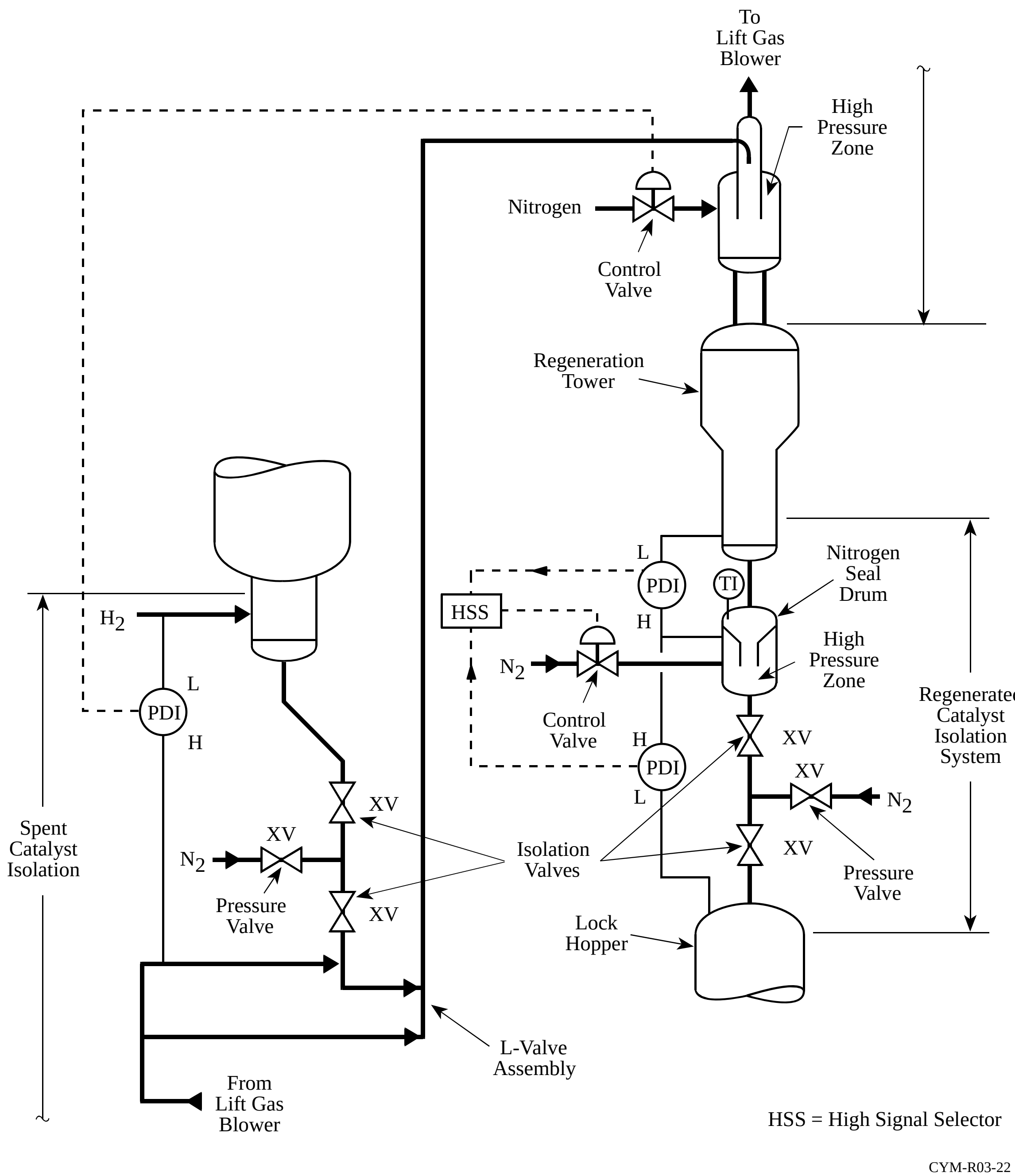


Figure IV-11
Regenerated Catalyst Isolation System
Open Condition

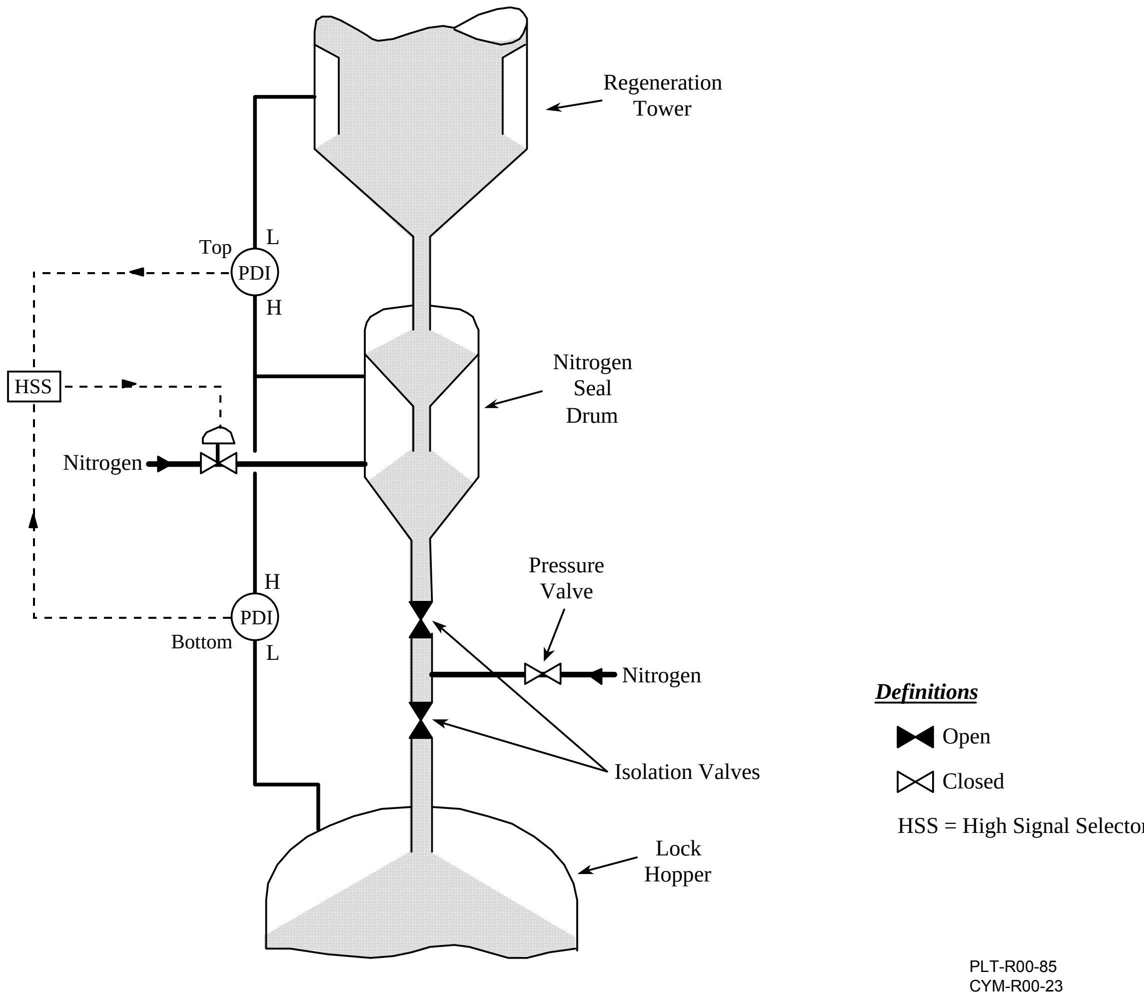
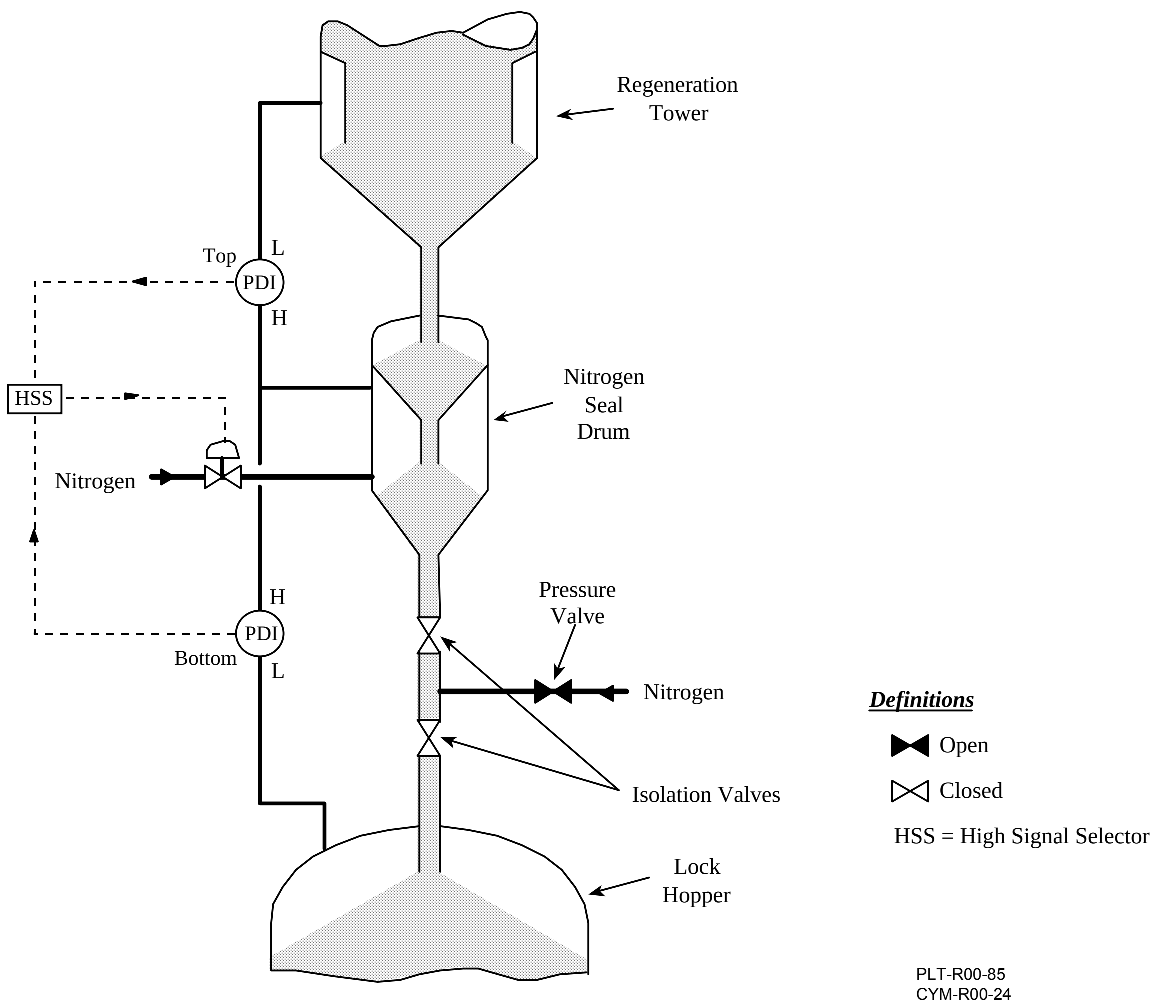


Figure IV-12
Regenerated Catalyst Isolation System
Closed Condition



F. OTHER SYSTEMS

1. Reduction Zone/Reactor #1 Differential Pressure System

The gas flows entering the Reduction Zone are on flow control. The pressure of reactor #1 is controlled in the Platforming unit. The normal control scheme (see Figure IV-13) maintains the Reduction Zone at a slightly higher pressure than Reactor #1 by controlling the valve in the Reduction Zone vent gas line (valve ‘A’ Figure IV-13).

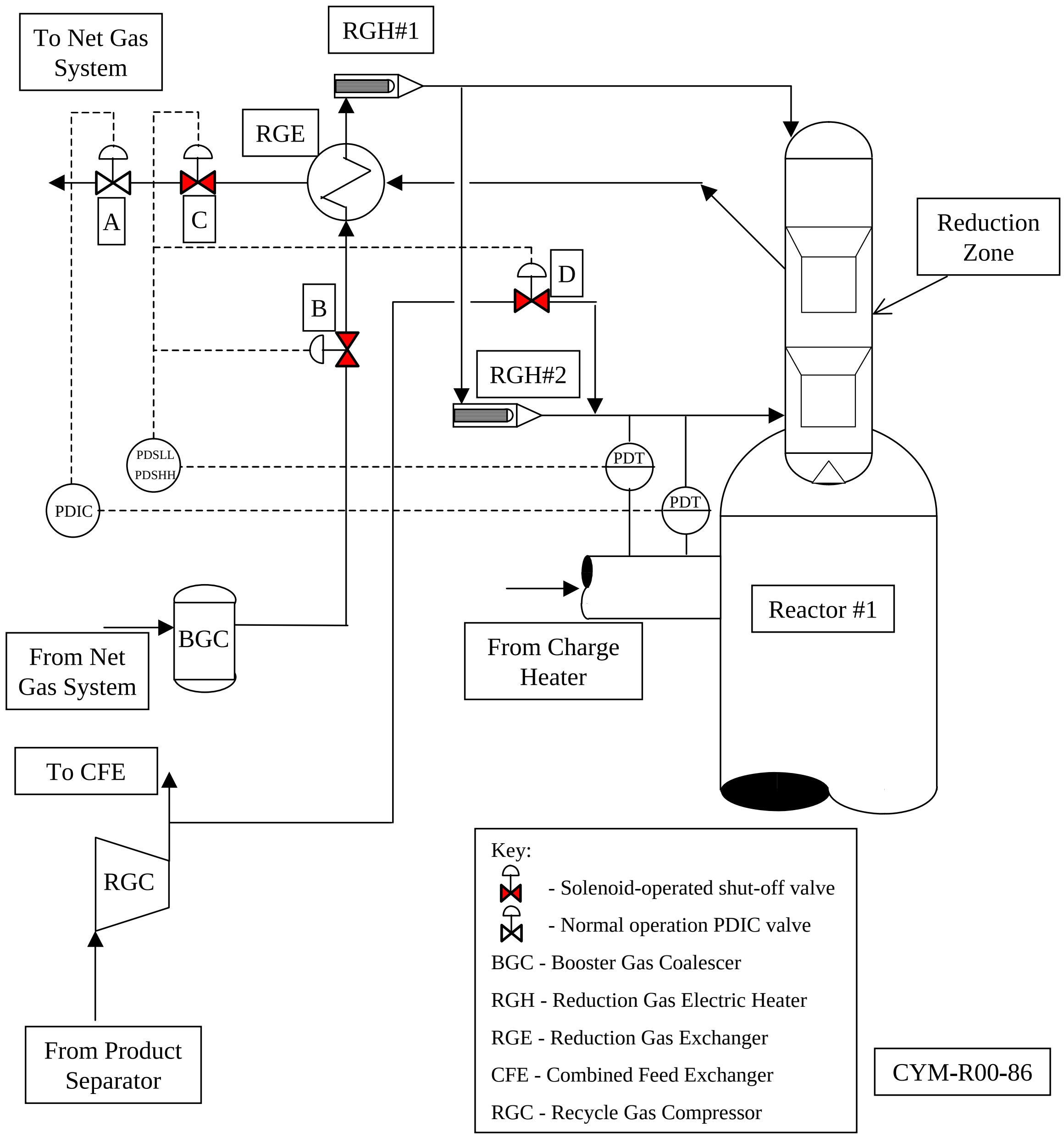
The CRCS monitors the ΔP between the Reduction Zone and Reactor No. 1 using a separate differential pressure transmitter than the one used for control (earlier units used the same transmitter). If the ΔP becomes too low or too high, there is a shutdown system incorporating three shut-off valves operated by solenoids. The shutoff valves are located in the Reduction Gas line from the Booster Gas Coalescer (valve ‘B’ Figure IV-13), in the Reduction Zone vent gas line (valve ‘C’ Figure IV-13), and in the stand-by (recycle) gas line to the Reduction Zone (valve ‘D’ Figure IV-13).

During normal operation, if the ΔP decreases below the shutdown (PDSLL) setting then the CRCS closes the valve in the Reduction Zone vent gas line and opens the valve in the stand-by (recycle) gas line to the Reduction Zone. This safeguard insures that the Reduction Zone pressure is always higher than that of Reactor #1. This prevents the back-flow of heavy hydrocarbons to the Reduction Zone that could lead to high temperatures and coke formation.

During normal operation, if the ΔP increases above the shutdown (PDSHH) setting then the CRCS closes the valve in the Reduction Gas line to the Reduction Zone. This safeguard insures that the Reduction Zone does not over-pressure. With the Reduction Gas flow stopped, the Reduction Zone electric heaters will trip on low gas flow thus causing a hot shutdown of the Regenerator. The lift gas flow will continue into the Reduction Zone and should be sufficient to prevent a low ΔP shutdown situation. When resetting the valve in the Reduction Gas line to the Reduction Zone after a high ΔP shutdown, insure that the Reduction Zone vent gas line is open.

Figure IV-13

Reduction Zone - Reactor #1 Differential Pressure System



NOTE: Once these high or low shutdown points have been reached and the logic-controlled valves have tripped, they must be manually re-set in the field before normal Reduction Zone and Regenerator operation can resume.

For more details of this control scheme, refer to the Process and Information Control Equipment and Information Databook, Section 2.20 (pp. 107-108).

2. Valve Verification System

Every valve in on-off service has two limit switches for indicating the valve's actual position, either open or closed. Each valve also has a Valve Verification Alarm that alerts the operator of a problem with a valve's position. Indicators on the control panel show the commanded and actual positions of each valve. If the commanded and actual positions for a valve are not the same, the alarm sounds. Time (usually 15 seconds) is allowed for the valve to change position whenever the commanded position changes.

The on-off valves and their failure positions are listed below:

TAG	DESCRIPTION	FAILURE POSITION
XV-1	Catalyst Addition Lock Hopper No. 1 Load	Closed
XV-2	Catalyst Addition Lock Hopper No. 1 Pressure	Closed
XV-3	Catalyst Addition Lock Hopper No. 1 Vent	Closed
XV-4	Catalyst Addition Lock Hopper No. 1 Unload	Closed
XV-5	Spent Isolation Top	Closed
XV-6	Spent Isolation Pressure	Open
XV-7	Spent Isolation Bottom	Closed
XV-9	Fines Collection Pot Load	Closed
XV-10	Fines Collection Pot Pressure	Closed
XV-11	Fines Collection Pot Vent	Closed
XV-12	Fines Collection Pot Unload	Closed
XV-13	Air	Closed
XV-14	Lower Air Supply Line	Closed
XV-15	Nitrogen	Open
XV-16	Chloride	Closed

XV-17	Catalyst Addition Lock Hopper No. 2 Load	Closed
XV-18	Catalyst Addition Lock Hopper No. 2 Pressure	Closed
XV-19	Catalyst Addition Lock Hopper No. 2 Vent	Closed
XV-20	Catalyst Addition Lock Hopper No. 2 Unload	Closed
XV-22	Regenerated Isolation Top	Closed
XV-23	Regenerated Isolation Pressure	Open
XV-24	Regenerated Isolation Bottom	Closed
XV-29	Regenerated Catalyst Lift Line	Closed

3. Bypass Switches

There are five bypass switches. Each switch bypasses a condition that causes a shutdown during normal operation. Each switch has only two positions: NORMAL and BYPASS. Each switch is locked and a key must be inserted into the switch in order to turn it. An indicator on the control panel shows the position of the switch.

The bypass switches and the condition for each bypass are:

Item		Condition
1.	CCR Nitrogen Header	High contaminants
2.	Oxygen Analyzer Sample	Low flow
3.	Burn Zone Oxygen Content	High O_2 content
4.	Burn Zone Gas	Low flow
5.	Air to Air Heater	Low flow

a. Bypass

The operator may turn the CCR Nitrogen Header switch to BYPASS at any time. This action bypasses the shutdown due to high contaminants detected by the CCR Nitrogen Header Analyzer. This allows the CCR Nitrogen Header Analyzer to be calibrated without shutting down the Regeneration Section.

The operator may turn the Oxygen Analyzer Sample to BYPASS at any time. This action bypasses the shutdown due to low flow detected by the Oxygen Analyzer Sample Flow Switch. This allows the Regeneration Section to continue in operation in the event of a very brief malfunction of the analyzer's sample flow switch. This bypass switch is also useful during the Final Startup Preparation when it allows the catalyst to be circulated and a carbon level to be established on the catalyst before the Regeneration Blower is started prior to the Black Catalyst Startup Procedure.

Although the operator may turn the bypass switches for the Burn Zone Oxygen Content, Burn Zone Gas, and Air to Air Heater to BYPASS at any time, these switches will only bypass their respective shutdowns when the Air Valve (XV-13) is confirmed closed and the Nitrogen Valve (XV-15) is confirmed open. This allows the Oxygen Analyzer and the flow meters for the Burn Zone gas, and the Air to Air Heater to be calibrated, but only when there is nitrogen but no air entering the Regeneration Tower. In the case of the flow meters, this also allows catalyst to be circulated and a carbon level to be established on the catalyst before normal flow rates of Burn Zone gas, and Air to Air Heater are set prior to the Black Catalyst Startup Procedure.

b. Normal

EXCEPT FOR THE SITUATIONS DESCRIBED UNDER "BYPASS" AND ALWAYS DURING NORMAL OPERATIONS, THE BYPASS SWITCHES SHOULD BE KEPT IN THE NORMAL POSITION.

V. CCR EQUIPMENT

A. REGENERATION TOWER

For most units, the Regeneration Tower and its internals are made of stainless steel. The Regeneration Tower contains five separate zones – the Burn Zone, Reheat Zone, Chlorination Zone, Drying Zone, and Cooling Zone. See Figures V-1, V-2 and V-3.

Catalyst enters the top of the Regeneration Tower via a number of symmetrical pipes. The catalyst flows by gravity into the Burn Zone. The system is designed for uniform catalyst flow into the Burn Zone.

The Burn Zone is an annular catalyst bed between a truly vertical outer screen and an inwardly sloping inner screen. The outer screen is welded at the bottom to the vessel wall of the Regeneration tower and it is connected at the top to the vessel wall by a wire mesh. At the bottom of the outer screen where it is attached, there are a number of horizontal slots to allow for free drainage of the area behind the outer screen.

A slip-stream from the Regeneration Blower enters the Regeneration Tower at the top of the outer screen as direct seal gas. A sealed, annular plate below this inlet prevents the gas from flowing downwards into the Burn Zone hence forcing it upwards. The wire mesh atop the outer screen allows for this direct seal gas to flow over the top of the outer screen and enter the catalyst bed from the top without catalyst falling behind the outer screen. This seal gas flow is to prevent catalyst fluidization at the top of the annulus.

The top of the inner screen is attached to the top head of the Regeneration Tower. At the bottom, the inner screen fits around guide vanes to prevent sideways movement. The screens are designed for uniform gas flow and coke burning all around the Burn Zone. Regeneration gas enters the Burn Zone through the inlet nozzle outside of the outer screen and it exits through the outlet pipe at the top of the inner screen. Both screens are specially made with smooth, vertical screen bars to minimize catalyst breakage and plugging. But periodically these screens must be cleaned to ensure good gas flow through them.

The Reheat Zone is directly below the Burn Zone, and catalyst flows by gravity into it. Like the Burn Zone except smaller, the Reheat Zone is a annular catalyst bed between the outer screen and the inner screen. The zone is designed to preheat the catalyst entering the Chlorination Zone with the hot outlet gases from the Burn Zone. It is separated from the Burn Zone by a baffle located outside of and near the bottom of the outer screen. The baffle is perforated by a number of small holes to allow for free drainage of the area above the baffle. Gas enters the Reheat Zone through the inlet nozzle outside of the outer screen and it exits upward inside the inner screen and into the Burn Zone.

Inside the inner screen are special thermocouples to measure the temperature of the regeneration gas at various points down the catalyst bed. These thermocouples are inside thermowells that extend down from nozzles in the top head of the Regeneration Tower. Except for the two thermocouples that measure the temperature in the Reheat Zone, all the rest measure temperatures in the Burn Zone. These “bed” temperatures give a very good indication of changes in the coke burning in the Burn Zone and should be recorded on a regular basis. There is a single thermocouple located at the catalyst exit of the Reheat Zone. This is called the Chlorination Zone thermocouple as it indicates the temperature of the gas exiting this zone. This temperature gives a good indication if there is any coke combustion in the Chlorination Zone.

Below the screens, guide vanes direct the catalyst by gravity flow into the Chlorination Zone. The Chlorination Zone is a cylindrical catalyst bed inside an annular baffle that is attached to the wall of the Regeneration Tower. Gas enters the Chlorination Zone from the Drying Zone through perforations in the plate separating the two zones. The gas first enters an annular region defined by the vessel wall and an annular baffle. At this point organic chloride is introduced to the gas via two chloride distributors set 180° apart. The gas then enters the bottom of the cylindrical catalyst bed where the chlorination of the catalyst occurs. The annular baffle is specially designed to provide uniform gas flow down the outside of the baffle and up through the catalyst bed. Gas exits the zone upward into the inside of the inner screen at the Reheat Zone.

The Drying Zone is below the Chlorination Zone, and catalyst flows by gravity into it through a conical funnel and a distributor. Like the Chlorination Zone, the Drying Zone is a cylindrical catalyst bed inside an annular baffle. Gas enters the Drying Zone through the inlet nozzle in the wall of the Regeneration Tower. The annular baffle is specially designed to provide uniform gas flow down the outside of the baffle and up through the catalyst bed. Gas exits the zone through the drying air outlet nozzle in the wall of the Regeneration Tower above the catalyst bed, and the aforementioned perforations in the plate separating the Drying Zone from the Chlorination Zone. One Drying Zone gas outlet is the inlet to the Chlorination Zone. Here, an organic chloriding agent is injected into the drying gas, and enters the Chlorination Zone. The other Drying Zone gas outlet nozzle is a vent that exhausts excess drying gas from the Regeneration Tower through a control valve.

The cylindrical distributor leading to the Drying Zone is pierced in four locations by vapor tunnels. These tunnels allow for vapor equalization between the area enclosed by the distributor and the area outside the distributor. This communication is important to ensure even gas distribution across the cylindrical bed of the Drying Zone.

The Cooling Zone is below the Drying Zone, and catalyst flows by gravity into it through a conical funnel and a distributor. Like the Drying Zone, the Cooling Zone is a cylindrical catalyst bed inside an annular baffle. Gas enters the Cooling Zone through the inlet nozzle in the wall of the Regeneration Tower. The annular baffle is specially designed to provide uniform gas flow down the outside of the baffle and up through the catalyst bed. Gas exits the zone through a cooling gas outlet nozzle in the wall of the Regeneration Tower above the catalyst bed. The gas exiting the nozzle is routed, along with air from the Air Dryer, to the Air Heater to supply the Drying Zone.

As above, the cylindrical distributor leading to the Cooling Zone is pierced in four locations by vapor tunnels. These tunnels allow for vapor equalization between the area enclosed by the distributor and the area outside the distributor. This communication is important to ensure even gas distribution across the cylindrical bed of the Cooling Zone.

For inspection purposes, access to the various zones is gained through the top of the vessel via the Burn Zone gas outlet nozzle. The inside of the inner screen is accessible immediately through the outlet nozzle. At the bottom of the inner screen, where the catalyst guide vanes attach to a cylindrical support, there is a manway for further access to the lower zones of the tower. Access to the Drying Zone and Cooling Zones is achieved by the use of a removable cone in the center of the conical funnels.

Figure V-1

Regeneration Tower

Burn Zone and Reheat Zone

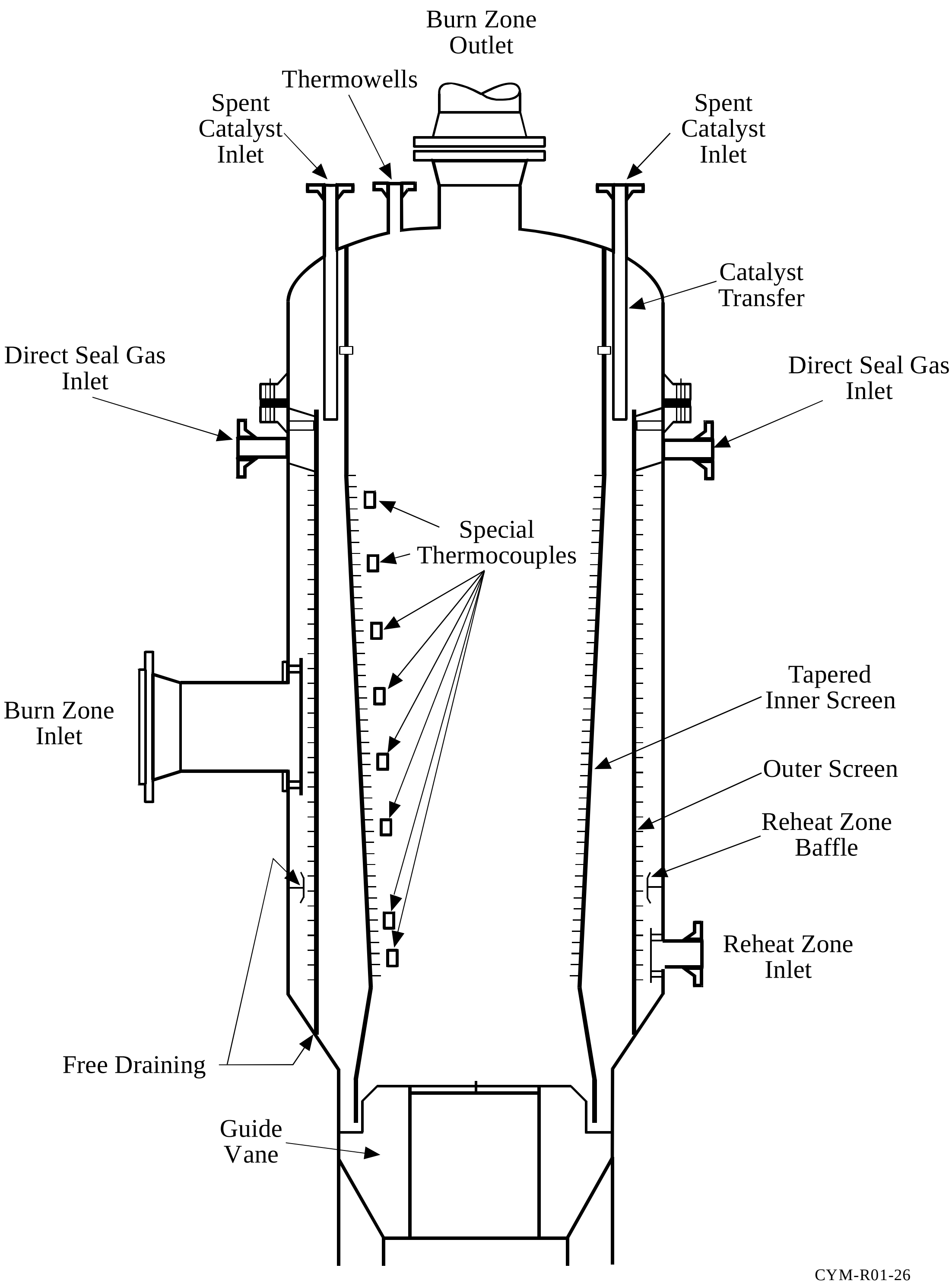


Figure V-2
Regeneration Tower
Chlorination Zone

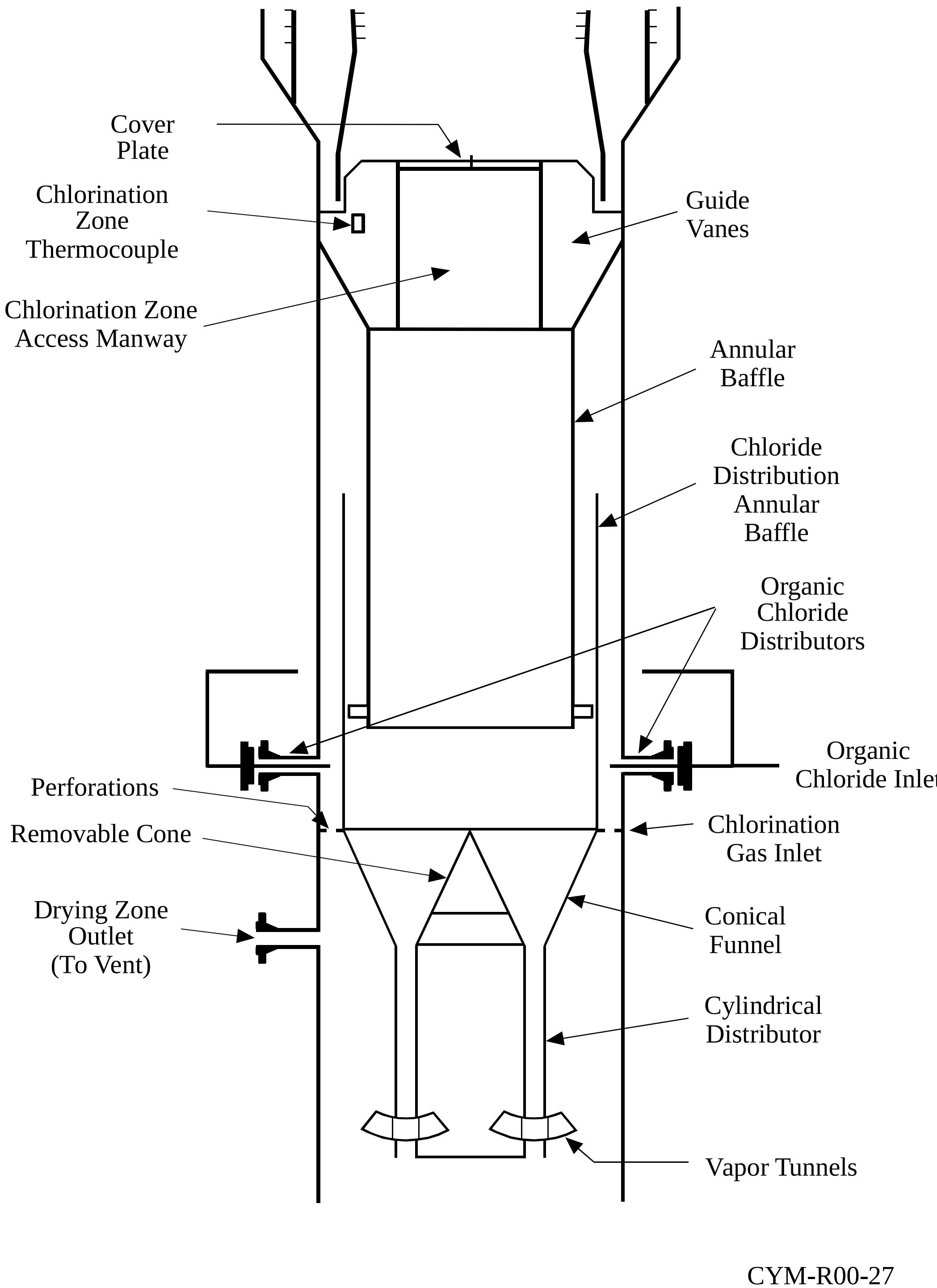
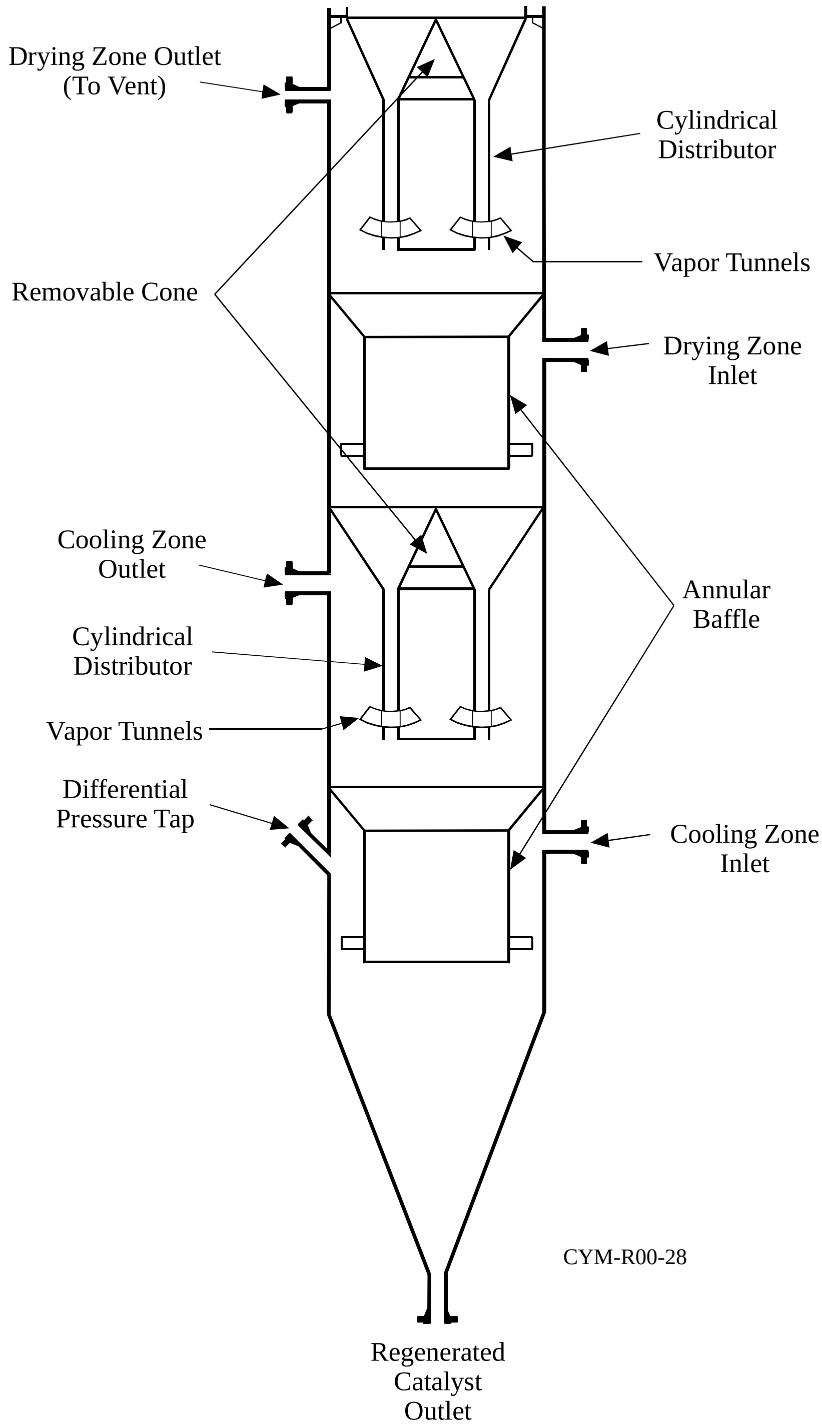


Figure V-3
Regeneration Tower
Drying Zone and Cooling Zone



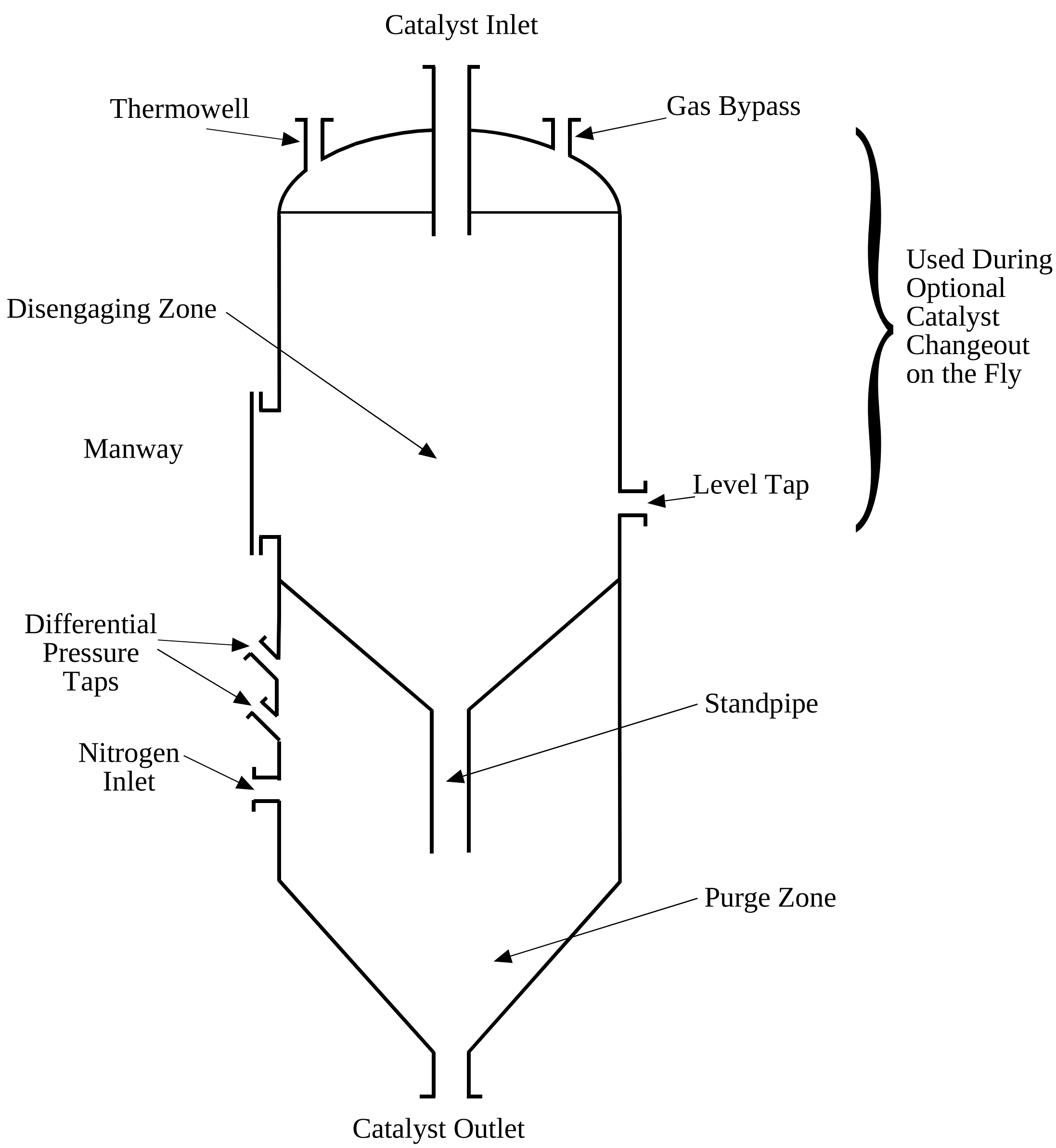
B. NITROGEN SEAL DRUM

The Nitrogen Seal Drum and its internals are made of carbon steel. Catalyst enters at the top of the Seal Drum into a gas Disengaging Zone (used primarily for Catalyst Change-out on the Fly). The catalyst then passes through a standpipe into a Purge Zone and then out of the vessel. Nitrogen enters the purge zone and flows upward through the standpipe and the catalyst bed in the disengaging zone then out the catalyst inlet. Nitrogen also flows downward through the catalyst bed in the purge zone and out of the catalyst outlet. See Figure V-4.

The normal function of this vessel is to provide a nitrogen addition point clear of catalyst for the Regenerated Catalyst Isolation System (Nitrogen Bubble), but serves an additional purpose for the optional Catalyst Change-out on the Fly. During Catalyst Change-out on the Fly, the Nitrogen Seal Drum serves to receive and purge air from fresh catalyst loaded into the unit. Fresh catalyst enters the seal drum catalyst inlet via a Catalyst Addition Hopper and passes through the drum as during normal operation. The difference is that the catalyst is added batchwise rather than continuously. To facilitate the catalyst addition a catalyst level indicator is provided to signal when the drum is ready to accept a load of fresh catalyst. The nitrogen flow path is also similar to normal operation except gas exits the vessel from the top via the gas bypass nozzle rather than the catalyst inlet. The reason for this is that during catalyst change-out the gas equalization between the seal drum and the Regeneration Tower is provided through this bypass line.

Figure V-4

Nitrogen Seal Drum



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C. LOCK HOPPER

The Lock Hopper and its internals are made of killed carbon steel. The Lock Hopper contains three separate zones – the Disengaging Zone, Lock Hopper Zone, and Surge Zone. See Figure V-5.

Catalyst enters at the top of the Lock Hopper via a Restriction Orifice. This orifice serves to limit the instantaneous catalyst withdrawal from the Regeneration Tower to an acceptable rate. This allows for maintenance of a steady burn profile as the catalyst is circulated through the unit. Below the Restriction Orifice are the three catalyst zones. The top zone is called the Disengaging Zone, the middle zone is called the Lock Hopper Zone, and the bottom zone is called the Surge Zone. The zones are designed to operate together to transfer catalyst in small batches and to raise the pressure surrounding the catalyst. All three zones operate under an environment of Platforming booster gas (or other source of hydrogen-rich gas), but at two different pressures. The Disengaging Zone operates at nearly Regeneration Tower pressure, the Surge Zone operates at nearly Regenerated Catalyst L-Valve Assembly (Reactor No. 1) pressure, and the Lock Hopper Zone cycles between these two pressures. A pressure instrument indicates the pressuring and depressuring of the Lock Hopper Zone.

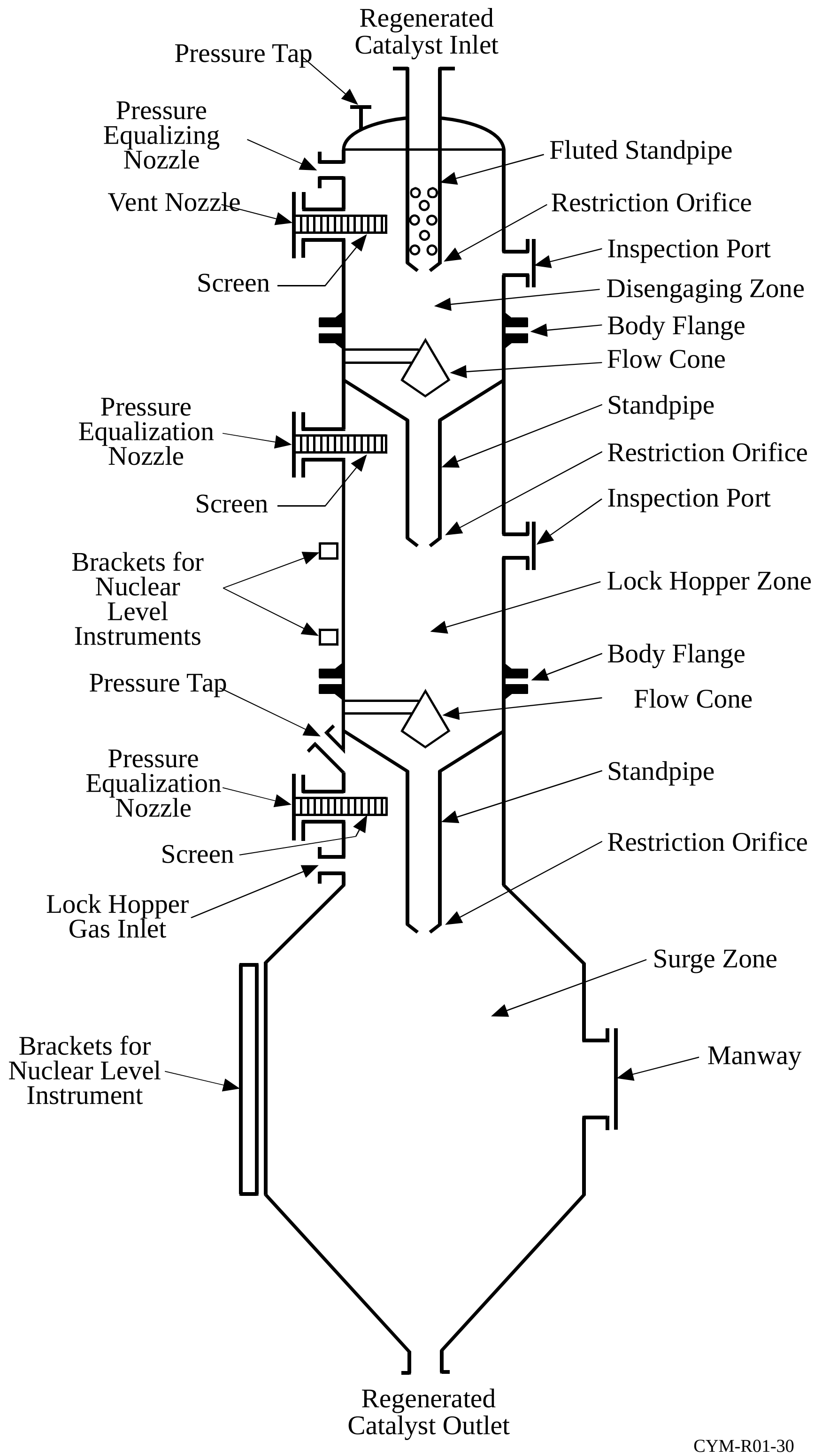
The Disengaging Zone has two gas nozzles – an equalization nozzle for gases from the Lock Hopper Zone and a vent nozzle equipped with a screen for venting excess gases. The Lock Hopper Zone has one gas nozzle – an equalization nozzle equipped with a screen that is for gases from the Surge Zone and to the Disengaging Zone. And the Surge Zone has two gas nozzles – an equalization nozzle equipped with a screen for gases to the Lock Hopper Zone and a nozzle for the makeup gas to the Lock Hopper.

Two nuclear level instruments – a high-level switch and a low-level switch – are mounted on brackets outside the Lock Hopper Zone to control the unloading and loading of the Lock Hopper Zone. Another nuclear level instrument is mounted on brackets outside the Surge Zone to indicate the catalyst level in the Surge Zone.

For inspection purposes, there is one manway in the Surge Zone. Also, there are inspection handholes to the bottom of the standpipe in each zone. The three sections of the Lock Hopper are connected with body flanges that can be opened as needed for access.

Figure V-5

Lock Hopper



D. L-VALVE ASSEMBLIES

There are two L-Valve Assemblies, located at the base of each catalyst lift line, that fluidize and transport catalyst using lift gas. See Figure V-6. The Spent Catalyst L-Valve Assembly transports spent catalyst from the bottom of the Platforming reactor stack to the top of the regeneration section. The Regenerated Catalyst L-Valve Assembly transports regenerated catalyst from the bottom of the regeneration section back to the top of the Platforming reactor stack.

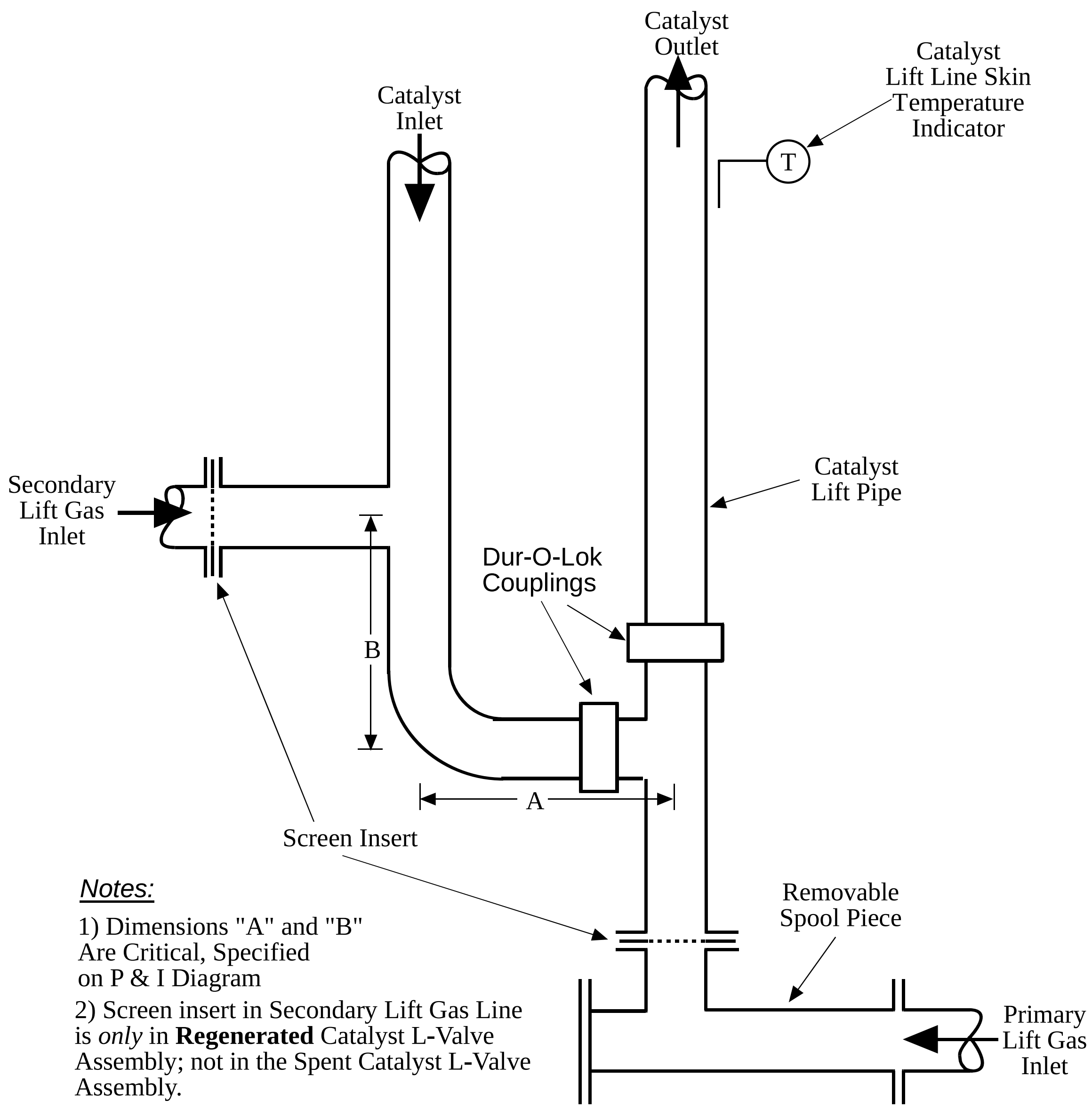
Both L-Valve Assemblies are identical in most essential respects, including metallurgy and geometry. Both assemblies are made of the same material as the catalyst lift pipe, that is carbon steel. Catalyst enters the assembly via a vertical pipe and then reaches a horizontal section. The horizontal section continues until it intersects the catalyst lift line proper. The length of the horizontal section is such that the catalyst slope that forms will not reach the lift line. Lift gas is supplied to the assembly at two locations. The primary lift gas is introduced at the bottom of the lift pipe, and the secondary lift gas is introduced at the side of the vertical pipe upstream of the horizontal section. At three of the four gas inlets, a screen is provided to prevent the catalyst from backing up into the lift gas supply line. This screen is not present in the Secondary Lift Gas line of the Spent Catalyst L-Valve assembly since plugging of this screen would send a false high signal to the Spent Catalyst Lift Line and Isolation System controllers. At the bottom of each lift pipe, a removable spool piece is provided in order to facilitate clearing the lift pipe if the catalyst slumps and can not be lifted by the lift gas flow. The catalyst lift line temperature is measured with a skin thermocouple.

The rate of catalyst lifting is set by the flow rate of secondary lift gas. As the rate of secondary gas increases so does the catalyst lift rate. The secondary lift gas, in effect, pushes the catalyst in the horizontal section into the primary lift gas flow and together both lift gas flows transport the catalyst upward. For this reason, the dimensions and orientation of the piping associated with the L-Valve Assembly are critical and must be maintained as specified.

The L-Valve Assembly must be kept clean of debris, hydrocarbon liquid, or foreign materials, because these can influence catalyst lifting. The removable spool piece allows the L-Valve Assembly to be cleaned if needed.

Figure V-6

L-Valve Assembly



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E. LIFT LINES

There are two lift lines that transport catalyst using lift gas. One transports spent catalyst from the Spent Catalyst L-Valve Assembly to the top of the regeneration section. The other transports regenerated catalyst from the Regenerated Catalyst L-Valve Assembly to the top of the Platforming reactor stack.

To minimize catalyst attrition and minimize fluctuations in lift line pressure drop, the construction of both lift lines is rigorous. Directional changes are made with special, “impactless” elbows (see Figure V-7). The number of elbows and line joints in the lift lines is minimized. Only downward sloping runs are allowed and the total length of the lift line is minimized.

Lift line joints are of special construction. Except for one flange at the top of the reactor stack, flanges are not allowed. Instead, pipe sections are joined together by one of two fabrication methods. The preferred method employs a Dur-O-Lok coupling assembly (see Figure V-8). The two Dur-O-Lok hubs are a machined pair. They match at the joint with minimal gap and offset. The seal is self-energizing using an internal O-ring and an external split coupler, held in position with set screws. Experience has shown a significant reduction in catalyst attrition in regeneration units using this type of lift pipe joint. The alternate (but not recommended) method is shown in Figure V-9.

Figure V-7

Catalyst Lift Lines

Impactless Elbow

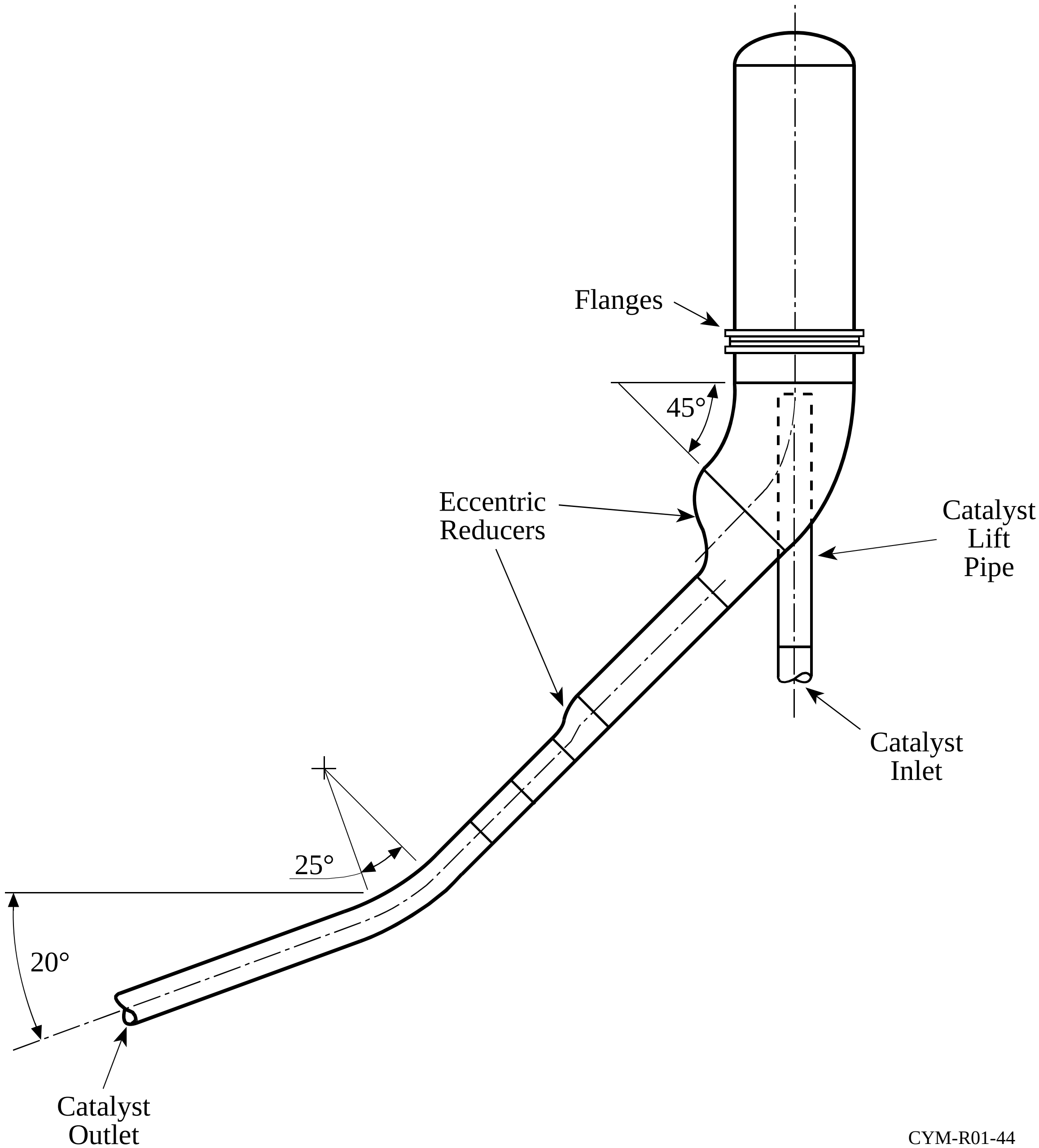
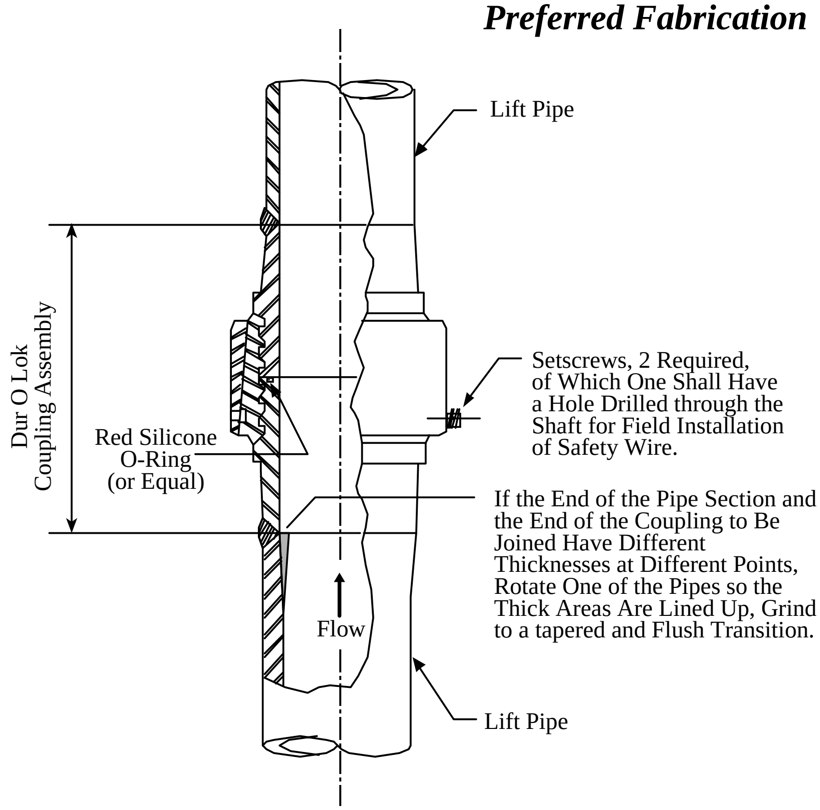


Figure V-8

Catalyst Lift Lines

Preferred Fabrication



Notes:

1. All Pieces to Be Shop Matched and Alignment Marked to Insure Minimum Offset when Field Joints are Made.
2. Straight Runs of Pipe to Be Maximum Length so that tha Minimum of Field Joints Are Necessary.

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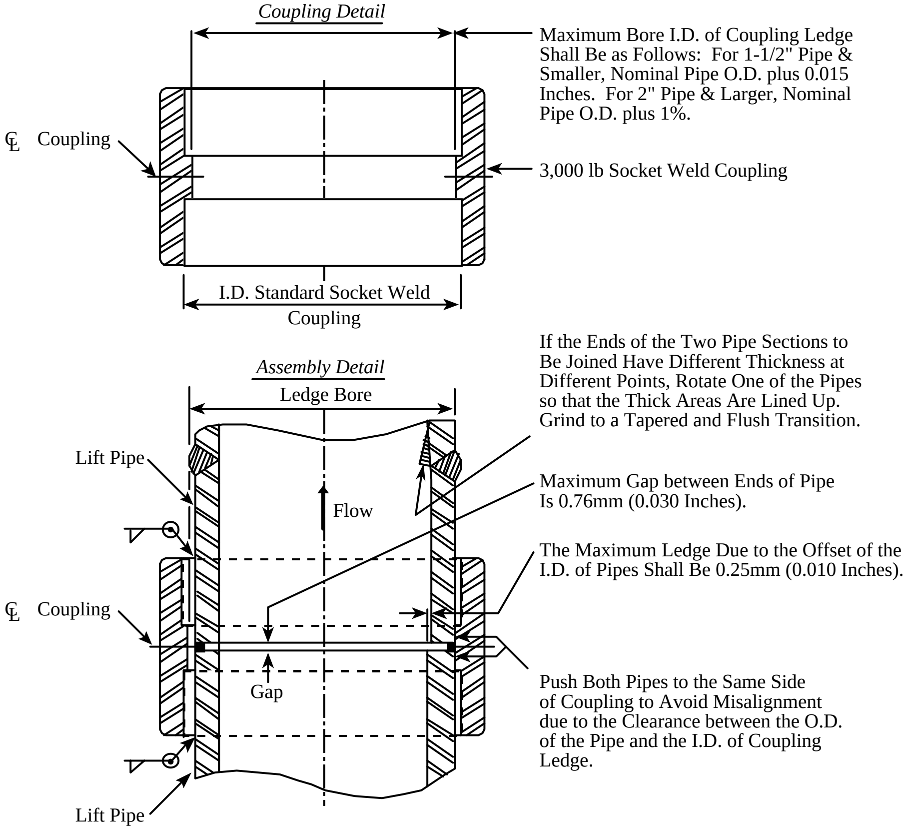
Figure V-9

Catalyst Lift Lines

Alternate Fabrication



Notes:

1. All Pieces to Be Shop Matched and Alignment Marked to Insure Minimum Offset when Field Joints are Made.
2. Straight Runs of Pipe to Be Maximum Length so that Minimum of Field Joints are Necessary.

PLT-R00-40
CYM-R00-48

F. REDUCTION ZONE

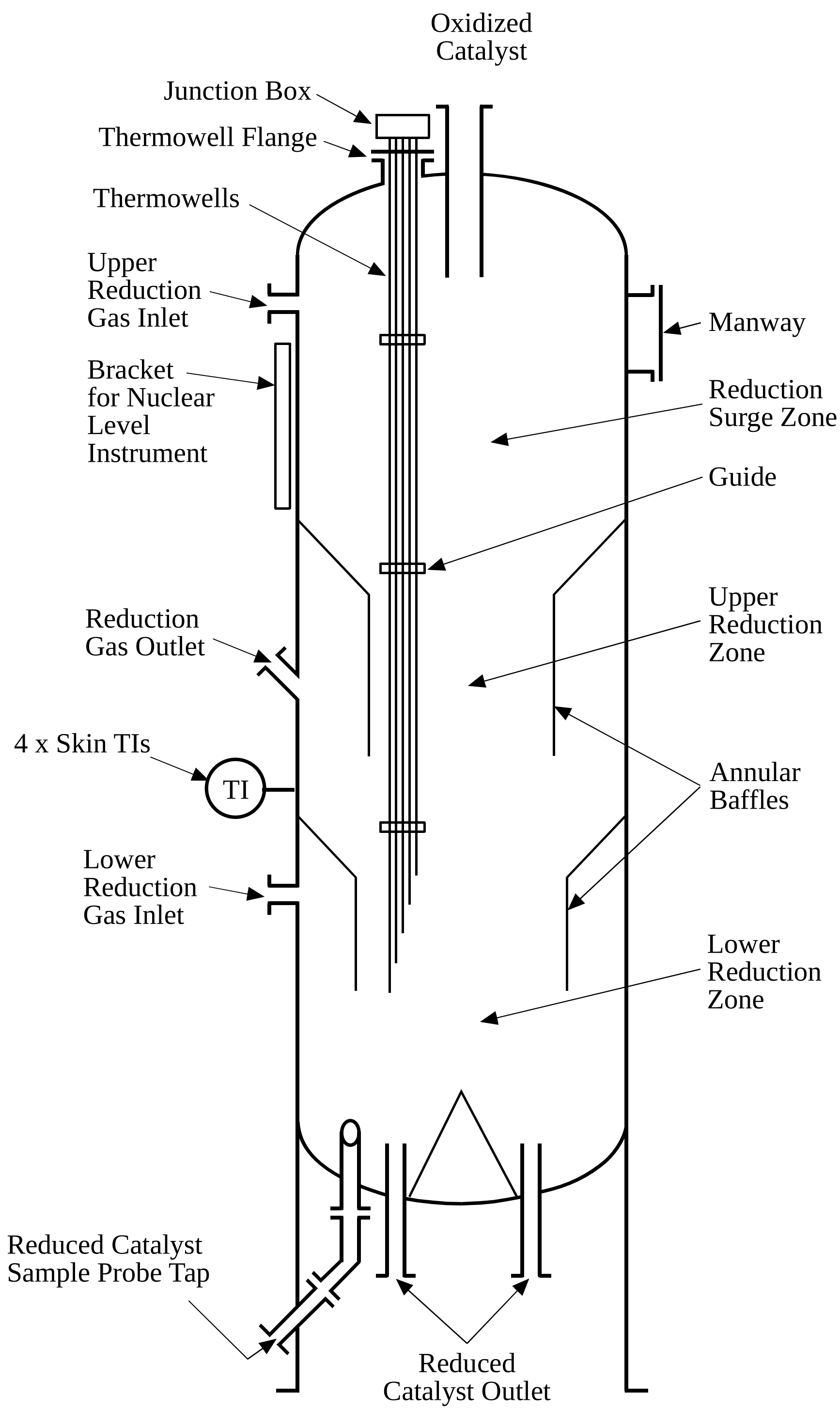
The Reduction Zone and its internals are made of Cr-Mo alloy steel. Catalyst enters at the top of the Reduction Zone via the regenerated catalyst lift line. The Reduction Zone vessel sits atop the reactor stack, and catalyst exits to the first Platforming reactor directly below it via catalyst transfer lines. The Reduction Zone actually consists of two zones, an Upper and Lower Reduction Zone. Both zones are cylindrical catalyst beds inside annular baffles that are attached to the wall of the vessel. See Figure V-10.

Gas enters the Reduction Zone through two inlet nozzles in the wall of the vessel. The upper reduction zone gas enters above the catalyst bed of the Upper Reduction Zone, flows through the bed, and exits the vessel through a nozzle behind the annular baffle of the Upper Reduction Zone. The annular baffle is specially designed for proper disengagement of the reduction gas from the catalyst to prevent entrainment. The lower reduction zone gas enters the vessel behind the annular baffle of the Lower Reduction Zone. The annular baffle is specially designed for uniform gas flow down the outside of the baffle and up through the catalyst bed. Gas exits the vessel through the same nozzle as the upper reduction zone gas. The gas outlet nozzle, and the immediate downstream piping, are set at an upward slope as an additional safeguard to prohibit any entrained catalyst from leaving the vessel.

A nuclear level instrument is mounted on brackets outside the Reduction Surge Zone to control the catalyst level of the entire Reactor stack, inclusive of the Reduction Zone. This control is effected by indirectly controlling the rate of catalyst withdrawal from the Reactor stack. Special thermocouples extend down from a nozzle in the top head of the Reduction Zone and measure the temperature at various points in the catalyst bed of the Lower Reduction Zone. There are also thermocouples to measure the vessel skin temperature in the area where catalyst is in contact with the vessel in between the two zones. This is to safeguard the vessel against potential high catalyst temperatures during an upset. Access to the Reduction Zone is provided by a manway located in the Reduction Surge Zone.

Figure V-10

Reduction Zone



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G. DISENGAGING HOPPER

The Disengaging Hopper and its internals are made of killed carbon steel. The Disengaging Hopper is a cylindrical vessel with an elutriation pipe down the center at the top. The spent catalyst lift line enters the side of the elutriation pipe, bends downward, and ends as an open pipe. Catalyst and lift gas enter through the lift line and flow down into the center of the elutriation pipe. Elutriation gas enters through a nozzle in the side of the Disengaging Hopper and flows upward through the elutriation pipe. See Figure V-11.

Catalyst chips, fines and some whole pills are carried with the gas out the top of the elutriation pipe. Whole catalyst pills drop to the bottom of the Disengaging Hopper where it is a surge inventory of spent catalyst for the Regeneration Tower. The whole catalyst pills exit the bottom of the Disengaging Hopper via outlet nozzles and associated transfer piping. See Figure V-12.

The Disengaging Hopper is sized to hold the excess catalyst from the reactors during start-up. This excess is due to the catalyst bed density change with the commencement of catalyst circulation. A nuclear level instrument is mounted on the outside of the vessel to indicate the catalyst level. A gauging nozzle is provided for initial calibration, and subsequent re-calibration, of the nuclear level instrument. For inspection purposes, there is one manway on the side of the Disengaging Hopper.

Figure V-11

Disengaging Hopper

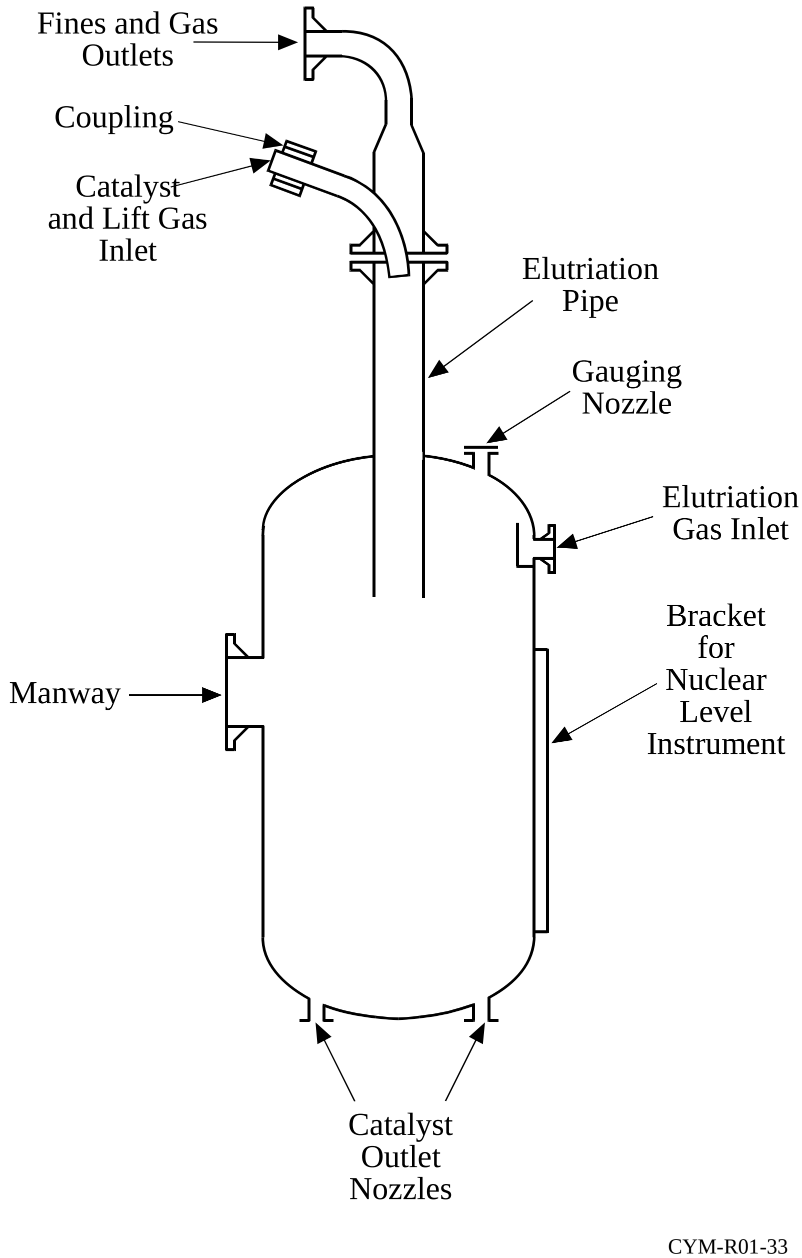
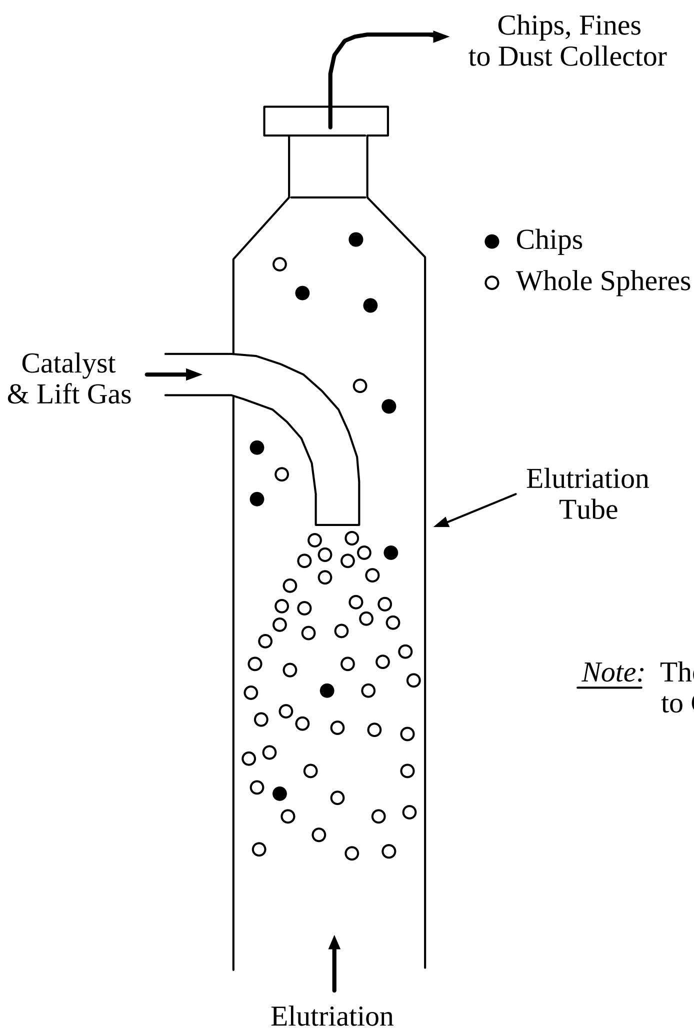


Figure V-12
Elutriator



Note: The Correct Pipe Schedule Must Be Used to Give the Right Pipe I.D.

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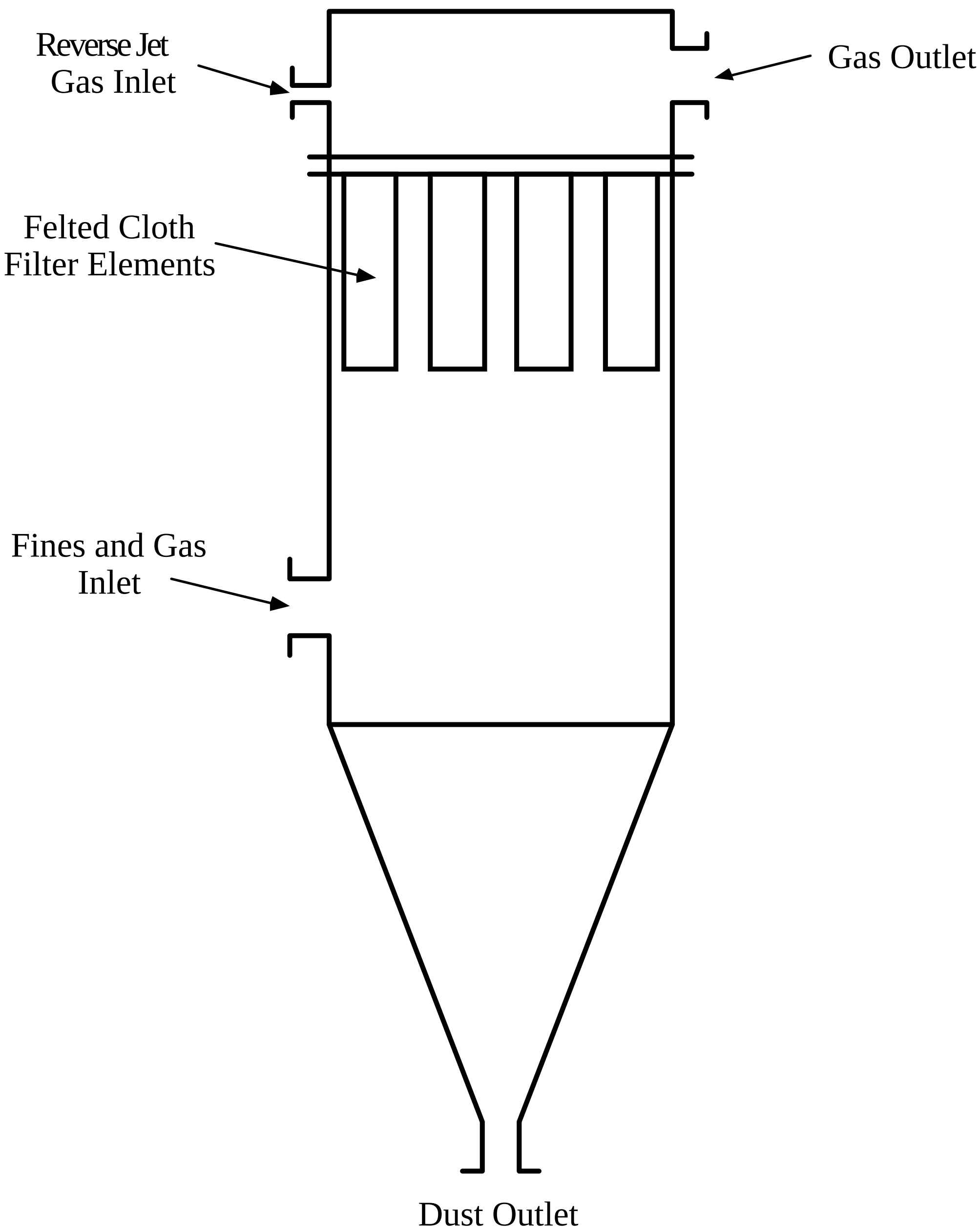
CYM-R00-34

H. DUST COLLECTOR

The Dust Collector removes catalyst chips and fines from the elutriation gas. The elutriation gas enters the side of the Dust Collector, flows through the felted cloth filter elements, and exits out the top. See Figure V-13. The catalyst pills, chips and fines collect on the elements and in the bottom head.

As the dust loading on the filter elements increases, the pressure drop across the elements increases. When a differential pressure alarm sounds, the filter elements must be cleaned. This is done while the Dust Collector is in service by reverse jet cleaning using nitrogen gas.

Figure V-13
Dust Collector
Typical Arrangement



CYM-R00-35

I. LIFT GAS AND FINES REMOVAL CIRCUIT

The Spent Catalyst L-Valve Assembly, the Disengaging Hopper, the Dust Collector, the Fines Removal Blower, and the Lift Gas Blower make up the Lift Gas and Fines Removal Circuit. See Figure V-14.

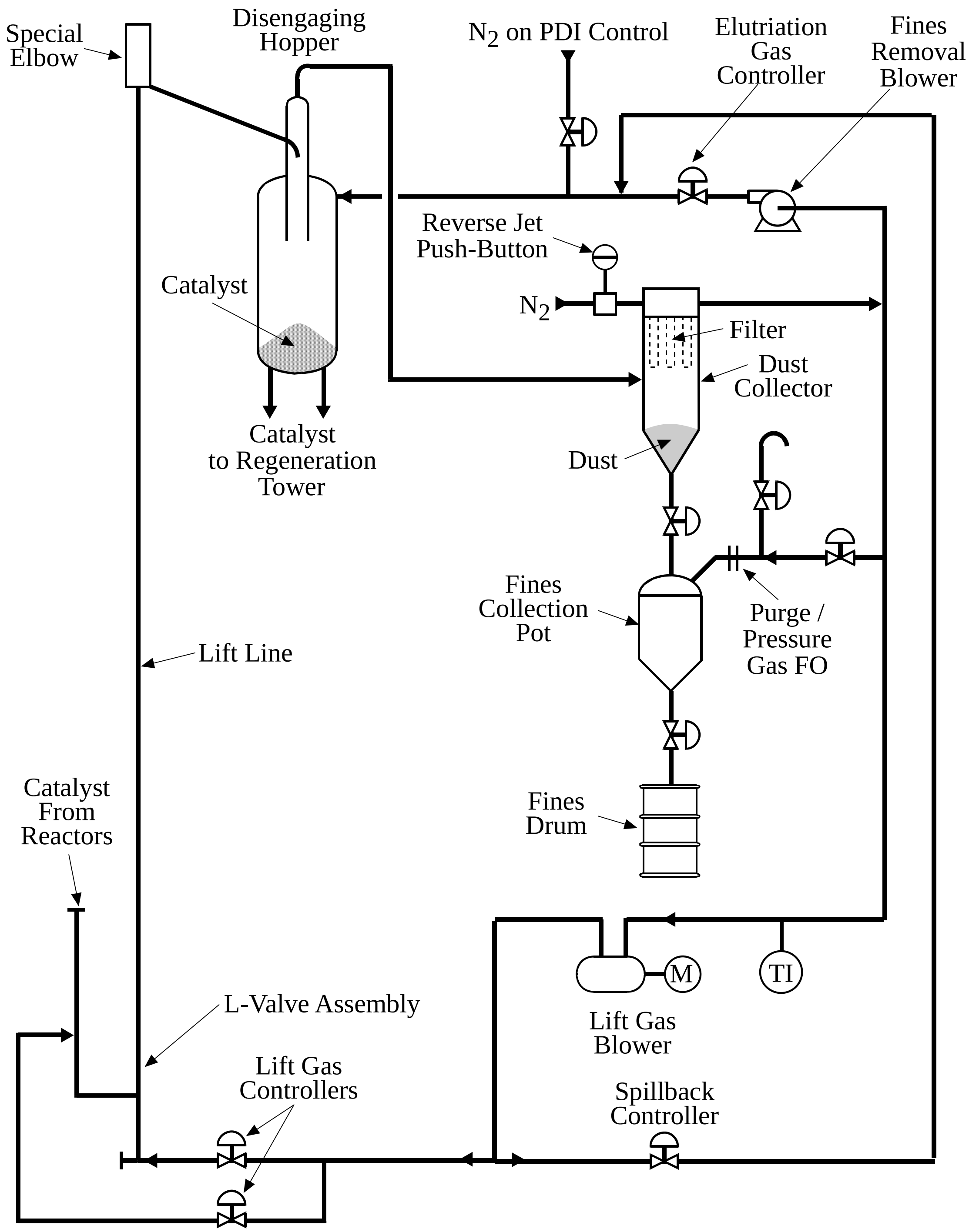
This circuit begins at the outlet of the Dust Collector where a stream of filtered nitrogen gas is routed to both the Fines Removal Blower, and the Lift Gas Blower. Nitrogen from the Lift Gas Blower flows as lift gas to the Spent Catalyst L-Valve Assembly to fluidize the catalyst and carry it up the lift line. Nitrogen is added to the discharge of the Fines Removal Blower to account for the nitrogen lost to the Catalyst Collector and to the Regenerator. The differential pressure controller between the secondary lift gas line and the catalyst collector controls this makeup rate.

Nitrogen from the Fines Removal Blower discharge flows as elutriation gas to the Disengaging Hopper, via the elutriation gas flow control valve, to separate the fines from the whole catalyst in the elutriation pipe. The whole catalyst drops into the bottom of the Disengaging Hopper, while lift gas, elutriation gas, and fines leave the vessel through the upper end of the elutriation pipe.

The circulating nitrogen gas stream leaving the Disengaging Hopper flows to the Dust Collector for removal of the catalyst pills, chips and fines. The fines settle to the bottom of the Dust Collector. From the bottom of the Dust Collector the catalyst fines and chips are unloaded into a drum via the Fines Collection Pot. The Fines collection pot serves as a lock hopper to transfer the fines from the Dust Collector pressure to atmospheric pressure. Once filtered, the nitrogen gas flows out and the gas circuit is completed at the suction of the blowers.

Figure V-14

Lift Gas and Fines Removal Circuit



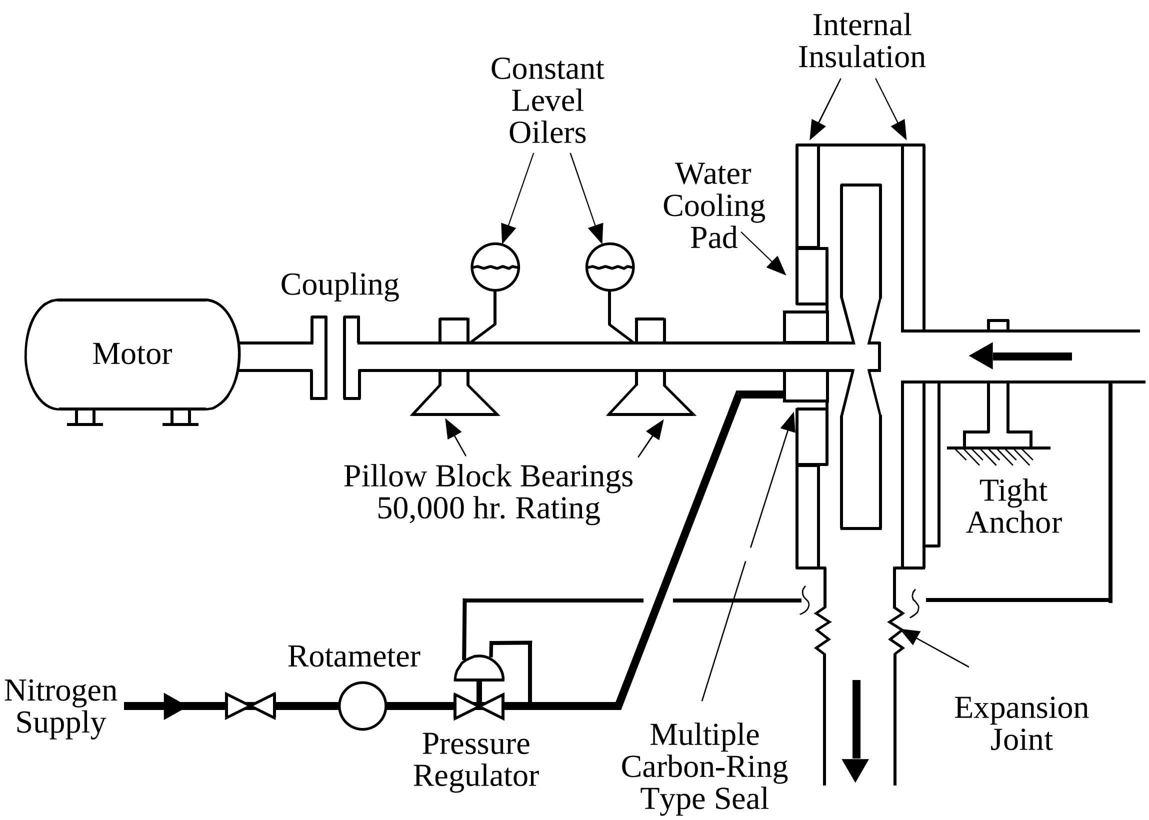
CYM-R02-36

J. REGENERATION BLOWER

The Regeneration Blower recycles the hot regeneration gas through the Regeneration Tower. See Figure V-15. The Blower plug unit is a paddle-wheel fan inside an internally-insulated housing. Continuous water cooling may be required at the shaft seals of some fan designs because of the fan’s hot service. The seals are the multiple carbon-ring type and continuous nitrogen purging is required and is controlled by a differential pressure regulator. The bearings are lubricated by gravity-feed oilers that must be kept clean, free-flowing, and filled with the manufacturer’s recommended lubricant at all times.

Figure V-15

Regeneration Blower

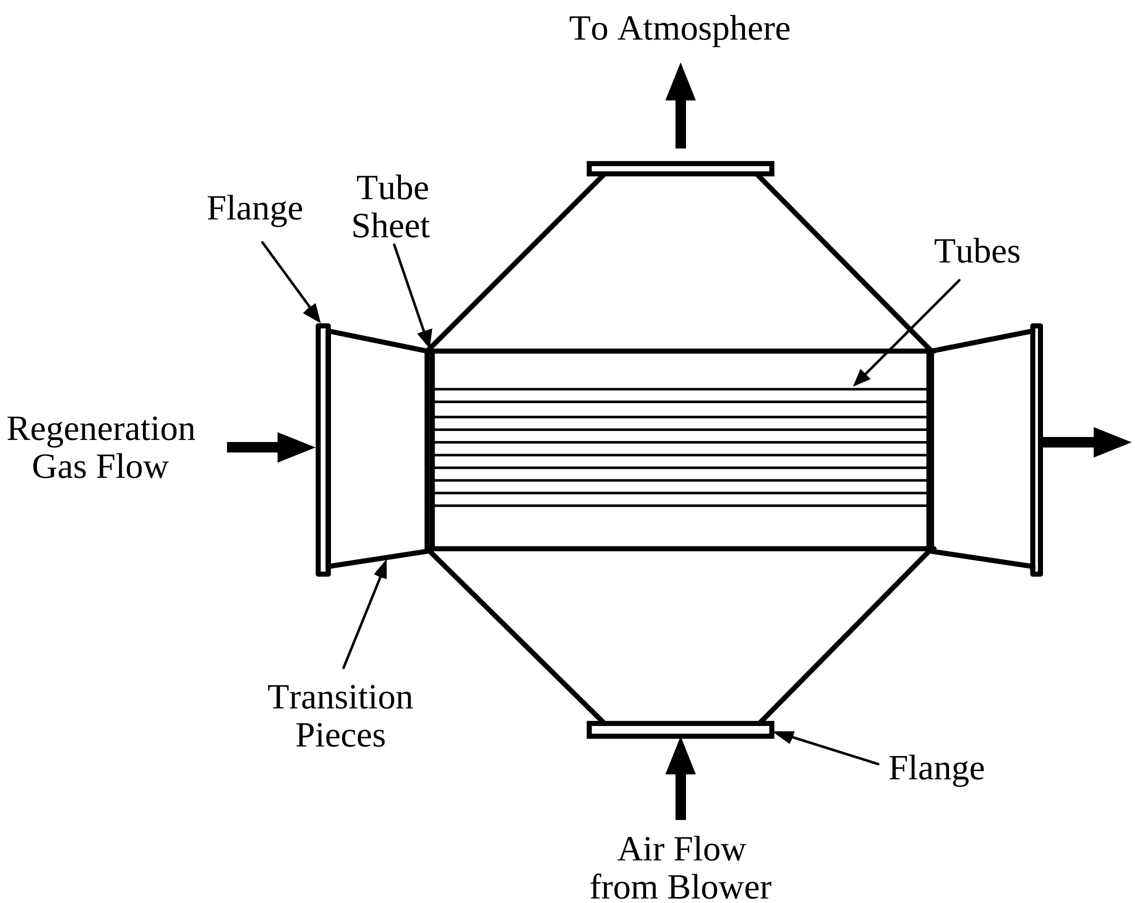


PLT-R00-43
CYM-R01-49

K. REGENERATION COOLER

The Regeneration Cooler cools the hot regeneration gas by removing the heat of coke combustion. See Figure V-16. It is a single-pass, shell-and-tube exchanger. Hot regeneration gas flows through the inside of the tubes of the Cooler and air is blown over the outside of the tubes. The Regeneration Cooler Blower blows the air through the Cooler. The flow of cooling air is controlled by a butterfly valve at the discharge of the Cooler Blower.

Figure V-16
Regeneration Cooler
Typical Arrangement



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CYM-R00-43

L. ELECTRIC HEATERS

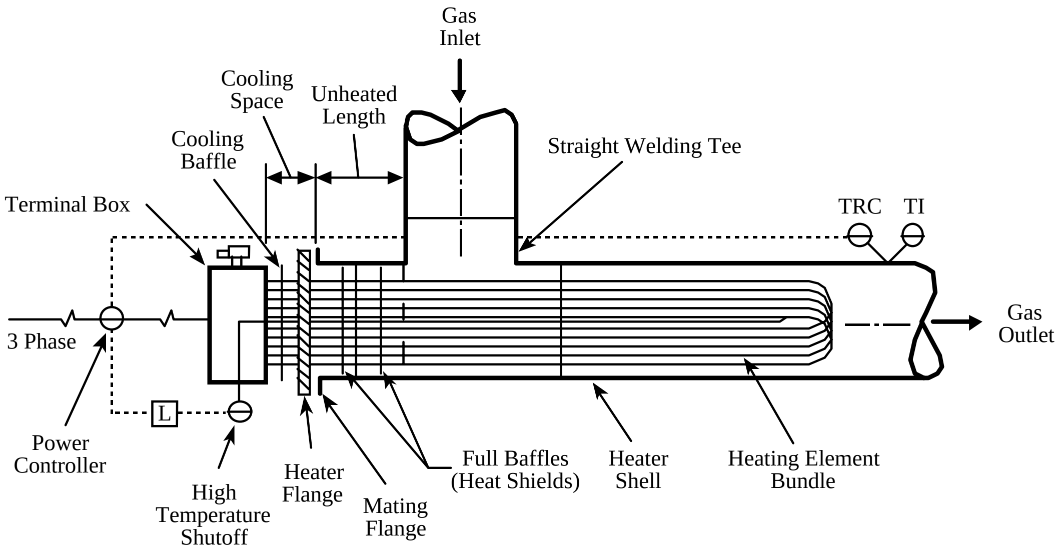
Electric Heaters are usually used to heat up three gas streams: regeneration gas, drying air, and reduction gas. On smaller units, there may also be an Electric Heater to heat the reheat gas stream. These heaters are immersion type. See Figures V-17 and V-18. The gas flows around the outside of the heater bundle, which fills the process piping. The bundle sheaths contain electrical elements. The bundle sheath temperatures are monitored by thermocouples that shut down the heater on high temperature. Gas must be flowing across the bundle during normal operation, or else the elements may overheat and burn up. The elements have an unheated length that includes the portion of the bundle that does not see gas flow. The terminal box is located a specified distance from the heater flange, and a cooling baffle is added between the two, to minimize heat conduction to the box.

The Regeneration Heater is a single-bundle design. For the Air Heater and the Reduction Gas Heaters, multiple bundles in series may be required because of duty requirements.

Figure V-17

Electric Heaters

Single Bundle

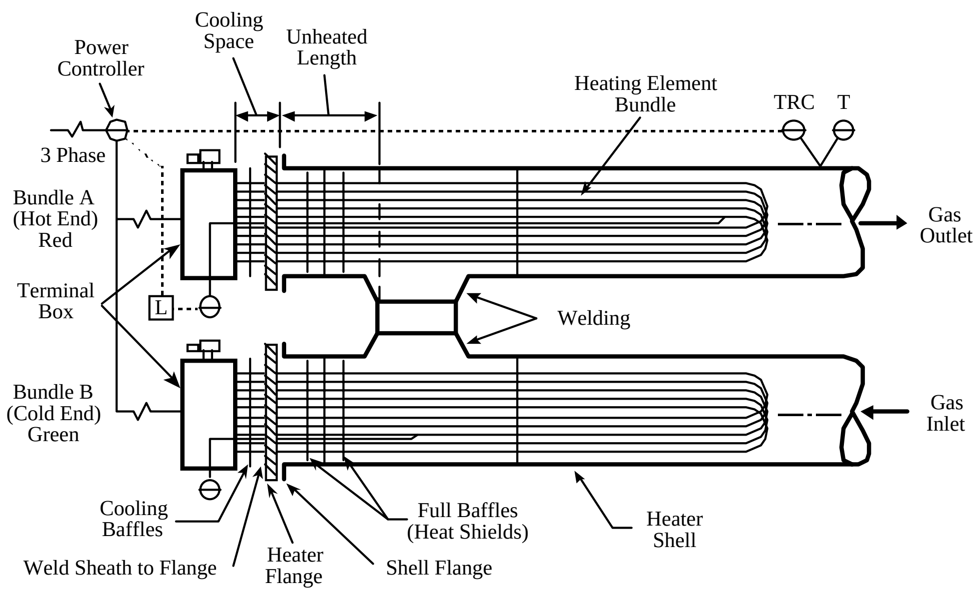


Notes:

1) Maximum Sheath Temperature Is About 700°C (1,300°F)
2) The Unheated Lengths on the Elements Shall Extend at least to the Gas Inlet to Ensure Gas Flow across All Heated Elements.
3) The Heating Element Bundle Diameter Should Fill the Process Piping.

PLT-R00-45
CYM-R00-37

Figure V-18
Electric Heaters
Two Bundles



Notes:

1) Maximum Sheath Temperature Is About 700°C (1,300°F)
2) The Unheated Lengths on the Elements Shall Extend at least to the Gas Inlet to Ensure Gas Flow across All Heated Elements.
3) The Heating Element Bundle Diameter Should Fill the Process Piping.

CYM-R00-38

M. VALVES

In addition to regular control valves and manual valves, there are three types of special valves in the Regeneration Section. These are “V” valves and two types of “B” valves. Some of these are in automatic services where the valves are equipped with actuators that are controlled by the Catalyst Regeneration Control System. Others are in manual services where the valves are opened and closed by hand.

Proper valve handling and maintenance is an important part of the operation of the Regeneration Section. Leaking or poor-performing valves can lead to hazardous situations and possibly cause a shutdown of the unit. It is very important that valves be properly assembled before installing them in the unit. Valves must be properly maintained, and when valves start to leak, they should be repaired promptly and correctly. Some valves require leak testing before installation in the field. Valves should be protected from dirt and the elements when they are in the field and between the field and the maintenance shop.

NOTE: In order to offer the best advice to our customers, UOP constantly reviews the latest valves supplied by various manufacturers. Please contact UOP for the most up-to-date list of recommended suppliers.

1. V-Valves

Whenever catalyst flow must be stopped, a special ball valve called a V-ball valve is used (See Figure V-19). This valve is designed with a V-notched ball so that the shearing action between the ball and seat stops catalyst flow without breaking many catalyst pills and without plugging. Although the valve stops catalyst flow, it does not completely seal against gas flow.

This type of valve is used in several automatic services in the Regeneration Section for on-off control. The valve body is Type 316 stainless steel, and the ball and seat are Type 317 stainless steel with stellite facing.

Both the top and bottom valves in both Spent and Regenerated Isolation Systems are V-ball valves. The manual isolation valves beneath the reactor stack and beneath the Lock Hopper also have a V-ball valve. The V-ball is on the top and the manual B-valve is below it. The manual B-valves do provide a gas-tight seal but are not intended to close on catalyst. So, when these lines must be closed and isolated, the V-ball valve is closed first to stop catalyst flow. Then, when the line below is empty of catalyst, the manual B-valve is closed to stop gas flow, if necessary.

A V-ball valve is also used as the first of two manual valves at two catalyst sample connections, one at the outlet of the Disengaging Hopper and the other at the outlet of the Nitrogen Seal Drum. Use of the catalyst samplers will be described in a later chapter.

2. B-Valves

“B” valves are used to provide a gas tight seal in catalyst and gas service in the Regeneration section. These valves are not intended to be closed while catalyst is present in the valve. There are two types of “B” valves specified for the Regeneration Section.

One is a full-port B-valve, with no reduction in flow area through the valve body and ball (See Figure V-20). This valve can therefore be used in gas streams that contain catalyst dust, as well as in clean gas streams. These valves are used for the two pressure equalization valves between the zones of the Lock Hopper, where the valves are designed to withstand catalyst dust at the sealing surfaces. The balls are Type 316 stainless steel with an abrasion-resistant coating and the seats are stellite. This type of valve is often referred to as the “Neles-Jamesbury” B-valve since that has been the recommended manufacturer for some time.

The other B-valve type has a reduced-port (See Figure V-21). It can be used in clean streams that do not contain much catalyst dust. These services include the Chloride Valve, and the inlet and outlet valves of the Catalyst Addition hopper (since fresh catalyst contains few fines). In these services, the valve seats are Teflon and the valve balls are stainless steel, inconel, or chrome-plated, depending on the service.

Manual B-valves are used in several locations in the Regeneration Section. Depending on the service, the specified valve may be full-port or reduced-port. Likewise, the valve construction and metallurgy depends on the service.

Figure V-19
Typical V-Ball Valve
Internals

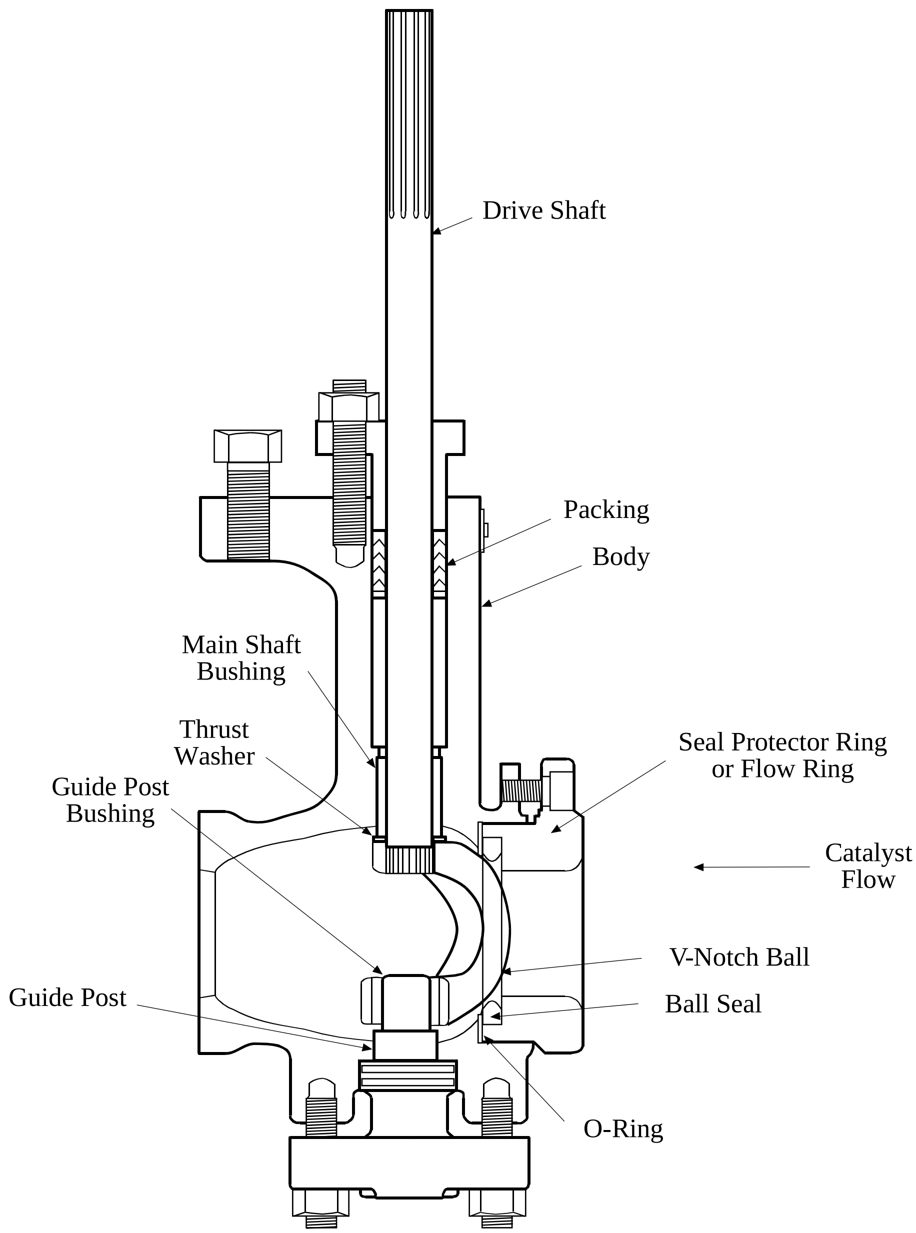


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Figure V-20

Typical Full-Port B-Valve

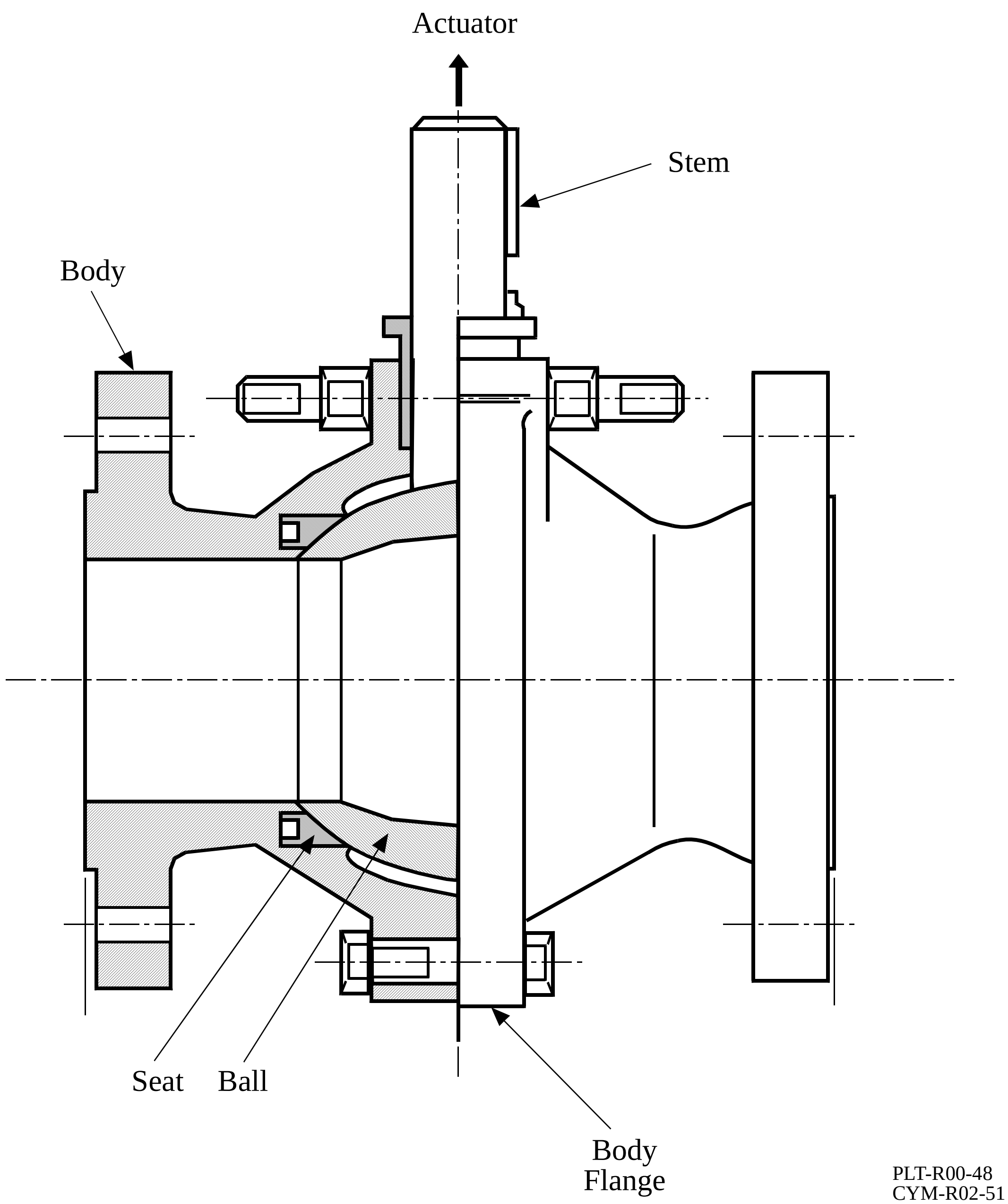
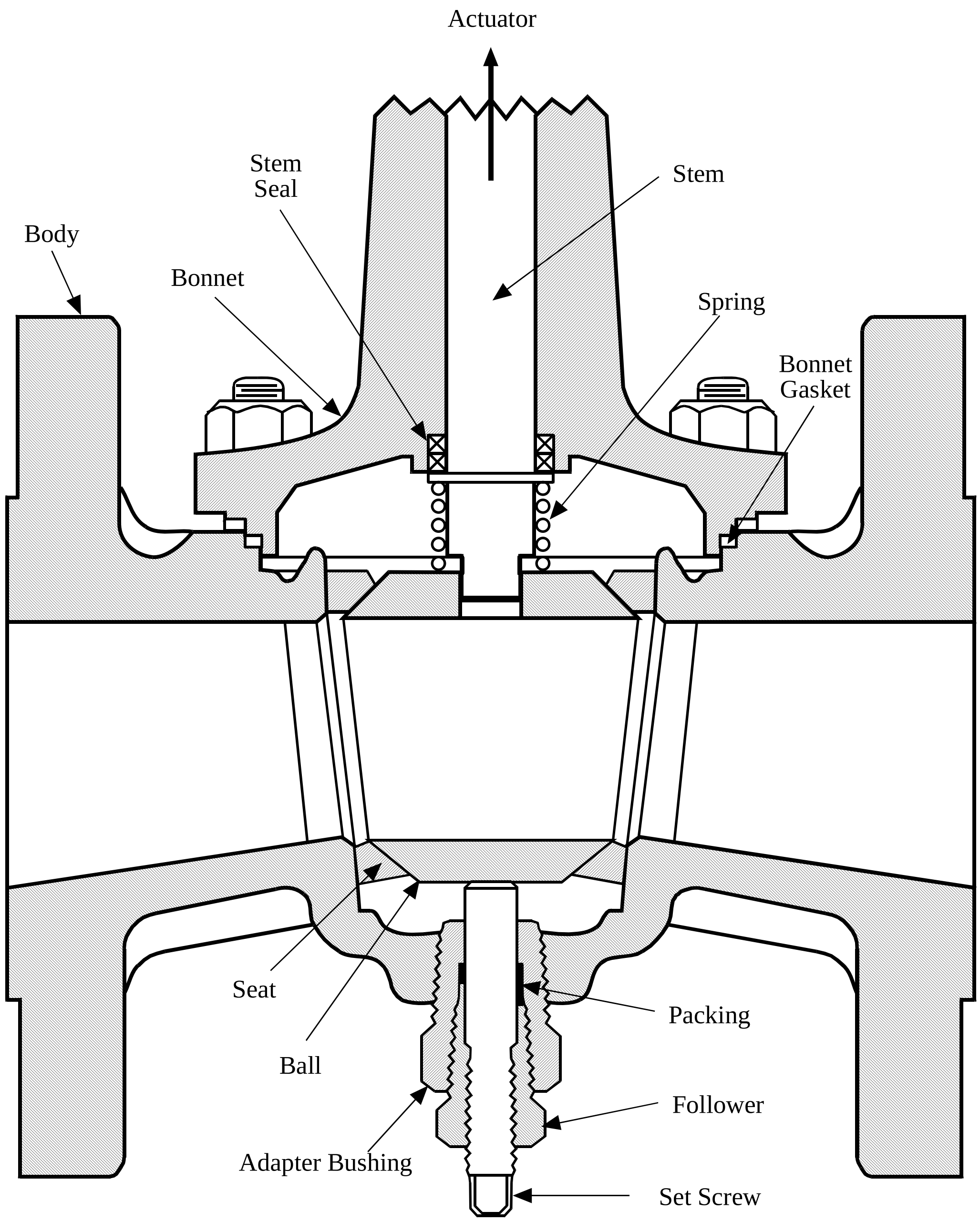


Figure V-21

Typical Reduced-Port B-Valve



PLT-R00-49
CYM-R01-52

N. OXYGEN ANALYZER

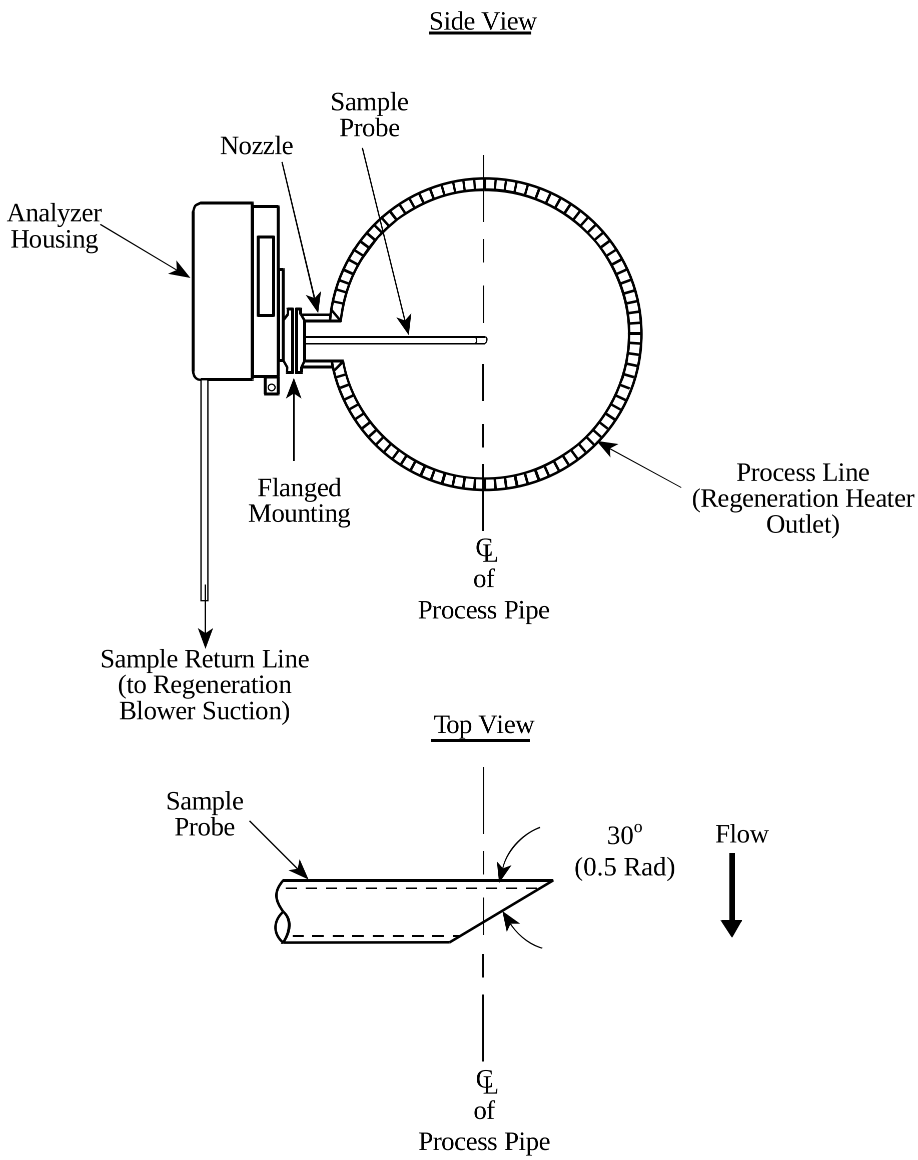
The oxygen analyzer measures the oxygen concentration at the inlet of the Burn Zone. With the original design (see Figure V-22), the sample enters the analyzer through a probe, flows through the analyzer, and returns to the Burn Zone in a closed loop. The analyzer must always have adequate sample flow. A flow switch inside the analyzer will alarm if the sample flow is too low. Without any sample flow, the analyzer will still display an oxygen concentration, but the reading will have no relation to the actual oxygen concentration in the Burn Zone.

The latest design is an “In-Situ” analyzer (see Figure V-23) with the sensing cell located in the process line rather than in the analyzer housing. This eliminates the need for sample lines. Low sample flow is no longer a concern but a micro-processor monitors the sensor for any errors in the analyzer.

The calibration of the “zero” and “span” of the analyzer should be checked regularly. The detector in the analyzer is a zirconium oxide cell and it measures the partial pressure of oxygen in the sample. When the analyzer is calibrated, the cell must be at its normal operating pressure.

Figure V-22

Thermox Oxygen Analyzer Installation



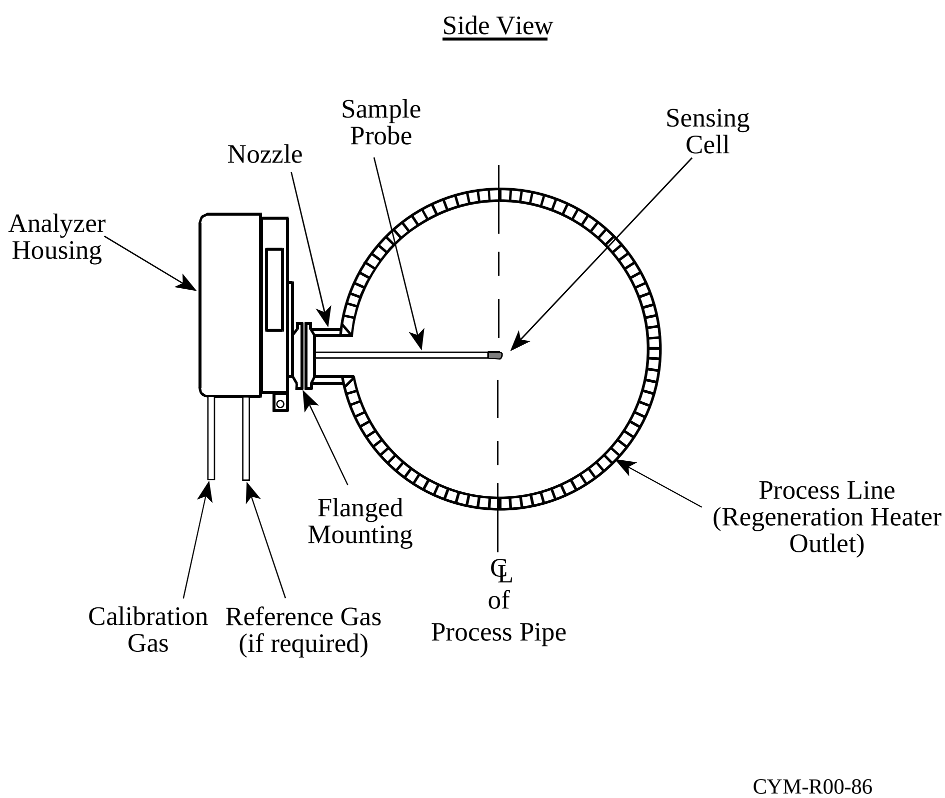
Notes:

1. Sample Probe Shall Be Provided by Analyzer Vendor.
2. Probe Opening Shall Face Downstream.
   Stamp Analyzer Housing to Indicate Downstream Side.
3. Probe Opening Shall Be Located at the Center of Process Pipe.
4. Bolt Holes in Nozzle Flange Shall Match Orientation
   of Analyzer Flange.

PLT-R00-52
CYM-R01-46

Figure V-23

In-Situ Oxygen Analyzer
Installation



O. HYDROGEN/HYDROCARBON ANALYZER

The hydrogen/hydrocarbon analyzer detects contaminants in the CCR Nitrogen Header to the Regeneration Section. If the sample of the CCR Nitrogen Header is contaminated by either hydrogen or hydrocarbon, the high or low analyzer reading will cause a contaminated nitrogen shutdown. Contamination of the CCR Nitrogen Header is a serious hazard that should be corrected immediately.

The analyzer piping is also equipped with "quick connect" connections to allow checking of the circulating lift gas nitrogen purity prior to and during the dumping of catalyst fines from the Dust Collector (see chapter V-III).

The analyzer is calibrated to measure both hydrogen and hydrocarbon. When the sample is pure nitrogen, the analyzer displays 50%. When the nitrogen is contaminated with hydrogen, the analyzer indication increases – up to 100% when the sample is 99% nitrogen and 1% hydrogen. When the nitrogen is contaminated with hydrocarbon, the analyzer indication decreases – down to 0% when the sample is 85% nitrogen and 15% hydrocarbon.

For safety reasons, nitrogen to the CCR Nitrogen Header should come from an independent source that is not connected to any other users. Nitrogen derived from liquefaction is preferred. The use of combustion-type inert gas generator is not allowed.

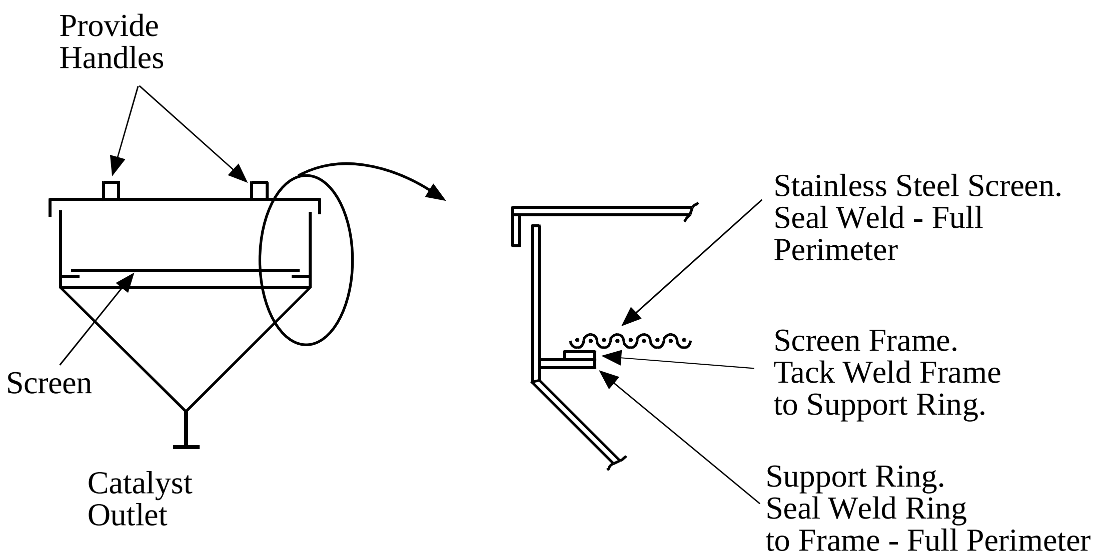
P. CATALYST ADDITION FUNNEL AND CATALYST ADDITION LOCK HOPPER

The Catalyst Addition Funnel (Figure V-24) and Catalyst Addition Lock Hopper (Figure V-25) are designed for adding fresh catalyst from drums into the Regeneration Section. This addition must be done on an occasional basis to replace catalyst that is removed as fines from the Regeneration Section by the Disengaging Hopper. The Funnel and the Lock Hopper are fabricated from Type 304 stainless steel to prevent rusting. The screen inside the funnel and the cover on top are intended to prevent any foreign objects from being loaded into the Regeneration Section.

An addition funnel and lock hopper are specified for the optional Catalyst Change-out On-The-Fly system. The specification for this equipment is the same as that for the regular catalyst addition system.

Figure V-24

Catalyst Addition Funnel

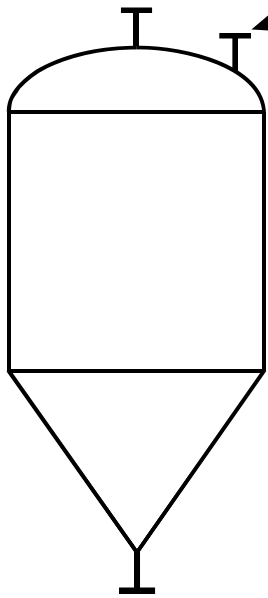


Note: 1) This Item Is Not a Code Vessel
2) Material: 304 SS

PLT-R00-53
CYM-R00-55

Figure V-25

Catalyst Addition Lock Hopper



Notes: 1) This Vessel Is Sized to Hold One Drum of Catalyst
2) Material: 304 SS

PLT-R00-54
CYM-R00-39

Q. AIR DRYER

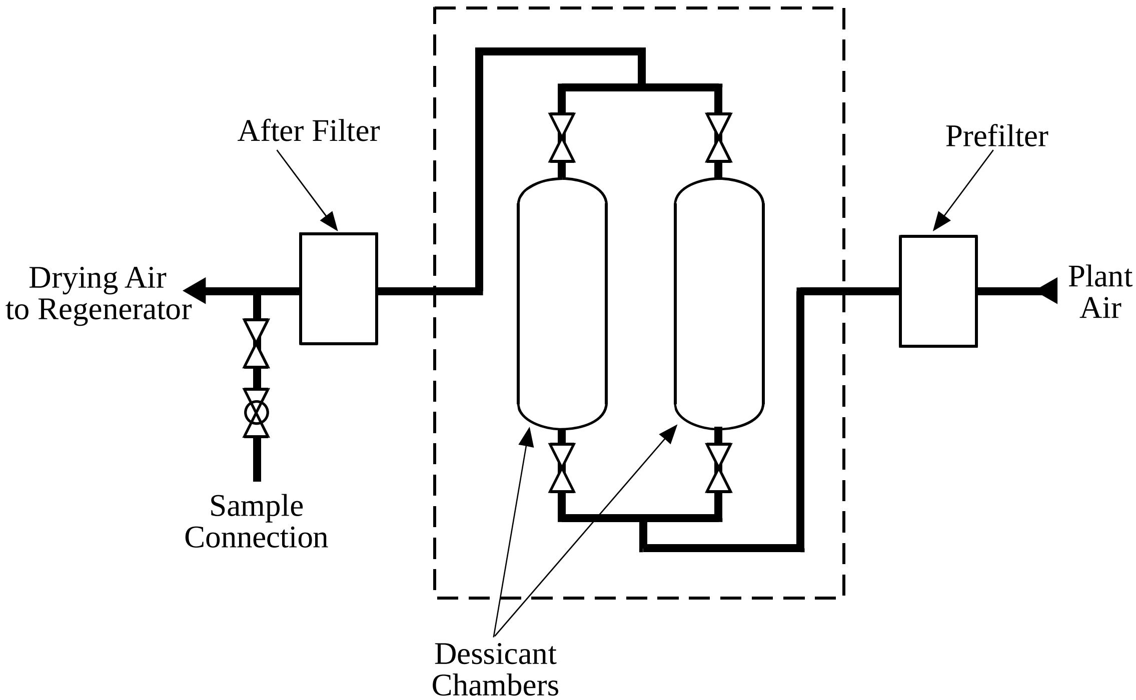
The Air Dryer (Figure V-26) is used to dry the air for the Cooling Zone and Drying Zone. It is a packaged unit that uses a desiccant that absorbs moisture from wet air. There are two desiccant chambers. Only one is in service while the other is reactivated using a purge stream of the dry air product. During normal operation, a timing device switches the chambers in and out of service.

The moisture content of the dried air must be checked regularly. There is a sample tap on the Air Dryer outlet for connecting a moisture analyzer or a dew point analyzer. If the moisture content is above specification (5 vppm), then the reactivation purge rate, the cycling sequence, and the condition of the desiccant should be checked in accordance with the manufacturer's recommendations. Refer to the manufacturer's instructions for additional information.

Figure V-26

Air Dryer

Typical Arrangement



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CYM-R00-40

R. CATALYST SAMPLERS

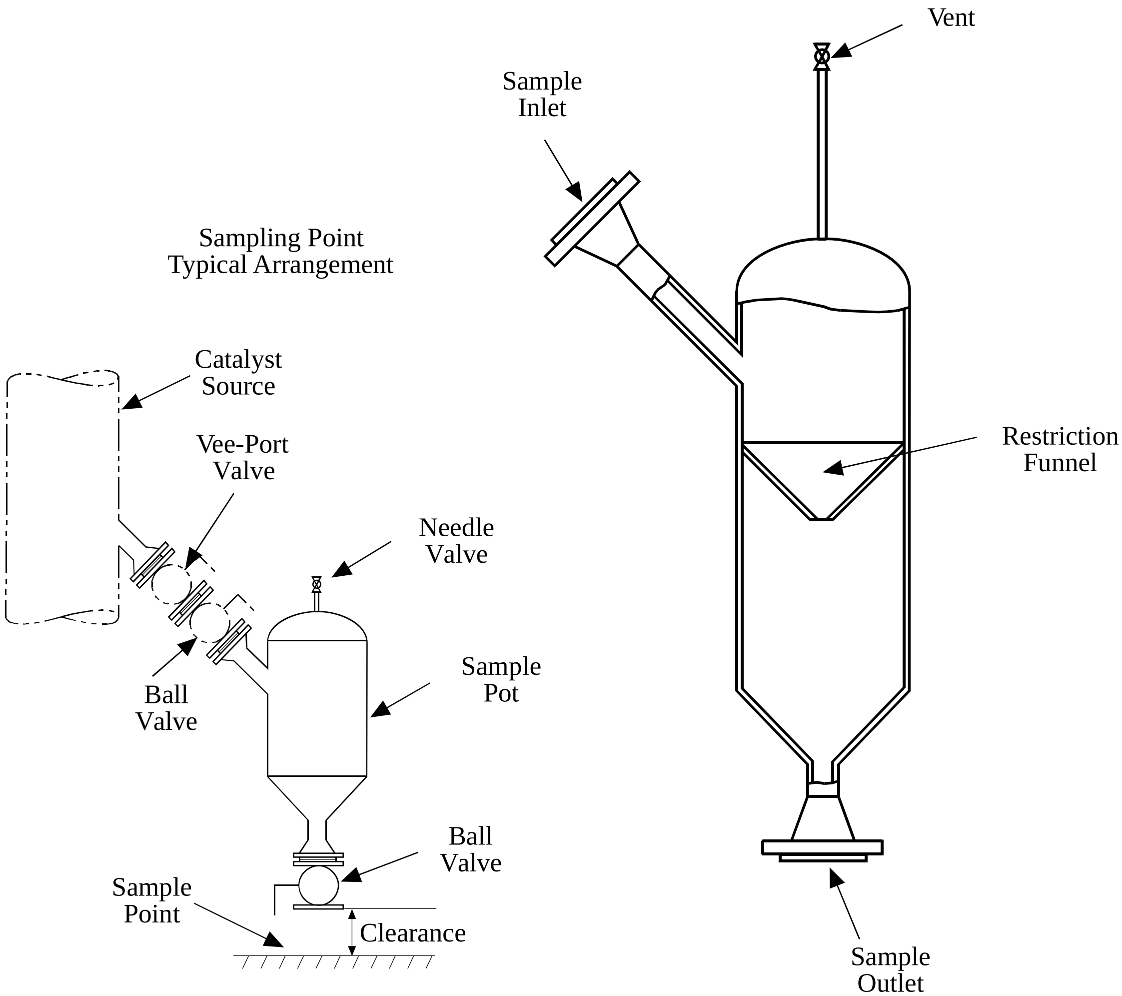
Catalyst sampler systems are used for sampling catalyst from the inlet line of the Regeneration Tower, the outlet line of the N_2 Seal Drum, and the outlet of the Reduction Zone.

The sampler systems around the Regeneration Tower (Figure V-27) consist of the sample pot, one V-ball valve, two ball valves, and a needle valve. The sample pot is divided in two sections by a restriction funnel. The top section includes the volume of the restriction funnel and the transfer line. This volume fills with catalyst when the sample inlet valves are opened. The bottom section is the collection area, and the catalyst drains into this area before the sample pot is depressured and unloaded. The four valves in the sampling system are intended to be opened and closed according to a specified sampling procedure. The procedure helps ensure that a fresh catalyst sample is safely obtained from the pressurized process line. The procedure also helps ensure that the gas-tight ball valve below the V-ball valve is not damaged from opening and closing on catalyst.

The reduced catalyst sampler system removes (Figure V-28) catalyst as it leaves the Lower Reduction Zone. This system differs from the above in several ways. One important difference is that it includes a sampling probe that extends into the flowing catalyst bed to obtain a representative sample. Catalyst withdrawal is achieved with this system not by gravity flow, but by a controlled depressurization of the sample probe. By opening the sample probe up to the sample receiver, which is at a lower pressure than the Reduction Zone, the probe pressure is lowered and catalyst is entrained with the gas flowing to the receiver. The reduced catalyst sampling procedure and the equipment are supplied by UOP PIC.

Figure V-27

Catalyst Sampler



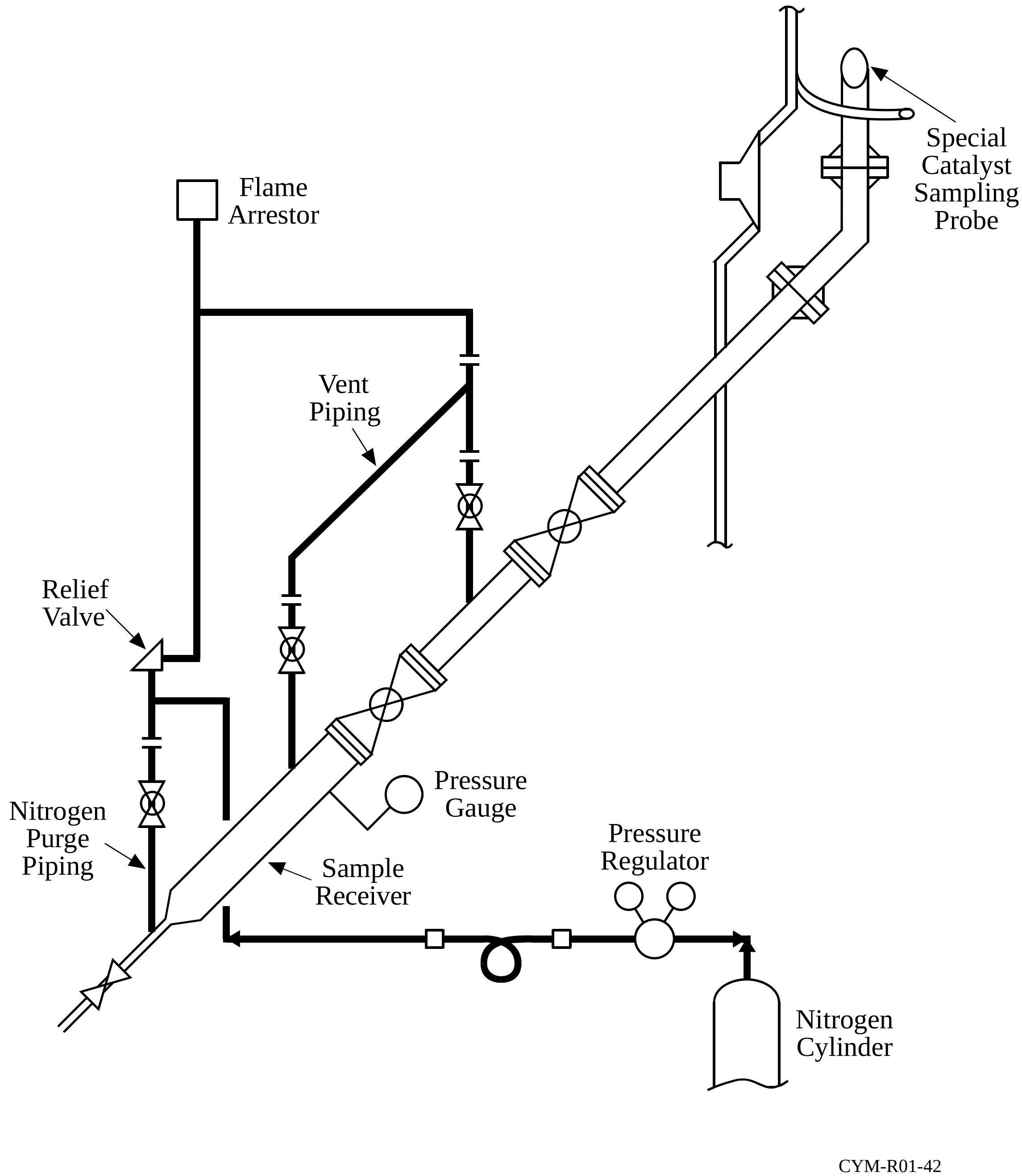
Note:

Metallurgy, Materials, and Rating Shall Be the Same as the Highest Metallurgy of the Pipe to Which the Sample Pot Connects.

PLT-R00-57
CYM-R00-41

Figure V-28

Reduced Catalyst Sampling Device



S. VENT GAS SCRUBBER

The Venturi Scrubber is constructed of Hastelloy C-2000 and is intended to provide good mixing of the Regenerator vent gas with a dilute caustic solution to remove the small amount of HCl and chlorine in the vent gas. Caustic flows to the Venturi on flow control at the design rate. The combined stream of caustic and regeneration gas exit the Venturi Scrubber for further treatment in the Vent Gas Wash Tower.

T. VENT GAS WASH TOWER

The Vent Gas Wash Tower (Figure V-29) is a cylindrical tower, with a packed bed of 19 mm (¾ inch) diameter carbon Raschig rings, to remove HCl and chlorine from the regeneration vent gas. The tower is constructed of carbon steel. A combined stream of caustic and regeneration vent gas enters through a nozzle near the bottom of the tower. A distributor located above the packed bed insures that the packed bed remains wetted with caustic. A spray nozzle, located below the packed bed, insures that the support grid and vessel walls below the packing are wetted. The caustic, after contacting the regeneration gas, collects in the bottom of the tower where it exits to the Caustic Circulation Pump. After the pump, a drag stream of spent caustic is removed and fresh caustic and condensate is injected. The circulating caustic then returns to the Venturi Scrubber and the two caustic inlets to the Wash Tower. The strength of the circulating caustic is monitored by an in-line pH meter.

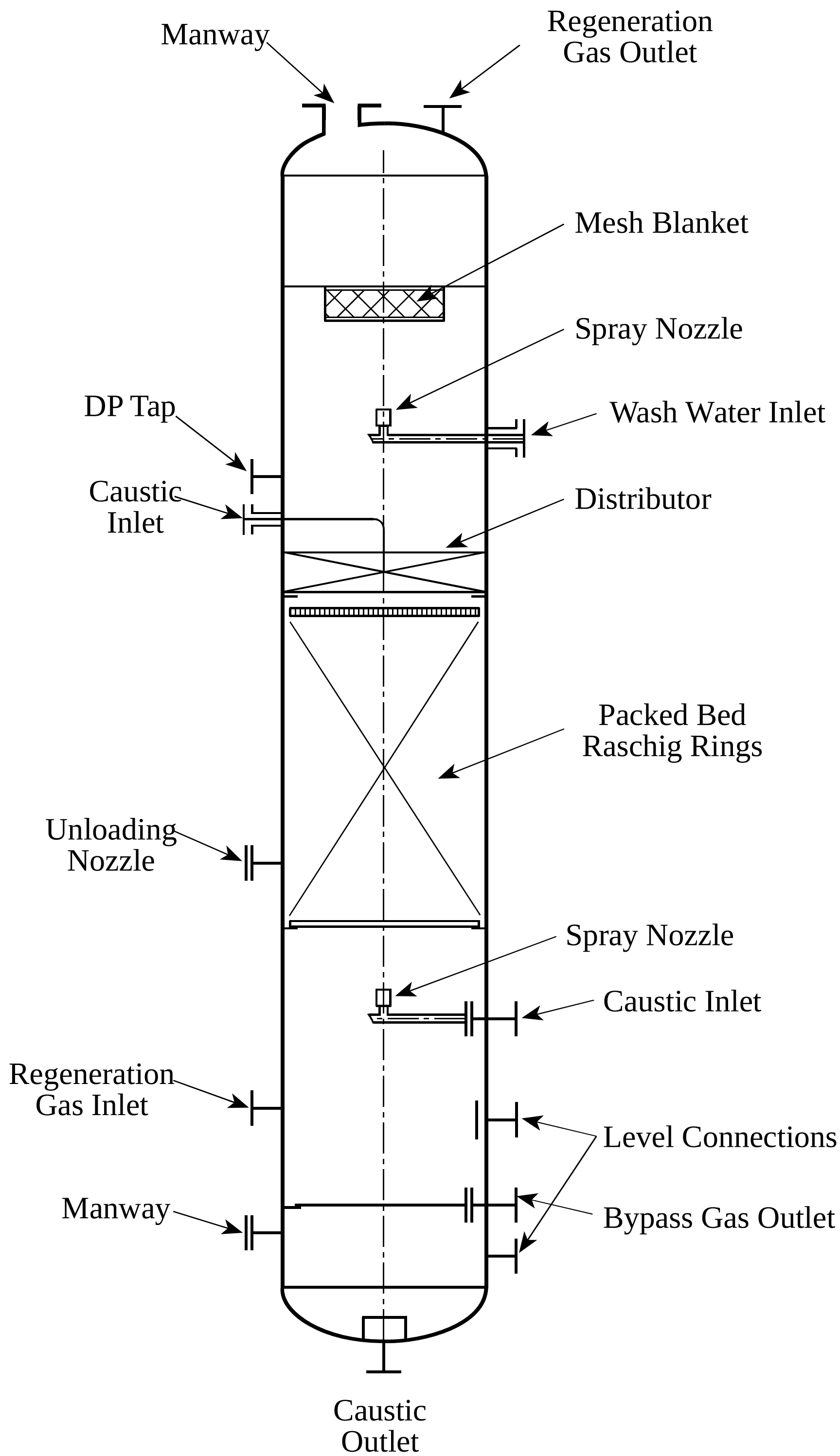
The regeneration gas passes through the packed bed where it is scrubbed of HCl and chlorine. The scrubbed gas then passes through a mesh blanket, located at the top of the tower, which serves as a demister pad. The gas exits the tower through a nozzle in the top head and is vented to atmosphere. A spray nozzle, located below the mesh blanket, provides for intermittent washing of the mesh with clean condensate. A pressure differential indicator across the mesh blanket indicates the build up of caustic salt on the mesh, and signals the need for condensate washing to dissolve the salt.

Tower over-pressure protection is provided via a gas bypass outlet nozzle. If the pressure below the packing is too high, part of the liquid inventory in the bottom will be pressured out to a safe location, and the vapor outlet to the bypass will be uncovered. This bypass allows the regeneration gas to bypass the packed bed and exit directly to the atmospheric vent.

Access to the tower for inspection, internals installation, and Raschig ring loading is provided by a manway in the top head of the tower. A Raschig ring unloading nozzle is provided in the tower wall located near the bottom of the packed bed. An additional manway is provided at the tower bottom for access to the region below the packed bed. The VGWT should be filled with water while the packing is loaded through the top manway to prevent breakage of the rings.

Figure V-29

Vent Gas Wash Tower



VI. COMMISSIONING

This section describes the preliminary and initial operations of the Regeneration Section.

A. PRELIMINARY REGENERATION SECTION PRECOMMISSIONING

This section includes preliminary inspection, installation, testing and commissioning of vessels and equipment. A suggested sequence for these preliminary operations is shown in Figure VI-3 at the end of this section.

It is essential that the items summarized below be completed before the Regeneration Section can be considered ready for initial startup. Subsequent startups will not require this detailed preparation. The UOP Chief Technical Advisor will usually provide detailed procedures for this preliminary preparation.

1. Hydrostatic Testing

Conduct hydrostatic pressure tests of pertinent equipment. This is generally handled by the construction contractor.

> **NOTE:** Gas-tight ball valves must never be installed before the final assembly of the unit. Free water and/or humidity in the air can cause damage to the sealing surface. The construction contractor should provide pipe spools to fill the flange-to-flange height of the ball valves to obtain proper piping fit-up.

2. Utilities

Clean and service utility systems.

3. Inspection and Testing

a. Inspect pertinent piping, instrumentation, and equipment for fabrication and installation in accordance with the UOP Project Specifications.

b. Check regenerator logic wiring. Ensure that all electrical connections from the logic cabinets to the field and to the control board are correct.

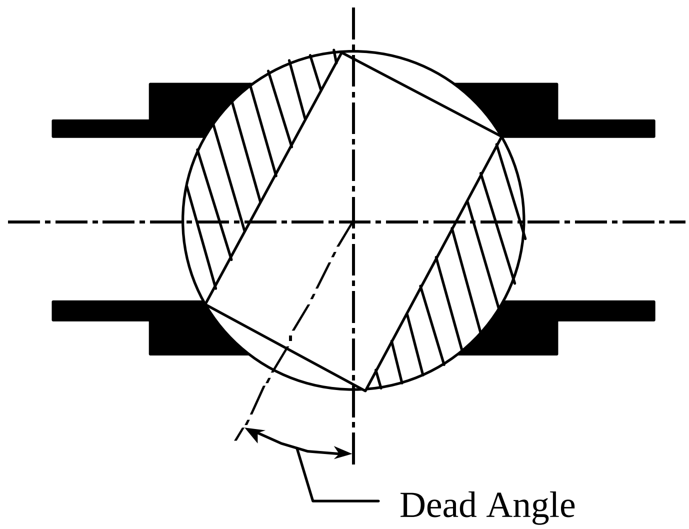
c. Verify the mechanics and the assembly of all automatic valves, manual ball valves, and control valves. Inspect clearances of valve internals. Bench test valves that require leak testing.

   Bench-calibrate the positioners and actuators of the two Equalization Valves and the two gas makeup valves of the Lock Hopper. Stroke each valve manually.

d. For the two Equalization Valves, measure the angle at which the port of the ball valve just begins to open up to the flow (“dead angle”). Refer to Figure VI-1.

e. Bench test all relief valves associated with the Regeneration Section.

Figure VI-1
Ball Valve Dead Angle



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4. Clean Lines

Blow down all lines associated with the Regeneration Section with air to remove trash, scale, and water. A thorough purge of all lines will minimize valve problems and ensure a smooth startup. The blowdown is accomplished by dividing the Regeneration Section system into loops, such as:

a. Nitrogen header to all Regeneration Section users.
b. Recycle gas header to all Regeneration Section users.
c. Booster gas header to all Regeneration Section users.
d. Nitrogen Lift System.
e. Regenerated Catalyst Lift System.
f. Combustion air system.
g. Organic chloride injection system.
h. Vent gas line from Reduction Zone and Lock Hopper.
i. Ejector line to Regeneration Section users.
j. Regeneration Tower associated piping.
k. Lock Hopper associated piping.

NOTE: Clearing each piping loop must be carefully planned to avoid blowing trash, scale, and water into an area of piping that has already been cleared. Likewise, trash, scale, and water should not be blown *into* vessels that have already been cleaned.

After line blowing, check visually for trash and scale in the catalyst lines between vessels of the Regeneration Section. Clean as required in preparation for installation of the automatic valves and the manual ball valves.

5. Equipment Commissioning

a. Run in the Regeneration Blower and the Regeneration Cooler Blower. Commission the cooling water (if applicable) and the nitrogen seal purge to the Regeneration Blower. Start the blowers in accordance with the manufacturer's instructions.

Regeneration Blower run-in will also serve to blow down the large-diameter suction and discharge lines. If possible, a screen should be placed at the suction of the Regeneration Blower to prevent any trash from being pulled into the Blower. In addition, at the Regeneration Tower, the flanged connections should be unbolted and spread apart with a blind installed on the Regeneration Tower nozzles. These steps provide suction flow to the Regeneration Blower and prevent trash from being blown into the Regeneration Tower.

b. Prepare the Electric Heaters. Check the continuity of the electrical wiring of the Regeneration Heater, Air Heater, Reduction Gas Heaters and Reheat Gas Heater (if applicable). Dry out the insulation surrounding the electric elements in the heaters in accordance with the manufacturer's procedures.

6. Instrumentation Installation

a. Install all metering orifices, restriction orifices, and any other flow-measuring elements. Before installation, measure and check all orifice diameters against the UOP Project Specifications and the contractor's calculations.

b. Install all control valves, automatic valves, and manual ball valves.

c. Install the two Equalization Valves and the two gas makeup valves of the Lock Hopper. Calibrate each valve's transducer in the field. Stroke each valve after installation via an input signal to the transducer to check the linearity of the control of the valve position.

d. Install the long Regeneration Tower thermocouples that extend from the top head of the Regeneration Tower down inside the Burn Zone, Reheat Zone, and Chlorination Zone.

e. Install the long Reduction Zone thermocouple assembly that extends from the top head of the Reduction Zone down into the Lower Reduction Zone.

f. Calibrate all instrumentation. For record purposes, measure with a Geiger counter and record the radiation strength at the detector tubes of all nuclear level instruments, including the Reduction Zone (2 instruments), the Disengaging Hopper (2 instruments), and the Lock Hopper (3 instruments).

7. Miscellaneous Equipment Preparation

a. Prepare the Air Dryer. Load the Air Dryer with the drying medium provided by the manufacturer. Pressure test the Air Dryer with the Combustion Air System at the normal operating air pressure. Cycle the logic sequence. Verify that the product air moisture content meets project specification at the design drying air flow rate.

b. Install all filter elements, this includes: Air Dryer pre and after filters, in-line filters; screen inserts inside the Reduction Zone gas outlet, L-Valve Assemblies, Fines Collection Pot, Lock Hopper; and the elements inside the Dust Collector, the Booster Gas Coalescer, and Reduction Gas Filters.

c. Install the Reduction Zone catalyst sampler. Follow vendor instructions regarding installation.

d. Install the Vent Gas Wash Tower internals, including the tower packing material.

NOTE: The tower should be filled with water before loading packing material.

8. Check the Logic of the Catalyst Regeneration Control System (CRCS)

a. Hand stroke all the manual and automatic ball valves to check ease of operation. Stroke all logic-controlled valves using the logic system. Stroke all control valves using the control board station.

b. Set and test the setpoints of all limit, logic, and alarm switches.

c. Set and check all timer settings in the logic and alarm systems.

d. Perform a dry-run cycling of all the various systems of the CRCS.

B. PRESSURE TEST THE REGENERATION SECTION

Pressure test the Regeneration Section in the following loops. Include in the pressure test all instrumentation associated with the equipment and piping of each pressure test loop.

1. The steam side of the Booster Gas Heater and the Organic Chloride Injection Line Steam Jacket, the cooling water pad of the Regeneration Blower (if applicable), and the cooling water side of the Lift Gas Blower Gas Cooler (if applicable) should be tested at their normal operating pressures.

2. The following equipment and associated piping are pressure-tested with the Platforming reactor circuit:

Reduction Zone
Reduction Gas Heaters
Reduction Gas Exchanger

3. The following equipment and associated piping are pressure-tested at the Platforming reactor circuit test pressure:

   Spent Catalyst Lift System
   Disengaging Hopper
   Dust Collector
   Lock Hopper
   Regenerated Catalyst Lift System

4. The Booster Gas Coalescer, the Booster Gas Heater and the associated piping are pressure-tested with the Platforming net gas booster compression section.

5. The following equipment and associated piping are pressure-tested at the Regeneration Tower normal operating pressure:

   Regeneration Tower
   Regeneration Blower
   Regeneration Cooler
   Regeneration Heater
   Air Heater
   Catalyst Addition Lock Hopper
   Nitrogen Seal Drum
   Organic Chloride Injection System
   Reheat Gas Heater (if applicable)

   If necessary, blind the Regeneration Blower from the rest of this loop and pressure-test it separately. When pressuring-up the Regeneration Blower, maintain the seal purge at the design differential pressure above the suction pressure at all times. The Regeneration Blower itself will not be gas-tight because its seals will leak. Check the housing and the flanges at the suction and discharge of the blower for leaks using a dilute soap solution.

6. The Combustion Air System, including the Air Dryer and the associated piping, are pressure-tested at the normal operating air pressure.

7. The nitrogen header and its distribution piping to the Regeneration Section users are pressure-tested at the normal operating nitrogen pressure.

C. PREPARATION FOR DRYOUT OF THE REGENERATION SECTION

It is necessary to dryout the Regeneration Tower and associated equipment before loading catalyst. The Regeneration Section dryout will be performed at the same time as the Platforming reactor section dryout.

The nitrogen header and the hydrogen system of the Regeneration Section must be air-freed by evacuation and/or purging with nitrogen to remove any oxygen prior to starting the dryout. Nitrogen should be purged through all vents, drains, and instrument taps to ensure that no air pockets are missed. Care should be taken not to back-purge into a system that has previously been purged. In the case of unavoidable dead ends in piping systems, an effective purge can only be achieved by repeated nitrogen pressuring and venting to atmosphere.

1. Nitrogen Header

Purge all piping from the independent nitrogen source through the nitrogen header to the various nitrogen users in the regeneration section. Commission the nitrogen header.

2. Equipment that is Included with the Platforming Unit Reactor Circuit

The following equipment and its associated piping is evacuated and purged simultaneously with the Platforming Unit reactor circuit:

Reactor Catalyst Collector purge line
Reduction Zone
Reduction Gas inlet lines and electric heaters
Reduction Gas Exchanger and outlet line to Platforming Unit

Before air-freeing, prepare the Regeneration Section as follows:

a. Close the blind in the catalyst line between the bottom of the reactors and the Spent Catalyst Isolation Valve. Keep this blind closed until the end of the Platforming reactor section and Regeneration Section dryouts.

b. Close the Ball-valve in the catalyst line to the top of the Reactor stack.

3. Regeneration Section Air System

This system includes the Regeneration Tower, Nitrogen Seal Drum, and associated piping. Prepare this system as follows:

a. Ensure that the Regenerated Catalyst Isolation System is open with the nitrogen purge off.

b. Install temporary blinds in the catalyst lines between the Disengaging Hopper and the top of the Regeneration Tower. Keep these blinds closed until the end of the Platforming reactor section and Regeneration Section dryouts.

c. Install a temporary blind in the catalyst line below the lower valve of the Lower Isolation System (above the Lock Hopper). Keep this blind closed until the end of the Platforming reactor section and Regeneration section dryouts.

d. Close the spectacle blind at the Cooling Zone gas outlet nozzle of the Regeneration Tower downstream of the pressure relief valve.

4. Regeneration Section Hydrogen System

This system includes the Lock Hopper, Regenerated Catalyst L-Valve Assembly, Regenerated Catalyst Lift Pipe, Booster Gas Coalescer, and Booster Gas Heater. Air-free this system as follows:

NOTE: The circuits for air-freeing and for dryout of the hydrogen sections are different. For air-freeing, the Reduction Zone and associated piping and equipment are included with the reactor section. For dryout, they are included with the Regeneration section hydrogen system.

a. Line-up the temporary dryout line from the Reduction Zone standby line (from the Recycle Gas Compressor) to the inlet nozzle of the Booster Gas Coalescer. Block in the standby line just upstream of this tie-in and also at the lower reduction gas line.

b. If the unit design calls for the Lock Hopper vent gas to be directed to the fuel gas system, blind the Lock Hopper vent gas line at the double block & bleed assembly. If the unit design calls for the Lock Hopper vent gas to return to the Platforming unit product condenser, isolate at the double block & bleed assembly (but a blind is not required).

c. Blind the booster gas inlet to the Booster Gas Coalescer at the double block & bleed assembly.

d. Isolate the Booster Gas Coalescer drain line at the double block & bleed assembly.

e. Evacuate the Regeneration Section hydrogen system and pressure with nitrogen:

   (1) Isolate all pressure and differential pressure instrument transmitters.

(2) Open the valves in the Hydrogen System so that the pressure throughout the system is equalized.

(3) Connect the ejector manifold to the outlet of the Booster Gas Heater and to the Regenerated Catalyst L-Valve assembly. Vacuums will be pulled from these 2 locations simultaneously.

(4) Commission the ejector and evacuate the hydrogen system to at least 600 mm Hg (24 in Hg) vacuum. Hold for one hour to determine system tightness. Break the vacuum and pressure up the system to 0.35 kg/cm^{2}g (5 psig) with nitrogen.

(5) Evacuate the hydrogen system again to at least 600 mm Hg (24 in Hg) vacuum. Break the vacuum and pressure up the system again to 0.35 kg/cm^{2}g (5 psig) with nitrogen. Repeat until oxygen measurements are less than 0.1 vol-%. In the case of dead ends in piping, purge by repeated pressuring with nitrogen and venting.

(6) Pressure up the system with nitrogen to about 2.1 kg/cm^{2}g (30 psig). Hold the pressure for one hour to determine system tightness. Keep the system under nitrogen pressure in preparation for the dryout.

5. Reactor Section

Air-free the Platforming Unit reactor section in preparation for dryout in accordance with UOP startup procedures. These steps are summarized as follows:

a. Isolate the reactor section from the booster gas compression section, the fractionation section, the fuel gas section and from the Recycle Gas Compressor.

b. Route the vent line from the Product Separator pressure control valve to atmosphere.

c. Air-free the reactor section by evacuating and purging the system with nitrogen until the oxygen level is below 0.1%.

d. Purge the Recycle Compressor with nitrogen.

D. DRY OUT THE REGENERATION SECTION

The dryout of the Regeneration section is divided into four loops (see Figure VI-2):

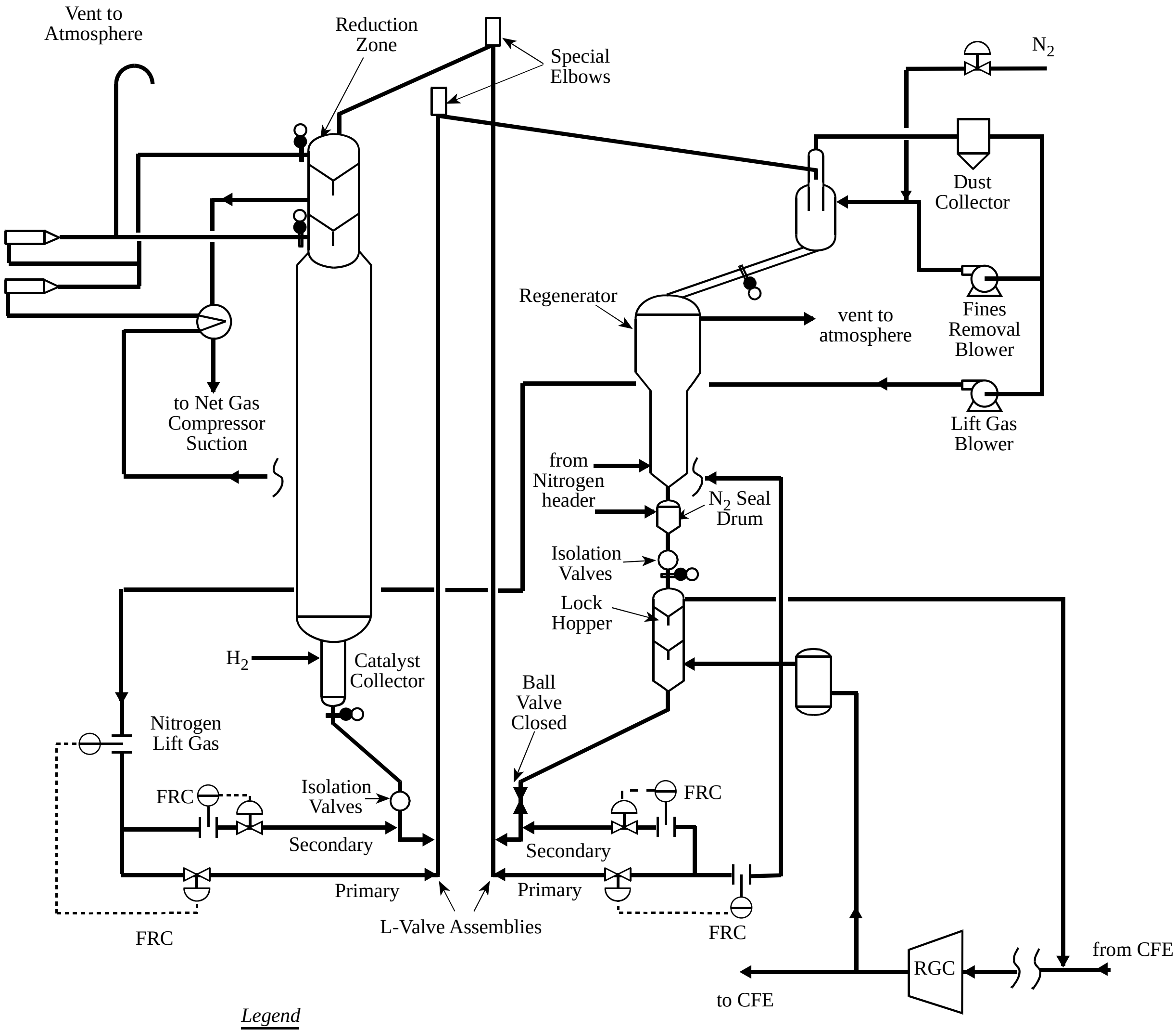
Platforming Reactor Circuit
Nitrogen Lift System
Regeneration Section Air System
Hydrogen System

The reactor section will be dried out by heating nitrogen with the Charge Heater and the inter-heaters and by circulating that nitrogen with the Recycle Compressor (see the CCR Platforming General Operating Manual for further details). The Regeneration section will be dried out at the same time as the reactor section using the circulating nitrogen from the reactor circuit. The Regeneration Tower will be dried out by heating nitrogen with the Air Heater, circulating that nitrogen with the Regeneration Blower and heating the circulating nitrogen with the Regeneration Heater. The Spent Catalyst Lift System, Disengaging Hopper, and Dust Collector will be dried out by circulating nitrogen with the Lift Gas and Fines Removal Blowers. The Catalyst Addition Lock Hopper will be dried with nitrogen vented from the Spent Catalyst Lift System. The Lock Hopper, Regenerated Catalyst Lift System, Reduction Zone, Reduction Gas Heaters and associated piping will be dried out by circulating nitrogen with the Recycle Compressor.

Figure VI-2

CCR Dryout Circuits

CycleMax Regeneration Section



Legend

- *Blind*
- *Closed Valve*

RGC - Recycle Gas Compressor
CFE - Combined Feed Exchanger

CYM-R00-81

The following procedure outlines a general procedure for carrying out this drying operation:

1. Line-Up Flows

Line up flows for dryout as follows:

a. Blind the Upper and Lower Reduction Gas inlet lines to the Reduction Zone at the vessel nozzles. This is to aid in the dryout of the Reduction Gas Heaters, Regenerated Lift Line and Reduction Zone dryouts. These blinds should remain in place until after catalyst loading is complete.

b. Remove the blind from the Lock Hopper vent gas line (if one was installed) and open up the double block & bleed. For units where the Lock Hopper gas is normally routed to the fuel gas drum, line up flows via the dryout line from the Lock Hopper to the recycle gas compressor suction.

c. Open the dryout line from the Reduction Zone standby gas (recycle gas purge) line to the Booster Gas Coalescer.

d. Close the manual valves in the catalyst line at the bottom of the Lock Hopper. Keep these valves closed until the end of the Platforming reactor section and Regeneration Section dryouts

2. Pressure Reactor Circuit

Pressure up the Platforming Unit reactor circuit with nitrogen and start the Recycle Compressor. These steps are summarized as follows:

a. Commission all instrumentation associated with the Platforming reactor circuit and the Recycle Compressor.

b. Pressure up the reactor section with nitrogen added at the Recycle Compressor discharge to a Product Separator pressure of approximately 2.5 kg/cm^{2}g (35 psig), with the Recycle Compressor blocked in. Hold the pressure for an hour to determine system tightness.

c. Establish normal operation of the Reactor Products Condenser(s) and the Reactor Products Trim Cooler(s).

d. Commission the pressure controller of the Product Separator and set the Product Separator pressure at 2.5 kg/cm^{2}g (35 psig), provided this is consistent with the mechanical limitations of the Recycle Compressor. Open the valves at the Recycle Compressor suction and discharge.

e. Start the Recycle Compressor. Establish nitrogen circulation through the system at the highest rate possible, compatible with the compressor discharge temperature limitations. Control the pressure of the Product Separator by venting with its pressure controller and by adding makeup nitrogen at the discharge of the Recycle Compressor.

f. Drain all free water from any low points in the system.

3. Establish Catalyst Collector and Reduction Gas Outlet Flows

a. Since there will be a low pressure differential between the Reduction Zone and reactor #1 during dryout, the CRCS will command the Reduction Gas Vent valve closed. Since there are no reactants in the reactors at this point (only nitrogen: the same as in the reduction Zone), there is no need for this safeguard at this time. Maintain the valve in the open position for as long as required for the dryout.

b. Start the Reduction Zone Gas Outlet flow through the Reduction Gas Exchanger directed to the Product Separator in the Platforming unit. Monitor the temperature of this flow with the TI upstream of the exchanger.

NOTE: As the reactor dryout proceeds, this temperature will increase. Stop the flow before the design temperature limits of the exchanger are reached.

c. Start the Catalyst Collector purge flow and increase the rate to design.

4. Reduction Gas Electric Heater Dryout

NOTE: The Electric Heater elements should have been tested for adequate resistance to ground before beginning the dryout procedure.

a. Line-up flows via the normal Reduction Gas route from the Booster Gas Coalescer to Reduction Gas Heater #1 to Reduction Gas Heater #2 (line to the Upper Reduction Zone is blinded at the vessel nozzle) to the Lower Reduction Zone. Open the vent to atmosphere in the line between Reduction Gas Heater #2 and the Lower Reduction Zone (line to the Lower Reduction Zone is blinded at the vessel nozzle).

b. Start the flow of recycle gas from the Booster Gas Coalescer, through the Reduction Gas Heaters to atmosphere. Open all valves as wide as possible to minimize pressure drop in this line and hence maximize flow.

c. **Caution**: Although the drying medium is nitrogen and it is being vented at a safe location, caution still needs to be exercised since the nitrogen will be heated to elevated temperatures.

d. Set the temperature controller for Reduction Gas Heater #1 in manual at zero output to the heater. Depress the electric heater pushbutton to start the heater.

e. Monitor the outlet temperature carefully with the TI in the line to the Lower Reduction Zone. Raise the zone inlet temperature at 100°F per hour (55°C per hour).

f. If there is no Reduction Zone Outlet flow through the shell of the Reduction Gas Exchanger at this time, the electric heaters will not be able to raise the temperature of the nitrogen to design temperatures. In this case, increase the firing as much as possible to complete the dryout. Confirm that all instrumentation is functioning correctly and that there are no problems due to thermal expansion in this area.

g. Hold the dryout temperature for 4 hours.

h. When the dryout of Reduction Gas Heater #1 is complete, switch off the heater and proceed to dry out Reduction Gas Heater #2 in the same manner.

5. Reactor Section Dryout

Start the dryout of the Platforming reactor section in accordance with UOP start-up procedures and any requirements of vendors for the Platforming Heater dryout and the Platforming Heater convection section boilout. The activities are carried out at the same time as the Regeneration Section dryout procedures. These steps are summarized as follows:

a. Commission all instrumentation associated with the Platforming Heaters.

b. Establish flows and operating conditions in the convection section in accordance with the boilout instructions.

c. Establish a draft through the heater in accordance with the heater vendor's instructions. Purge the heater. Light the pilots.

d. Light a few burners in each Platforming heater.

e. Raise the temperatures of the reactor inlets at the specified heat-up rate. Rotate burners in accordance with the heater dryout procedures.

f. Raise the temperature of the Catalyst Collector Purge along with the reactor inlets up to its normal operating temperature.

g. Hold the reactor inlet temperatures at the specified hold temperatures for the specified time periods.

h. Drain water from the Product Separator and plant low points until the total drainage rate from the Product Separator and all other low points is less than 100 ml per hour.

i. Inspect closely the entire reactor section and Regeneration Section for thermal expansion throughout the dryout.

j. After the reactor section dryout, heater dryout, and convection section boilout are judged complete, cooldown the Platforming Unit reactor section in accordance with the dryout procedures. These steps are summarized below:

(1) Reduce reactor inlet temperatures.

(2) Shutdown the Platforming heaters.

(3) Continue recycle nitrogen circulation until all reactor temperatures have cooled at least below 66°C (150°F). In addition, continue operation of the Recycle Compressor until the dryout of the Regeneration Section is complete.

6. Start Vent Gas

Commission the vent gas lines from the Regeneration Section.

a. Ensure that the Regeneration Section hydrogen system is pressured up with nitrogen to about 2.5 kg/cm^{2}g (35 psig).

b. (If applicable.) If the Lock Hopper vent gas line is normally routed to fuel gas drum, then install the temporary line for dryout from the outlet of the filters to the Recycle Gas Compressor suction. Do not open the line to the fuel gas drums. Set the vent rate carefully in order to maintain the pressure of the Lock Hopper.

c. (If applicable.) If the Lock Hopper vent gas line is normally routed to the Product Condenser, then open the valves in the line to the suction of the Recycle Compressor.

7. Nitrogen Lift System Dryout

Start dryout of the Nitrogen Lift System. This system includes the Spent Catalyst L-Valve Assembly, Spent Catalyst Lift Pipe, Disengaging Hopper, Dust Collector, Lift Gas Blower, Lift Gas Blower Cooler (if applicable), Fines Removal Blower, Catalyst Addition Lock Hopper, and the associated piping.

Start circulation of elutriation gas, lift gas to Spent Catalyst L-Valve Assembly and to the Dust Collector:

a. Open the Unload and Vent lines of the Catalyst Addition Lock Hopper.

b. Pressure up the spent catalyst lift system with nitrogen via the normal addition point to the normal operating pressure. Adjust nitrogen addition to balance venting through the Catalyst Addition Lock Hopper.

c. Commission the Lift Gas Blower Cooler (if applicable).

d. Commission the Lift Gas Blower and the Fines Removal Blower. Establish design flows to the Disengaging Hopper and Spent Catalyst L-Valve assembly.

e. Verify that all instrumentation is functioning correctly. Cycle Catalyst Addition Lock Hopper #1 through one cycle (without adding catalyst).

8. Hydrogen System Dryout

Start flow of lift gas to the Regenerated Catalyst L-Valve Assembly and makeup gas to the Lock Hopper:

a. Open the Booster Gas Coalescer drain.

b. Commission the Booster Gas Heater.

c. Open the ball valve in the regenerated catalyst lift line at the top of the Platforming reactors. Recycle gas will backpressure the lift line from Reactor #1 through the Reduction Zone.

d. Establish the primary and secondary lift gas to the L-Valve Assembly. With the dryout of the Platforming reactors ongoing, the pressure at the Reduction Zone will be quite high. Verify that there is positive flow through the regenerated catalyst lift line by checking the primary and secondary lift gas flow indicators.

e. Establish makeup gas to the Surge Zone of the Lock Hopper through both the logic-ramped control valve and the differential pressure control valve. This will result in flow through the Lock Hopper back to the Recycle Gas Compressor suction.

9. Pressure Up the Regeneration Tower with Nitrogen

a. Close the vent control valve from the Burn Zone and the excess air control valve from the Drying Zone.

b. Slowly open the drying air control valve and pressure up the Regeneration Tower with nitrogen to 2.5 kg/cm^{2}g (35 psig). Monitor the Regeneration Tower pressure closely in order to avoid over-pressuring the system. Also, during pressure-up of the system including the Regeneration Blower, maintain the blower's seal purge at the design differential pressure above the suction pressure to avoid over-pressuring the seal.

c. Hold the pressure and determine the tightness of the system by checking for leaks at all flanges with soapy water. The system will not hold pressure because of leakage through the seals of the Regeneration Blower.

d. Set and control the differential pressure between the Regeneration Tower and the Lock Hopper at 0 mm H_2O (0 in. H_2O).

10. Commission the Vent Gas Scrubber System

a. Commission all instrumentation associated with the Vent Gas Scrubber System, including nitrogen purges to impulse lines.

b. Inventory the wash tower with condensate via the normal condensate injection line.

c. Commission cooling water to the Caustic Cooler.

d. Commission condensate circulation to the wash tower inlets above and below the packed bed. Set flows at design rates.

e. Commission condensate circulation to the Venturi Scrubber. Set flow to the design rate.

f. Start caustic injection to the circulating condensate and perform a short test of the injection pump.

11. Regeneration Tower Dryout

a. Establish the following flows and conditions:

(1) Nitrogen purge to the Regeneration Tower through the Lower Air system at the design rate. Adjust the valves in the lines to the Drying and Cooling Zones to send 30% of this flow to the Cooling Zone. Since this flow will not leave via the Cooling Zone outlet line during dryout, 70% of the flow needs to go directly to the Drying Zone to maintain a minimum flow through the Air Heater.

(2) Nitrogen purge to the Nitrogen Seal Drum: design flow rate.

(3) Nitrogen purge to Regeneration Blower seal: design differential pressure.

(4) Nitrogen purges to the regeneration gas and reheat gas flow meters: design flow rates.

(5) Cooling water flow to the Regeneration Blower water pad (if applicable).

b. Vent nitrogen through the Drying Zone vent at a rate insuring that the apparent Chlorination Zone flow is maintained at the design flow.

c. Start the Regeneration Blower and the Regeneration Cooler Blower.

d. Calibrate and set up the analyzers for normal operation:

(1) Nitrogen header hydrogen/hydrocarbon analyzer

(2) Regeneration gas oxygen analyzer

e. Set the Emergency Stop Switch to RUN. Depress the Regenerator Run/Stop button to RUN.

f. Start the Air Heater and heat up the Regeneration Tower:

NOTE: The Electric Heater elements should have been tested for adequate resistance to ground before beginning the dryout procedure.

(1) Set the temperature controller for the Drying Zone inlet in manual at zero output to the heater.

(2) Depress the electric heater pushbutton to start the heater.

(3) Raise the zone inlet temperature at 55°C per hour (100°F per hour) to 150°C (300°F). Hold for four hours. Drain all low points.

(4) Inspect the entire Regeneration Section for problems associated with thermal expansion.

g. Start the Regeneration Heater (and Reheat Gas Heater if applicable) and heat up the Regeneration Tower.

(1) Set the temperature controller for the Burn Zone inlet in manual at zero output to the heater.

NOTE: The inlet temperature controller for the Burn Zone is split-ranged to the Regeneration Heater (50-100%) and the Regeneration Cooler (50-0%). Set its output at 50% for zero output to the Regeneration Heater.

(2) Depress the electric heater pushbutton to start the Regeneration Heater.

(3) If applicable, set the temperature controller for the Reheat Zone inlet in manual at zero output to the heater.

(4) If applicable, depress the electric heater pushbutton to start the Reheat Gas Heater.

(5) Raise the zone inlet temperatures at 55°C per hour (100°F per hour) to 150°C (300°F).

h. Raise the zone inlet temperatures at 55°C per hour (100°F per hour) to 150°C (300°F) to design temperatures:

	Burn Zone inlet	477°C (890°F)
	Drying Zone inlet	565°C (1050°F)
(if applicable)	Reheat Zone inlet	510°C (950°F)

Hold for four hours. Again, inspect the entire Regeneration Section for problems associated with thermal expansion.

12. Shut Down

a. Shut down the electric heaters and cool down to 200°C (400°F), or to as low as the Regeneration Blower will allow.

b. Shut down the Regeneration Blower and the Regeneration Cooler Blower.

c. Maintain nitrogen purges to the Regeneration Tower Drying Zone and the Nitrogen Seal Drum to cool the Regeneration Tower to 38°C (100°F).

d. After the completion of the reactor section dryout, heater dryout, and convection section boilout, cool down the Platforming Unit reactors by continuing recycle nitrogen until the reactors are below 66°C (150°F).

e. Prior to shutting down the Recycle Compressor, block in all flows between the reactor section and the Regeneration Section hydrogen system, including the vent gas flow from the Lock Hopper.

f. Stop the Lift Gas and Fines Removal Blower and depressure the Spent catalyst lift system.

g. Remove and clean the screen inserts from the L-Valve Assemblies.

h. Isolate the Regeneration Section hydrogen system from the reactor section. Depressure the hydrogen system and maintain under a slight positive pressure of nitrogen.

i. Shut down and isolate the Recycle Compressor. Depressure the reactor section and maintain under a slight positive pressure of nitrogen. Isolate the reactors from the rest of the Platforming reactor section with blinds. Purge the Platforming reactors with dry instrument air. Open the manways of the reactors and inspect the reactor internals.

j. Depressure the Regeneration Tower and the Regeneration Section air system. Purge the Regeneration Tower with dry instrument air. Open the manway of the Regeneration Tower, prepare the vessel for safe entry, and inspect the internals.

k. Disconnect and blank off the temporary dryout piping, remove or open the dryout blinds.

E. LOAD CATALYST

Maintain the dry instrument air purges established following the reactor section and the Regeneration Section dryouts.

1. Load Platforming Reactors

Load catalyst into each Platforming reactor in the reactor stack according to the procedures in the General Operating Manual for the UOP CCR Platforming Process Unit.

NOTE: The Spent catalyst L-Valve Assembly will not be filled with catalyst at this time. The manual V-ball and B-valve below the catalyst collector should remain closed throughout the loading. The blind above the upper, V-ball valve must be open before loading. The blind below the lower, B-ball valve can be closed until after catalyst loading is complete.

2. Load Reduction Zone

Load catalyst into the Reduction Zone at the top of the Platforming reactors through the catalyst inlet nozzle in the top head or through the manway of the Reduction Zone.

The quantity of catalyst loaded above the Reduction Zone low-level alarm instrument should at least be sufficient to satisfy the net thermal and mechanical slump of the catalyst in the Platforming reactor stack.

NOTE: Two percent of the catalyst loaded into all of the Platforming reactors is normally provided for net thermal and mechanical slump requirements.

However, for the purpose of checking the response and linearity of the Reduction Zone's level controller, the quantity of catalyst loaded in the Reduction Zone should be up to near the top (around 80-90%) of the level controller.

During loading of the Reduction Zone, gauge the level in the Reduction Zone using a measuring tape as it is being filled and compare it with the level indication of the Zone's level controller. Gauge the level after loading, say, each 2 or 3 drums of catalyst or at each 5 or 10% change in the level indication, in order to check the response and the linearity of the level instrument.

3. Load Disengaging Hopper and Regeneration Tower

Load the Disengaging Hopper and Regeneration Tower through the top nozzle of the Disengaging Hopper.

During the loading of the Disengaging Hopper, the response and linearity of Disengaging Hopper's level recorder will be checked. Close the manual V-port ball valve above the Nitrogen Seal Drum. Load catalyst into the Disengaging Hopper through the top nozzle. The Regeneration Tower will fill first and then the Disengaging Hopper. Perform the calibration of the level instrument as per the manufacturer's procedure. This usually requires gauging the level in the Hopper using a measuring tape on a plumb-bob as it is being filled. For each 5~10% of the range of the level indication, check the response and the linearity of the level instrument. Load catalyst up to the top (100%) of the level recorder.

Some level instruments can be calibrated before the vessel is loaded. In this case, the calibration should be checked during loading of the vessel in a similar manner to that outlined above.

NOTE: The Regenerated Catalyst L-Valve Assembly will not be filled with catalyst at this time. The manual V-ball and B-valve below the Lock Hopper should remain closed throughout the loading of the Disengaging Hopper.

4. Cautions

a. For record purposes, keep complete and accurate records of the number of catalyst drums loaded into each of the Platforming reactors and the Regeneration Section.

b. Be careful to avoid spilling any of the catalyst during loading because platinum reforming catalyst is relatively expensive. If any catalyst does spill, sweep it up and return it with catalyst fines for metals recovery.

c. Do not discard empty catalyst drums. Store them with their lids and clamp rings in a dry location. Normal practice is to use the empty catalyst drums for return of catalyst fines or spent catalyst and for handling catalyst during unloading.

F. LOAD AND CALIBRATE THE LOCK HOPPER'S SURGE ZONE

The Lock Hopper Surge Zone level instrument must be calibrated so that the Lock Hopper load size (i.e., the amount of catalyst transferred during each cycle of the Lock Hopper) can be determined during initial operation. The initial positions of the (point) sources and detectors for the high-level and low-level nuclear level instruments in the Lock Hopper Zone of the Lock Hopper should have been set at their design positions, according to the UOP Project Specifications. The position of the low-level source and detector will be adjusted to give the required Lock Hopper load size during initial operation. Accurate measurement of the Lock Hopper load size is important because it is the basis for determining the catalyst circulation rate during normal operation.

a. Remove the spoolpiece below the two manual ball valves below the Lock Hopper. Install a canvas sock (as required) below the valves leading to a convenient location to collect catalyst. Open the lower ball valve keeping the upper (V-ball) valve closed.

b. Open the observation port nozzle of the Lock Hopper Surge Zone that is located close to the bottom of the standpipe from the Lock Hopper Zone. This port is used for observing the catalyst level and measuring the outage with a plumb-bob.

c. Place an empty, tared drum under the sock attached to the manual ball valve.

d. Open the manual V-port ball valve above the Nitrogen Seal Drum and allow catalyst to flow from the Disengaging Hopper and Regeneration Tower through the Nitrogen Seal Drum and into the Lock Hopper.

NOTE: As the Disengaging Hopper catalyst level decreases, re-check the calibration of the level instrument against the readings taken during the filling.

e. Carefully observe the rate of filling of the Lock Hopper Surge Zone such that the catalyst level can be stopped at the bottom (0%) of the Surge Zone level instrument.

f. Proceed with the calibration of the Surge Zone level instrument, filling the Surge Zone from the Disengaging Hopper controlling the rate with the manual V-port ball valve above the Nitrogen Seal Drum. Use the same method as was employed during the calibration of the Disengaging Hopper level instrument.

g. When the calibration is complete and the catalyst level is at 100% of the level instrument, continue to fill the Surge Zone until the tip of the cone (catalyst bed surface) reaches the bottom of the standpipe from the Lock Hopper Zone. Close the manual V-port ball valve above the Nitrogen Seal Drum.

h. Open the manual V-port ball valve below the Lock Hopper and empty the catalyst from the Surge Zone into catalyst drums. Carefully weigh all catalyst removed from the Surge Zone. As the catalyst level decreases in the Surge Zone, re-check the calibration of the level instrument against the readings taken during the filling.

i. When the Surge Zone is empty, close the manual V-port ball valve below the Lock Hopper. Re-install the piping at the outlet of the manual valves.

j. Carefully record the total mass of catalyst removed from the Surge Zone. Set this catalyst aside for the first catalyst addition to the system. Take a sample of this catalyst for LOI analysis. This information is needed to calculate the dry mass of the catalyst in the Surge Zone.

k. Open the manual V-port ball valve above the Nitrogen Seal Drum and allow catalyst to fill the Nitrogen Seal Drum and the entire Lock Hopper.

NOTE: The level in the Disengaging Hopper should now be at a reasonable working level for initial operation and allow for catalyst “fluff” (decrease in catalyst density when it is flowing versus initial, loaded density) during initial circulation of catalyst. Detailed calculations for the individual unit should be performed to determine whether this is the case or whether more catalyst will be required to make-up inventory into the Disengaging Hopper.

G. CHECK CATALYST LIFTING OPERATIONS (OPTIONAL)

After loading catalyst but prior to closing any of the vessels, check the operation of the Spent and Regenerated Catalyst L-Valve Assemblies. As a result, operable catalyst lift systems will be available during the startup of the CCR Platforming Unit. This is especially important for the Regenerated Catalyst L-Valve Assembly, which **must** be operating during the startup to satisfy reactor thermal and mechanical slump, or else the catalyst level in the Reduction Zone could become unacceptably low.

In each L-Valve the rate of catalyst lifting is set by the dimensions in the L-Valve and the flow rate of secondary lift gas to the L-Valve.

The following discussion outlines a satisfactory procedure for checking the catalyst lifting rates:

1. Spent Catalyst L-Valve Assembly

Establish lift gas flow to the Disengaging Hopper via the Spent Catalyst L-Valve Assembly.

a. Commission the Lift Gas Blower and the Fines Removal Blower.

b. Open the manual ball valves below the Reactor.

c. Open the control valve for the primary lift gas to the L-Valve Assembly to provide an actual flowing velocity of 7.6 to 9.1 meters per second (25 to 30 feet per second) in the spent catalyst lift line to the Disengaging Hopper. Keep the control valve for the secondary lift gas to the L-Valve assembly closed. There should be no catalyst flow with the secondary lift gas closed.

   NOTE: Since the manway of the Disengaging Hopper is open, the pressure in the spent catalyst lift line is only slightly above atmosphere.

d. Open the Spent Catalyst Isolation Valves.

e. Slowly increase the secondary gas flow to confirm the L-Valve's ability to lift catalyst.

2. Regenerated Catalyst L-Valve Assembly

Establish nitrogen lift gas flow to the Reduction Zone via the Regenerated Catalyst L-Valve Assembly.

a. Install a nitrogen hose at a convenient point on the lift gas line upstream of the flow meter for the total lift gas to the L-Valve.

b. Open the valve in the nitrogen line. Nitrogen will pressure up the line to the control valves for the primary and secondary lift gas.

c. Open the manual ball valve below the Lock Hopper.

d. Open the manual V-ball completely.

e. Open the control valve for the primary lift gas to L-Valve Assembly to provide an actual flowing velocity of 9.1 to 10.6 meters per second (30 to 35 feet per second) in the regenerated catalyst lift line to the Reduction Zone. The rate of nitrogen lift gas required to establish this velocity usually can be measured by the flow meter for the total lift gas to the L-Valve Assembly without changing the meter span or the orifice bore size. Keep the control valve for the secondary lift gas to the L-Valve assembly closed. There should be no catalyst flow in the lift line with the secondary lift gas closed.

   NOTE: Since the manway of the Reduction Zone is open, the pressure in the regenerated catalyst lift line is only slightly above atmosphere.

f. Slowly increase the secondary gas flow to confirm the L-Valve's ability to lift catalyst.

NOTE: The following sections (in the remainder of this chapter) are written with the assumption that all of the Regeneration Section’s CCR Preliminary Operations (detailed in the previous sections of this chapter) have been completed. For the initial startup of the Regeneration Section, it is essential that each step of this Final Startup Preparation (as detailed in the following sections) be completed prior to starting coke burning operations. For subsequent startups of the Regeneration Section, however, some variation in the Final Startup Preparation is possible, depending on how completely the Regeneration Section was shutdown. In fact, for most subsequent startups, the startup sequence can begin with the Black Catalyst Startup Procedure or the White Catalyst Startup Procedure, whichever applies.

IMPORTANT: Before beginning the Final Startup Preparation, ensure that all shutdown bypass switches in the CRCS are in the NORMAL position.

H. AIR-FREE THE REGENERATION SECTION

The Regeneration Section must be purged with nitrogen to remove any oxygen prior to admitting combustible gases into any part of the system. To accomplish this, the Regeneration Section is divided into five sections:

- Nitrogen Header
- Equipment that is included with the Platforming reactor circuit
- Nitrogen Lift System
- Regeneration Section Air System
- Hydrogen System

Nitrogen should be purged through all vents, drains, and instrument taps to ensure that no air pockets are missed. Care should be taken not to back-purge into a system that has previously been purged. In the case of unavoidable dead ends in piping systems, an effective nitrogen purge can only be achieved by repeated pressuring and venting to atmosphere.

1. Nitrogen Header

Purge all piping from the independent nitrogen source through the nitrogen header to the various nitrogen users in the Regeneration Section. Commission the nitrogen header.

2. Equipment Included with the Platforming Reactor Circuit

The following equipment and its associated piping is evacuated and purged simultaneously with the Platforming Unit reactor circuit:

- ♦ Reactor Purge Exchanger
- ♦ Reactor Catalyst Collector purge line
- ♦ Reduction Zone
- ♦ Reduction Gas Exchanger (shell side) and outlet line to Platforming Unit

NOTE: One side of the Reduction Gas Exchanger can not be evacuated at the same time as the other side is under pressure. Either perform the evacuation of both sides of the exchanger simultaneously or make sure that the tube side is at atmospheric pressure while the shell side is being evacuated (and vice versa).

3. Regeneration Section Air System and Nitrogen Lift System

This system includes the Regeneration Tower, Nitrogen Seal Drum, and associated piping. It also includes the Spent Catalyst L-Valve Assembly, Spent Catalyst Lift Pipe, Disengaging Hopper, Dust Collector, Lift Gas Blower, Lift Gas Blower Cooler (if applicable), Fines Removal Blower, Catalyst Addition Lock Hopper No. 1, and the associated piping.

Prepare this system as follows:

a. Ensure that the Spent Catalyst and Regenerated Catalyst Isolation Systems are closed.

NOTE: The nitrogen purge line between the two V-ball valves of each isolation system should be open and the manual valves in these nitrogen supply lines should be locked open.

b. Purge the system using nitrogen through the Air Heater into the Cooling Zone and through the Regeneration Tower. Vent from the Burn Zone vent to atmosphere so as not to over-pressure the Regeneration Tower.

c. Purge the system using nitrogen from the Nitrogen Seal Drum normal addition point. Vent into the Regeneration Tower.

d. Purge the Burn Zone circuit and the Reheat Zone circuit using the Regeneration Blower.

e. Purge the system using nitrogen introduced at the normal addition point at the Fines Removal Blower discharge and the other addition point at the Lift Gas Blower discharge. The bleed valves provided at the Lift Gas Blower suction isolation valves can be used to vent the air.

f. Purge the Fines Removal circuit and the Lift Gas circuit using the Fines Removal and Lift Gas Blowers.

g. Maintain the purge flows. Keep the Regeneration Section Air System under a slight positive pressure of nitrogen for the startup.

4. Regeneration Section Hydrogen System

This system includes the Lock Hopper, Reduction Gas Heaters, Reduction Gas Exchanger (tube side), Regenerated Catalyst L-Valve Assembly, Regenerated Catalyst Lift Pipe, Booster Gas Coalescer, and Booster Gas Heater. Air-free this system as follows:

a. Isolate the Hydrogen System from:

(1) Regeneration Section Air System – Install a blind below the lower valve of the Regenerated Catalyst Isolation System.

Allow sufficient time after closing the isolation system for the catalyst in the line to have settled into the Lock Hopper so that the line can be opened without spilling catalyst.

(2) Reactor Section:

- At the booster gas coalescer drain
- Downstream of the Reduction Gas Heaters
- At the Lock Hopper offgas line
- At the ball valve at the top of the Regenerated Catalyst lift pipe.

(3) Net Gas Section – Immediately upstream of the booster gas coalescer.

(4) Fuel Gas Section – At the Lock Hopper offgas line (if applicable).

b. Evacuate the Regeneration Section Hydrogen System and pressure with nitrogen:

(1) Open valves within the Hydrogen System so that the pressure throughout the system is equalized.

(2) Isolate pressure instruments during evacuation.

(3) Connect the ejector manifold to the outlet of the Booster Gas Heater.

(4) Commission the ejector and evacuate the Hydrogen System to at least 600 mm Hg (24 in Hg) vacuum. Hold for one hour to determine system tightness. Break the vacuum and pressure up the system to at least 0.35 kg/cm^{2}g (5 psig) with nitrogen. Hold the pressure for one hour to determine system tightness.

(5) Evacuate the Hydrogen System again to at least 600 mm Hg (24 in Hg) vacuum. Break the vacuum and pressure up the system again to 0.35 kg/cm^2g (5 psig) with nitrogen. Repeat until oxygen measurements are less than 0.1 vol-%.

(6) Maintain a nitrogen purge through all lines being opened while removing all blinds that were installed for this operation to prevent oxygen ingress. Take all necessary respiratory safety precautions.

(7) Keep the system under a slight positive pressure of nitrogen for the startup.

I. REGENERATION SECTION FINAL COMMISSIONING

1. Start-Up Platforming Unit

Start up the Platforming Unit in accordance with UOP startup procedures.

a. Commission the fuel gas system.

b. (If applicable.) Control the fuel gas drum at its normal operating pressure.

c. Start up the reactor section, net gas compression section, and the fractionation section of the Platforming Unit in accordance with UOP startup procedures. Line out at normal operating conditions, especially the normal reactor pressures.

2. Establish Catalyst Collector and Reduction Zone Purge Flows

It is imperative that the recycle gas purge flow to the Catalyst Collector and Reduction Zone be started when the Platforming Recycle Compressor is first placed on stream.

a. Raise the flow of the Catalyst Collector purge to the design rate as soon as possible.

b. Raise the temperature of the Catalyst Collector purge along with the reactor inlet temperature to its normal operating temperature which is normally 150~200°C (300~390°F).

c. Establish recycle gas purge flow to the Reduction Zone through the standby gas line to maintain the pressure in that zone above that of the reactor.

NOTE: The Reduction gas outlet line should be closed at this time.

3. Pressure Hydrogen Section

Pressure up the Regeneration Section Hydrogen System with recycle gas from the Platforming reactor section.

a. Pressure up the system to 0.35 kg/cm^{2}g (5 psig) with nitrogen.

b. Isolate all pressure and differential pressure instruments from the process.

c. Evacuate the hydrogen system again to at least 600 mm Hg (24 in Hg) vacuum. Break the vacuum and pressure up the section to 0.35 kg/cm^{2}g (5 psig) with booster gas.

d. Open up all instrument taps that were closed. Purge the taps and commission the instruments.

e. Pressure up the system with booster gas to about 2.5 kg/cm^2g (35 psig). Hold the pressure for one hour to determine system tightness.

4. Lock Hopper Vent Gas

(If applicable.) Commission the vent gas line from the Lock Hopper to the fuel gas drum.

a. Adjust the pressure of the Fuel Gas Drum to be about 2.5 kg/cm^2g (35 psig).

b. Slowly open the valves between the Lock Hopper and the Fuel Gas Drum so as not to upset the Fuel Gas Drum pressure.

(If applicable.) Commission the vent gas line from the Lock Hopper to the Product Condenser.

a. Open the valves between the Lock Hopper and the Product Condenser.

b. Note the differential pressure between the Lock Hopper and the Regeneration Tower, as measured by the differential pressure indicator.

5. Booster Gas Section

Commission the booster gas line from the net gas compression section.

a. Close the following valves:
   - Booster gas valve in the line to the Reduction Zone.
   - Control valves for the total and secondary lift gas to the Spent Catalyst L-Valve Assembly.
   - Make-up gas valves to the Lock Hopper Surge Zone.

b. Open the valves upstream of the Booster Gas Coalescer. Booster gas will pressure up the Booster Gas Coalescer and heater to the booster gas supply pressure.

c. Open the Booster Gas Coalescer drain.

d. Commission the Booster Gas Heater.

6. Establish Hydrogen Flows

Start flow of reduction gas, lift gas to the Regenerated Catalyst L-Valve Assembly, and makeup gas to the Lock Hopper Surge Zone.

a. Reset the solenoid in instrument air line of the shut-off valve in the Reduction Gas Outlet line. The Reduction Zone/Reactor pressure differential control valve should be in auto control. With the design setpoint, the valve will most likely be closed since only the standby gas is flowing to the Reduction Zone.

b. Slowly start booster gas flow to the Reduction Zones, then increase to their design flows. With the introduction of booster gas, the Reduction Zone/Reactor No. 1 pressure differential will come into its control range. Off gas will now leave the Reduction Zone and flow to the net gas section. When the pressure differential is established, the standby recycle gas purge gas valve can be closed.

c. When the Booster gas has pressured up the L-Valve Assembly to just above the inlet pressure of the first reactor, open the ball valve in the regenerated catalyst lift line at the top of the Platforming reactors.

d. Establish total lift gas to the L-Valve assembly and increase it to the design rate.

e. Open the manual valves below the Lock Hopper; B-valve first, then V-ball valve.

f. Make sure that the Lock Hopper is in the STOP step.

g. Start makeup gas to the Surge Zone of the Lock Hopper. Open the Surge Zone/L-Valve differential pressure control valve in manual. Booster gas will pressure up the Surge Zone. Unblock the logic-ramped Makeup Valve, which is in Mode No. 1 because the Lock Hopper is stopped. Booster gas will continue to pressure up the Surge Zone to about the pressure of Platforming Reactor No. 1. When the differential pressure controller comes into range, control in automatic the pressure of the Surge Zone of the Lock Hopper at the design differential pressure (which is normally near zero differential).

7. Pressure Up the Regeneration Tower with Nitrogen

a. Close the Burn Zone vent control valve. The lower nitrogen purge to the cooling zone will pressure up the Regenerator. Slowly increase the pressure of the Regeneration Tower to about 2.5 kg/cm^2g (35 psig) then stop the nitrogen flow to the Cooling Zone. Hold the pressure for one hour to determine system tightness by checking for leaks at all flanges. The system will not hold pressure because of leakage through the seals of the Regeneration Blower.

b. Restart the lower N_2 purge and control the differential pressure between the Lock Hopper and the Regeneration Tower at 0 mm H_2O (0 in. H_2O).

8. Nitrogen Lift System

Pressure the Nitrogen Lift System and establish the Spent Catalyst nitrogen "bubble" below the Reactor.

a. Depress the Regenerator Run/Stop Pushbutton to RUN.

b. Open the nitrogen valve to the Nitrogen Lift System. Increase the lift system pressure to 0.15 kg/cm^2 (2 psi) higher than the Catalyst Collector purge line according to the differential pressure indicator.

c. Commission the Lift Gas Blower and Fines Removal Blower. Establish design flows to the Disengaging Hopper and total lift gas to the Spent Catalyst L-Valve Assembly.

d. Open the manual valves below the Catalyst Collector.

e. Depress the Spent Catalyst Isolation Pushbutton to OPEN.

f. Adjust the differential pressure controller to control the Nitrogen Lift System pressure 0.15 kg/cm^2 (2 psi) higher than the Catalyst Collector purge line.

9. Regen Bubble

Establish the nitrogen "bubble" between the Regeneration Tower and the Lock Hopper.

a. Open the nitrogen valve to the Nitrogen Seal Drum. Increase the Seal Drum pressure to 250 mm H_2O (10 in. H_2O) higher than both the Regeneration Tower and the Lock Hopper.

b. Depress the Regenerated Catalyst Isolation Pushbutton to OPEN.

c. Adjust the two differential pressure controllers – one between the Regeneration Tower Cooling Zone and the Nitrogen Seal Drum and the other between the Nitrogen Seal Drum and the Lock Hopper – to control the Nitrogen Seal Drum pressure 250 mm H_2O (10 in. H_2O) higher than both the Cooling Zone and the Lock Hopper.

J. INITIAL CATALYST CIRCULATION

1. Commission the Lock Hopper and Establish Control of Catalyst Levels

a. Cascade the secondary lift gas for the Spent Catalyst L-Valve Assembly to the Spent Catalyst Lift Line Pressure Differential Controller, which in turn is reset by the level controller for the Reduction Zone.

b. Cascade the secondary lift gas for the Regenerated Catalyst L-Valve Assembly to the Regenerated Catalyst Lift Line Pressure Differential Controller.

c. Turn the shutdown bypass switches for the Burn Zone Gas flow, Drying Zone Air flow, and Oxygen Analyzer Sample flow to the BYPASS position. When the last switch is turned, catalyst circulation for both L-Valve Assemblies will be enabled.

Allow the differential pressure controller between the Surge Zone of the Lock Hopper and Regenerated Catalyst L-Valve Assembly to reestablish the pressure in the Surge Zone at the design differential higher than the pressure of L-Valve Assembly.

d. Adjust the level for the Reduction Zone to normal.

2. Establish Catalyst Circulation

Establish catalyst circulation as follows:

a. Set the Catalyst Flow Setpoint at 50% of the design catalyst circulation rate.

b. Depress the Catalyst Flow Pushbutton to start transfer of catalyst from the Lock Hopper to the Reduction Zone. This action will initiate the ramping of secondary gas to the Regenerated Catalyst L-Valve Assembly.

c. Increase the catalyst circulation rate stepwise to the desired rate but no higher than the design catalyst circulation rate.

d. Monitor the catalyst level in the Disengaging Hopper.

3. Establish a Carbon Level in the Regeneration Tower

The reactor section of the Platforming Unit is in operation, and so the coke content of the catalyst in the reactors will increase.

a. Continue catalyst circulation at the desired catalyst circulation rate, but no higher than the design catalyst circulation rate.

b. Blow-back and empty the dust collector at least once per shift during initial catalyst circulation to remove catalyst fines. Refer to Chapter VIII “Normal Operations” for the procedure.

c. Analyze daily the spent catalyst for carbon. Take a sample at the sample point between the Disengaging Hopper and the Regeneration Tower.

d. Stop catalyst circulation when the carbon content of the spent catalyst is about 3.0 wt-%. Proceed with the Black Catalyst Startup Procedure.

4. Lock Hopper Calibration

During initial circulation of catalyst, perform the on-line calibration of the Lock Hopper as detailed in Chapter XIII, “Special Procedures”.

K. INITIAL CCR PLATFORMING UNIT OPERATION

The initial period of Platforming unit operation is referred to as “Drydown”. During this period, water is released from the freshly-loaded catalyst until it reaches the required equilibrium level (See the CCR Platforming General Operating Manual). To aid in this drying of the catalyst, the CCR Reduction Zone heaters can be used.

a. Insure that the upper and lower Reduction Gas flows are set at their design rates.

b. Increase the output of both Reduction Zone Heaters to increase the gas outlet temperatures at a rate of 100°F/hr (55°C/hr).

c. When the temperatures of both the upper and lower Reduction Gas streams reaches 700°F (370°C), put both controllers in automatic at that value.

d. Continue this operation until the Platforming Unit Drydown is complete and the CCR is ready for Black Catalyst Start-Up.

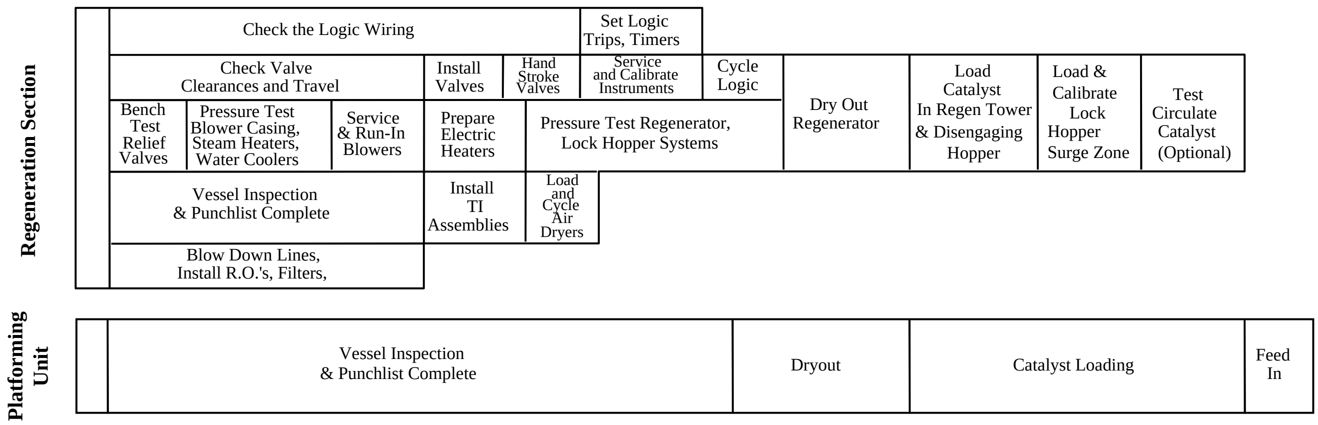
CAUTION NOTES FOR THE CYCLEMAX CCR UNIT

CAUTION:
All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

CAUTION:
Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

CAUTION:
All upstream piping and equipment must be purged with inert gas before isolating the relief gas header from the line to the knockout drum and flare.

Figure VI-3
Sequence for Preliminary Regeneration Section Preparation



Note: Hydrostatic Pressure Testing by Contractor and Commissioning of Utilities Should Be Complete Prior to the Above Timing.

VII. NORMAL STARTUP

There are two procedures used to start up the Regeneration section. The Black Catalyst Startup Procedure MUST be used for the initial startup of the Regeneration Section. For subsequent startups, the Black Catalyst Startup Procedure must also be used if there is ANY possibility that coked catalyst is present in the Regeneration Tower below the Burn Zone. Otherwise, the White Catalyst Startup Procedure may be used.

A. BLACK CATALYST STARTUP PROCEDURE

1. Establish the following flows and conditions:

    a. Nitrogen purge to the Regeneration Tower Cooling Zone: Minimum flow required to cool the circulating catalyst to 150ºC (300ºF).

    b. Nitrogen purge to the Regeneration Tower Drying Zone: design flow of nitrogen for startup. (NOTE: This rate is lower than the design flow rate of drying air for normal operations.) This flow corresponds to the design rate of Chlorination Zone flow for normal operations.

    c. Excess air vent: no flow. Close excess air vent hand-control valve in manual.

    d. Chlorination Zone flow: equal to Nitrogen purge to the Regeneration Tower Drying Zone and Cooling Zone.

    e. Spent Catalyst nitrogen “Bubble”: design differential pressures.

    f. Regenerated Catalyst nitrogen “Bubble”: design differential pressures.

    g. Spent Catalyst Isolation System: open.

    h. Regenerated Catalyst Isolation System: open.

i. Nitrogen purge to Regeneration Blower seal: design differential pressure.

j. Nitrogen purges to Regeneration Gas and Reheat Gas flowmeters: design flow rates.

k. Cooling water flow to the Regeneration Blower water pad (if applicable).

l. Normal Disengaging Hopper catalyst level.

m. Total lift gas to Spent Catalyst L-Valve Assembly: design flow.

n. Total lift gas to Regenerated Catalyst L-Valve Assembly: design flow.

o. Regeneration Tower Pressure: design pressure.

p. Reduction Gas Heater booster gas: design flows.

q. Purge Gas to Catalyst Collector: design flow.

r. Air Drier activated in accordance with the manufacturer’s procedures.

2. Start the Regeneration Blower and the Regeneration Cooler Blower. If Regeneration Blower has a two speed electric driver, start on Low speed.

3. Calibrate and set up the analyzers for normal operation:

   Nitrogen header hydrogen/hydrocarbon analyzer
   Burn Zone gas oxygen analyzer

   NOTE: The oxygen concentration in the Regeneration Tower should be nil before commissioning the electric heaters. The analyzer must be at the design pressure when calibrating or the analyzer will not read correctly at normal operating conditions.

4. Stop catalyst circulation by setting the catalyst flow pushbutton to stop. Except for initial start-up and perhaps during periods of low-coke operation, there would be catalyst circulation at this point. Catalyst should not be circulated while the Regeneration Tower and Reduction Zone are being heated up.

5. Ensure that all shutdown bypass switches are in the NORMAL position.

6. Start the electric heaters and heat up the Regeneration Tower and the Reduction Zone:

   a. Set the temperature controller for each zone inlet – Burn Zone inlet, Drying Zone inlet, Reduction Zone inlets, and Reheat Zone inlet (if applicable) – in manual at zero output to its heater.

      <u>NOTE</u>: The inlet temperature controller for Burn Zone is split-ranged to the Regeneration Heater (50-100%) and the Regeneration Cooler (50-0%). Set its output at 50% for zero output to the Regeneration Heater.

   b. Depress the electric heater pushbuttons to start the heaters.

   c. Raise the zone inlet temperatures at 55°C per hour (100°F per hour) to design temperatures:

	Burn Zone inlet	477°C	(890°F)
	Drying Zone inlet	565°C	(1050°F)
	Upper Reduction Zone inlet	377°C	(710°F)
	Lower Reduction Zone inlet	482°C	(900°F)
(if applicable)	Reheat Zone inlet	510ºC	(950ºF)

<u>NOTE</u>: If the Regeneration Gas Blower has a two speed electric driver, the speed should be switched from high to low speed at the suction temperature recommended by the blower/motor vendor.

7. (If applicable.) Readjust, if necessary, the pressures of the Fuel Gas Drums to keep the Regeneration Tower pressure at design. The Regeneration Tower pressure floats on the Lock Hopper pressure, which in turn floats on the Fuel Gas Drum pressure.

8. Determine the maximum permissible catalyst circulation rate from the General Operating Curve (Figure VII-1). Use the coke content determined from the actual laboratory carbon analysis and an oxygen concentration within the recommended range of Burn Zone inlet oxygen concentrations (0.5-1.0 mole percent). Refer to the CCR Process Variables Section.

9. Start upper combustion air and begin an in-situ burn of the coked catalyst in the Burn Zone. (Refer to Figure VII-2.)

    a. Confirm that the Tie Line Valve (XV-14 on Figure VII-2) is CLOSED.

    b. Confirm that the control valve for the upper combustion air is closed. Open the manual valve in this line at the injection point.

    c. Record the Burn Zone temperature profile.

    d. Open the Air Valve (XV-13) by depressing the Air On Pushbutton. Inject upper combustion air through the startup line into the Burn Zone loop as required to establish the oxygen concentration that was selected in Step 7 above.

    e. Stabilize the oxygen concentration and the upper combustion air flow. Then, cascade the upper combustion air flow controller to the oxygen analyzer controller.

    f. Maintain the desired oxygen concentration while the in-situ burn continues. The amount of coke in the Burn Zone will gradually decrease. Eventually, some of the oxygen entering the catalyst bed will begin breaking through the bed and will be recycled to the Regeneration Blower and back to the Burn Zone inlet. This will significantly decrease the upper combustion air required to maintain the desired inlet oxygen concentration.

10. Start catalyst circulation when the upper combustion air rate decreases to about one-half of its original rate (in Step 9e):

    a. Set the Catalyst Flow Setpoint at or below the maximum permissible catalyst circulation rate from the General Operating Curve (Figure VII-1).

    b. Depress the Catalyst Flow On Pushbutton to start catalyst circulation.

11. Maintain the coke burn at the following conditions:

Burn Zone inlet	477°C	(890°F)
Burn Zone outlet (max)	565°C	(1050°F)
Burn Zone delta T (max)	88°C	(160°F)
Burn Zone bed (max)	593°C	(1100°F)
Burn Zone inlet oxygen	Per Gen. Op. Curve: (0.5 mole-% min,1.0 mole-% max)	
(if applicable) Reheat Zone inlet	510ºC	(950ºF)
Drying Zone inlet	565°C	(1050°F)
Drying Zone inlet	2.5 kg/cm^2	(35 psig)
Nitrogen to Drying Zone	Design for startup	
Nitrogen to Cooling Zone	To maintain 150°C (300°F) in Nitrogen Seal Drum	
Upper Reduction Zone inlet	377°C	(710°F)
Lower Reduction Zone inlet	482°C	(900°F)
Catalyst circulation rate	Per Gen. Op. Curve: (not greater than design)	
Reduction Gas Exchanger Shell Side Outlet	65°C	(150°F)
Booster Gas to Lock Hopper	150°C	(300°F)

12. Sample the regenerated catalyst:

    After one turnover of the catalyst in the Regeneration Tower has been completed, begin sampling the regenerated catalyst every two hours below the Nitrogen Seal Drum for carbon analysis. Consecutive samples should show the catalyst to meet all of the following criteria:

    (1) The coke content should be 0.1 wt-% or less.

    (2) The catalyst pills should have coke-free centers. (Break open several pills.)

    (3) There should be essentially no whole black spheres.

    When two consecutive samples of regenerated catalyst meet the above three criteria, establish dual air injection.

13. Start air injection to the Drying Zone and Cooling Zone and establish dual air injection as follows:

    a. During this step, monitor the Regeneration Blower suction temperature, the Burn Zone, Reheat Zone and Chlorination Zone bed temperatures, and the Cooling Zone outlet temperature while establishing dual air operation. If any significant temperature increase occurs, start nitrogen flow and stop air flow to the Air Heater IMMEDIATELY.

    b. Ensure that the nitrogen flow to the Drying Zone is at the design rate for startup. Ensure that the excess air vent control valve is closed in manual.

    c. Confirm that the current flow of upper combustion air is sufficient to permit continued cascade control of the upper air when lower air flow to the Drying Zone is started. Confirm that the current flow of upper combustion air is also sufficient to maintain the apparent flow of chlorination gas at the current rate when lower air to the Drying Zone is started.

NOTE: After the lower air flow to the Drying Zone is started, the upper air flow to the Burn Zone will have to be reduced to compensate for the effect of the lower air on the Regeneration Tower's oxygen balance. The upper air flow rate will have to be reduced by an amount that is roughly equal to the lower air flow rate. Therefore, the upper air flow rate must be sufficient so that, after it is reduced, the remaining upper air flow still permits control of the Burn Zone oxygen content by the upper air control valve.

Example VII-1

If the current Regeneration Section operation is:

Upper Air Flow Rate	400 Nm^3/Hr (15,000 SCFH)
Lower Nitrogen Flow Rate	267 Nm^3/Hr (10,000 SCFH)

then, after lower air is started, the operating conditions will roughly be:

Upper Air Flow Rate	133 Nm^3/Hr (5,000 SCFH)
Lower Air Flow Rate	267 Nm^3/Hr (10,000 SCFH)

So, prior to starting lower air, ensure that 133 Nm^3/Hr (5,000 SCFH) is sufficient for the upper air control valve to control the Burn Zone oxygen content. Generally, the upper air flow is sufficient for control if it is >20% of the lower air flow.

d. Place the upper combustion air in local-automatic control.

e. Depress the Tie Line Pushbutton to open the Tie Line Valve (XV-14).

f. As soon as the Tie Line Valve is opened, depress the Nitrogen Pushbutton to close the Nitrogen Valve (XV-15).

g. Twenty to thirty seconds after the Nitrogen Valve is closed, reduce the upper air flow to compensate for the effect of the lower air on the Regenerator's oxygen balance. In the example above, the upper air flow would be reduced from 400 Nm^3/hr to about 133 Nm^3/hr, while carefully watching the oxygen analyzer.

h. Stabilize the oxygen concentration and the upper combustion air flow. Then cascade the upper combustion air flow controller back to the oxygen analyzer controller.

14. Establish excess drying air flow and stop upper combustion air flow:

a. As soon as the oxygen concentration has stabilized, increase the lower air injection in local-automatic to the design air rate for regeneration. At the same time, increase the flow of air through the excess air vent a corresponding amount by opening the hand-control valve in local-manual. Maintain the apparent chlorination gas flow at the current rate.

b. Confirm that the current excess air vent flow is sufficient to permit control of the burn zone oxygen concentration when upper combustion air is stopped.

NOTE: Before the upper air flow to the Burn Zone is stopped, the excess air vent from the Drying Zone will have to be reduced to compensate for the effect of the upper air on the Regeneration Tower's oxygen balance. The excess air vent rate will have to be reduced by an amount that is roughly equal to the upper air flow rate. Therefore, the excess air vent rate must be sufficient so that, after it is reduced, the remaining excess air vent rate will permit control by the excess air control valve of the Burn Zone oxygen content.

Example VII-2

If the current Regeneration Section operation is:

Upper Air Flow Rate	133 Nm^3/Hr (5,000 SCFH)
Excess Air Vent Rate	267 Nm^3/Hr (10,000 SCFH)
Lower Air Flow Rate	534 Nm^3/Hr (20,000 SCFH)

then, after upper air is stopped, the operating conditions will roughly be:

Upper Air Flow Rate	0 Nm^3/Hr (0 SCFH)
Excess Air Vent Rate	133 Nm^3/Hr (5,000 SCFH)
Lower Air Flow Rate	534 Nm^3/Hr (20,000 SCFH)

So, prior to stopping upper air, ensure that 133 Nm^3/Hr (5,000 SCFH) is sufficient for the excess air control valve to control the Burn Zone oxygen content.

c. Place the upper combustion air in local-automatic control.

d. Reduce the excess air vent flow by the amount of upper combustion air flow.

e. Ten to twenty seconds after the excess air vent flow has been reduced, close the upper combustion air control valve to anticipate and compensate for the effect of the lower air on the Tower's oxygen balance.

f. Stabilize the oxygen concentration and the excess air vent flow. Switch the oxygen analyzer-controller to control the excess air vent control valve.

g. Block in the upper combustion air line at the Burn Zone.

15. Establish the desired injection rate of organic chloride to the Chlorination Zone by setting the Chloride pushbutton to “ON” and adjusting the pump stroke of the injection pump.

16. Sample the regenerated catalyst:

    a. After the catalyst inventory in the Chlorination Zone, Drying Zone, and Cooling Zone of the Regeneration Tower has been turned over at lined-out conditions, sample the regenerated catalyst below the Nitrogen Seal Drum for chloride content.

    b. Adjust the chloride injection rate to provide the target chloride level on the regenerated catalyst.

17. Continue to monitor the coke burn. The operating conditions are as follows:

Burn Zone inlet	477°C	(890°F)
Burn Zone outlet (max)	566°C	(1050°F)
Burn Zone delta T (max)	89°C	(160°F)
Burn Zone bed (max)	593°C	(1100°F)
Burn Zone inlet oxygen	Per Gen. Op. Curve: (0.5 mole-% min, 1.0 mole-% max)	
(if applicable) Reheat Zone inlet	510ºC	(950ºF)
Drying Zone inlet	565°C	(1050°F)
Drying Zone inlet	2.5 kg/cm^2	(35 psig)
Air to Drying Zone	Design for regeneration	
Air to Cooling Zone	To maintain 150°C (300°F) in Nitrogen Seal Drum	
Upper Reduction Zone Inlet	377°C	(710°F)
Lower Reduction Zone inlet	482°C	(900°F)
Catalyst circulation rate	Per Gen. Op. Curve: (Design CCR maximum)	
Reduction Gas Exchanger Shell Side Outlet	65°C	(150°F)
Booster Gas to Lock Hopper	150°C	(300°F)

18. Maintain normal Regeneration Section operations.

19. Stop injection of water into the feed (if it was being injected) to the CCR Platforming Unit after one turnover of the catalyst in the Regeneration Tower, Lock Hopper, and Reduction Zone has been completed following Step 8. This would be approximately 14 hours at 100% of design catalyst circulation rate.

20. Stop injection of chloride compound into the feed to the CCR Platforming Unit after one turnover of the catalyst in the Regeneration Tower, Lock Hopper, and Reduction Zone has been completed following Step 14. This would be approximately 14 hours at 100% of design catalyst circulation rate.

B. WHITE CATALYST STARTUP PROCEDURE

The White Catalyst Startup Procedure may be used for subsequent startups of the Regeneration Section, but only under certain conditions. Namely, IF i) the Regenerator had previously been operating in white burn mode, ii) the Regeneration Section was shut down in accordance with the Hot Shutdown or Cold Shutdown procedure AND iii) no catalyst was transferred from the Regeneration Tower during or after these shutdowns, then coked catalyst in the Regeneration Tower will be present only in the Burn Zone and so the White Catalyst Startup Procedure may be used.

1. Establish the following flows and conditions:

   a. Nitrogen purge to the Regeneration Tower Cooling Zone: Minimum flow required to cool the catalyst leaving the Cooling Zone to 150ºC (300ºF).

   b. Nitrogen purge to the Regeneration Tower Drying Zone: design flow of nitrogen for startup. (NOTE: This rate is lower than the design flow rate of drying air for normal operations.) This flow corresponds to the design rate of Chlorination Zone flow for normal operations.

c. Excess air vent: no flow. Close excess air vent hand-control valve in manual.

d. Chlorination Zone flow: equal to Nitrogen purge to the Regeneration Tower Drying Zone and Cooling Zone.

e. Spent Catalyst nitrogen “Bubble”: design differential pressures.

f. Regenerated Catalyst nitrogen “Bubble”: design differential pressures.

g. Spent Catalyst Isolation System: open.

h. Regenerated Catalyst Isolation System: open.

i. Nitrogen purge to Regeneration Blower seal: design differential pressure.

j. Nitrogen purges to Regeneration Gas and Reheat Gas flowmeters: design flow rates.

k. Cooling water flow to the Regeneration Blower water pad (if applicable).

l. Normal Disengaging Hopper catalyst level.

m. Total lift gas to Spent Catalyst L-Valve Assembly: design flow.

n. Total lift gas to Regenerated Catalyst L-Valve Assembly: design flow.

o. Regeneration Tower Pressure: design pressure.

p. Reduction Gas Heater booster gas: design flows.

q. Purge Gas to Catalyst Collector: design flow.

r. Air Drier activated in accordance with the manufacturer’s procedures.

2. Start the Regeneration Blower and the Regeneration Cooler Blower. If Regeneration Blower has a two speed electric driver, start on Low speed.

3. Calibrate and set up the analyzers for normal operation:

   Nitrogen header hydrogen/hydrocarbon analyzer
   Burn Zone gas oxygen analyzer

   NOTE: The oxygen concentration in the Regeneration Tower should be nil before commissioning the electric heaters. The analyzer must be at the design pressure when calibrating or the analyzer will not read correctly at normal operating conditions.

4. Ensure that all shutdown bypass switches are in the NORMAL position.

5. Start the electric heaters and heat up the Regeneration Tower and the Reduction Zone:

   a. Set the temperature controller for each zone inlet – Burn Zone inlet, Drying Zone inlet, and Reduction Zone inlets, and Reheat Zone inlet – in manual at zero output to its heater.

      NOTE: The inlet temperature controller for the Burn Zone is split-ranged to the Regeneration Heater (50-100%) and the Regeneration Cooler (50-0%). Set its output at 50% for zero output to the Regeneration Heater.

   b. Depress the electric heater pushbuttons to start the heaters.

c. Raise the zone inlet temperatures at 55°C per hour (100°F per hour) to design temperatures:

	Burn Zone inlet	477°C	(890°F)
	Drying Zone inlet	565°C	(1050°F)
	Upper Reduction Zone inlet	377°C	(710°F)
	Lower Reduction Zone inlet	482°C	(900°F)
(if applicable)	Reheat Zone inlet	510ºC	(950ºF)

NOTE: If the Regeneration Gas Blower has a two speed electric driver, the speed should be switched from high to low speed at the suction temperature recommended by the blower/motor vendor.

6. (If applicable.) Readjust, if necessary, the pressures of the Fuel Gas Drums to keep the Regeneration Tower pressure at design. The Regeneration Tower pressure floats on the Lock Hopper pressure, which in turn floats on the Fuel Gas Drum pressure.

7. Determine the maximum permissible catalyst circulation rate from the General Operating Curve, Figure VII-1. Use the coke content determined from the actual laboratory carbon analysis and an oxygen concentration within the recommended range of Burn Zone inlet oxygen concentrations (0.5-1.0 mole percent). Refer to the CCR Process Variables Section.

8. Start upper combustion air. (Refer to Figure VII-2):

   a. Confirm that the Tie Line Valve (XV-14) is CLOSED.

   b. Confirm that the control valve for the upper combustion air is closed. Open the manual valve in this line at the injection point.

   c. Record the Burn Zone bed temperature profile.

d. Open the Air Valve (XV-13) by depressing the Air On Pushbutton. Inject upper combustion air through the startup line into the Burn Zone loop as required to establish the oxygen concentration that was selected in Step 7, above.

e. Stabilize the oxygen concentration and the upper combustion air flow. Then, cascade the upper combustion air flow controller combustion to the oxygen analyzer-controller.

f. Record the Burn Zone bed temperature profile and verify that no burning is evident in the bottom of the Burn Zone or in the Reheat Zone. If burning is observed in these locations, use the Black Catalyst Startup procedure.

9. Start catalyst circulation:

   a. Set the Catalyst Flow Setpoint at or below the maximum permissible catalyst circulation rate from the General Operating Curve.

   b. Depress the Catalyst Flow On Pushbutton to start catalyst circulation.

10. Start air injection to the Drying Zone and Cooling Zone and establish dual air injection as follows:

    a. During this step, monitor the Regeneration Blower suction temperature, the Burn Zone, Reheat Zone and Chlorination Zone bed temperatures, and the Cooling Zone outlet temperature while establishing dual air operation. If any significant temperature increase occurs, start nitrogen flow and stop air flow to the Air Heater IMMEDIATELY.

    b. Ensure that the nitrogen flow to the Drying Zone is at the design rate for startup. Ensure that the excess air vent control valve is closed in manual.

c. Confirm that the current flow of upper combustion air is sufficient to permit continued cascade control of the upper air when lower air flow to the Drying Zone is started. Confirm that the current flow of upper combustion air is also sufficient to maintain the apparent flow of chlorination gas at the current rate when lower air to the Drying Zone is started.

NOTE: After the lower air flow to the Drying Zone is started, the upper air flow to the Burn Zone will have to be reduced to compensate for the effect of the lower air on the Regeneration Tower's oxygen balance. The upper air flow rate will have to be reduced by an amount that is roughly equal to the lower air flow rate. Therefore, the upper air flow rate must be sufficient so that, after it is reduced, the remaining upper air flow still permits control of the Burn Zone oxygen content by the upper air control valve.

Example VII-3

If the current Regeneration Section operation is:

Upper Air Flow Rate	400 Nm^3/Hr (15,000 SCFH)
Lower Nitrogen Flow Rate	267 Nm^3/Hr (10,000 SCFH)

then, after lower air is started, the operating conditions will roughly be:

Upper Air Flow Rate	133 Nm^3/Hr (5,000 SCFH)
Lower Air Flow Rate	267 Nm^3/Hr (10,000 SCFH)

So, prior to starting lower air, ensure that 133 Nm^3/Hr (5,000 SCFH) is sufficient for the upper air control valve to control the Burn Zone oxygen content. Generally, the upper air flow is sufficient for control if it is >20% of the lower air flow.

d. Place the upper combustion air in local-automatic control.

e. Depress the Tie Line Pushbutton to open the Tie Line Valve (XV-14).

f. As soon as the Tie Line Valve is opened, depress the Nitrogen Pushbutton to close the Nitrogen Valve (XV-15).

g. Twenty to thirty seconds after the Nitrogen Valve is closed, reduce the upper air flow to compensate for the effect of the lower air on the Regenerator's oxygen balance. In the example above, the upper air flow would be reduced from 400 Nm^3/Hr to above 133 Nm^3/Hr, while carefully watching the oxygen analyzer.

h. Stabilize the oxygen concentration and the upper combustion air flow. Then cascade the upper combustion air flow controller back to the oxygen analyzer-controller.

11. Establish excess drying air flow and stop upper combustion air flow:

a. As soon as the oxygen concentration has stabilized, increase the lower air injection in local-automatic to the design rate for regeneration. At the same time, increase the flow of air through the excess air vent a corresponding amount by opening the hand-control valve in local-manual. Maintain the apparent chlorination gas flow at the current rate.

b. Confirm that the current excess air vent flow is sufficient to permit control of the burn zone oxygen concentration when upper combustion air is stopped.

NOTE: Before the upper air flow to the Burn Zone is stopped, the excess air vent from the Drying Zone will have to be reduced to compensate for the effect of the upper air on the Regeneration Tower's oxygen balance. The excess air vent rate will have to be reduced by an amount that is roughly equal to the upper air flow rate.

Therefore, the excess air vent rate must be sufficient so that, after it is reduced, the remaining excess air vent rate will permit control by the excess air control valve of the Burn Zone oxygen content.

Example VII-4

If the current Regeneration Section operation is:

Upper Air Flow Rate	133 Nm^3/Hr (5,000 SCFH)
Excess Air Vent Rate	267 Nm^3/Hr (10,000 SCFH)
Lower Air Flow Rate	534 Nm^3/Hr (20,000 SCFH)

then, after upper air is stopped, the operating conditions will roughly be:

Upper Air Flow Rate	0 Nm^3/Hr (0 SCFH)
Excess Air Vent Rate	133 Nm^3/Hr (5,000 SCFH)
Lower Air Flow Rate	534 Nm^3/Hr (20,000 SCFH)

So, prior to stopping upper air, ensure that 133 Nm^3/Hr (5,000 SCFH) is sufficient for the excess air control valve to control the Burn Zone oxygen content.

c. Place the upper combustion air in local-automatic control.

d. Reduce the excess air vent flow by the amount of upper combustion air flow.

e. Ten to twenty seconds after the excess air vent flow has been reduced, close the upper combustion air control valve to anticipate and compensate for the effect of the lower air on the Tower's oxygen balance.

f. Stabilize the oxygen concentration and the excess air vent flow. Switch the oxygen analyzer-controller to control the excess air vent control valve.

g. Block in the upper combustion air line at the Burn Zone.

12. Establish the desired injection rate of organic chloride to the Chlorination Zone by setting the Chloride pushbutton to “ON” and adjusting the pump stroke of the injection pump.

13. Sample the regenerated catalyst:

a. After the catalyst inventory in the Chlorination Zone, Drying Zone, and Cooling Zone of the Regeneration Tower has been turned over at lined-out conditions, sample the regenerated catalyst below the Nitrogen Seal Drum for chloride content.

b. Adjust the chloride injection rate to provide the target chloride level on the regenerated catalyst.

14. Continue to monitor the coke burn. The operating conditions are as follows:

Burn Zone inlet	477°C	(890°F)
Burn Zone outlet (max)	566°C	(1050°F)
Burn Zone delta T (max)	89°C	(160°F)
Burn Zone bed (max)	593°C	(1100°F)
Burn Zone inlet oxygen	Per Gen. Op. Curve: (0.5 mole-% min, 1.0 mole-% max)	
(if applicable) Reheat Zone inlet	510°C	(950°F)
Drying Zone inlet	565°C	(1050°F)
Drying Zone inlet	2.5 kg/cm^2(35	psig)
Air to Drying Zone	Design for regeneration	
Air to Cooling Zone	To maintain 150°C (300°F) in Nitrogen Seal Drum	

Upper Reduction Zone inlet	377°C	(710°F)
Lower Reduction Zone inlet	482°C	(900°F)
Catalyst circulation rate	Per Gen. Op. Curve: (Design CCR maximum)	
Reduction Gas Exchanger Shell Side Outlet	65°C	(150°F)
Booster Gas to Lock Hopper	150°C	(300°F)

15. Maintain normal Regeneration Section operations.

16. Stop injection of chloride compound and water (if it had been started) into the feed to the CCR Platforming Unit after one turnover of the catalyst in the Regeneration Tower, Lock Hopper, and Reduction Zone has been completed following Step 12. This would be approximately 14 hours at 100% of design catalyst circulation rate.

Figure VII-1

Continuous Platforming CycleMax Regeneration Section

General Operating Curve

Basis:
477°C (890°F) Burn Zone Inlet

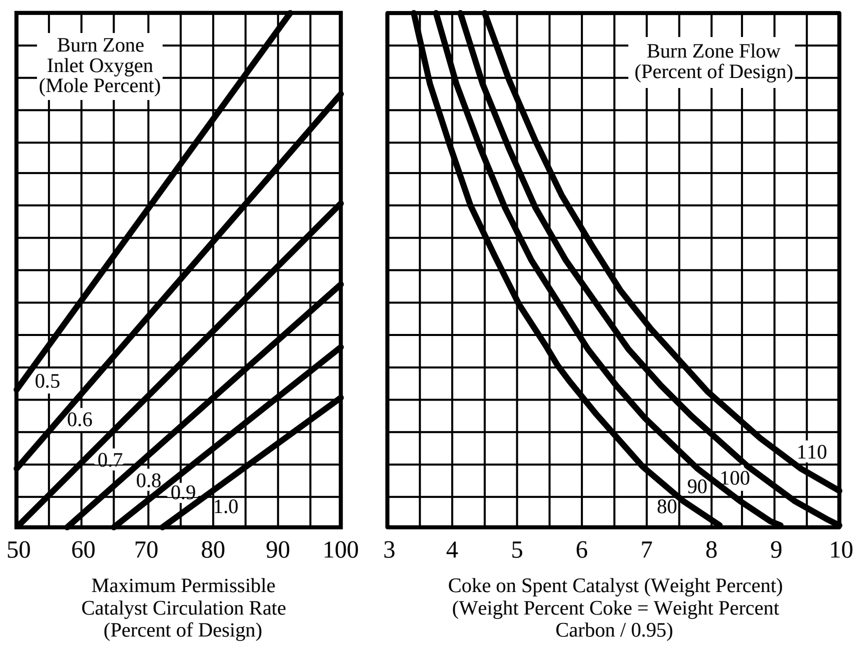


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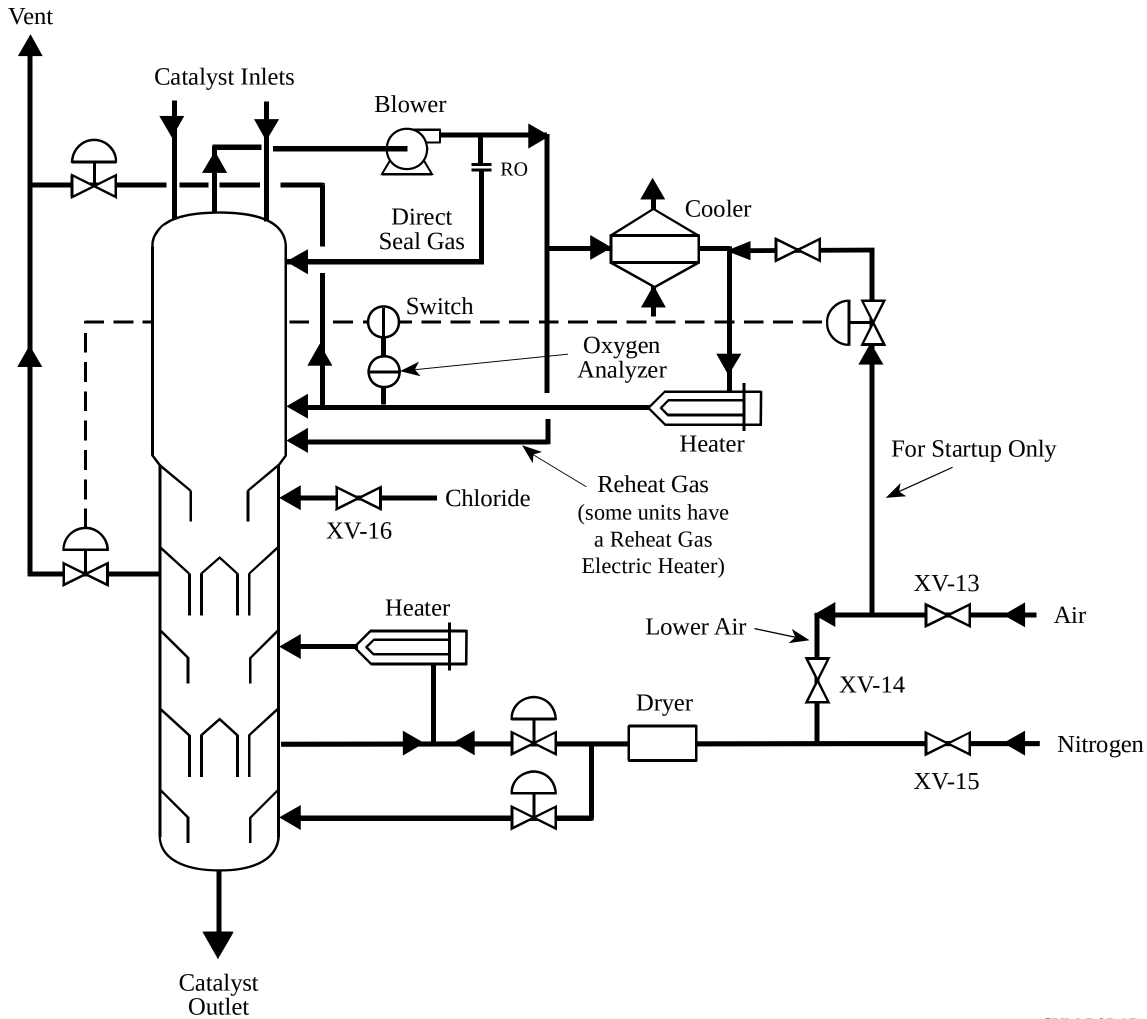
Figure VII-2
CycleMax Regeneration Tower



VIII. NORMAL OPERATIONS

This section outlines normal operating procedures that are done on a day-to-day basis when the Regeneration Section is in operation. This section includes: operational monitoring and adjustments, preventive maintenance schedule, Dust Collector cleaning, Catalyst Addition, Filter Cleaning, and Vent Gas treating (if applicable).

A. OPERATIONAL MONITORING AND ADJUSTMENTS

When the unit has been commissioned, the unit operators and engineers are concerned with continued smooth unit operation and optimization. All aspects of unit operation require careful monitoring but this sections outlines some areas where specific attention is required.

1. Reheat Zone and Chlorination Zone Temperature

It is **extremely** important to closely monitor the burn profile in the Burn Zone of the Regenerator. The burn profile will change with the operating parameters of the CCR: Spent Catalyst Coke, catalyst circulation rate, Regen Gas flow rate, and burn zone oxygen content. Usually, the peak temperature (and hence the burn front) is at the second to third TI from the top of the Burn Zone. The last two TIs in the Burn Zone should read approximately the same, indicating no burning. The two TIs in the Reheat Zone should be approximately the same as the Burn Zone Gas outlet temperature. The Chlorination Zone TI should read approximately the same as the Reheat Zone.

If the peak of the profile moves down the Burn Zone, this is an indication that the residual coke may no longer be burned off in the Burn Zone where it should be. If this situation is not remedied immediately, coke can slip from the Burn Zone into the Chlorination Zone. Coke that burns in the oxygen-rich (21%) atmosphere of the Chlorination Zone will generate sufficiently high temperatures to damage the catalyst and the internals of the Chlorination Zone causing an extended Regenerator shutdown.

If coke slips from the Burn Zone, the Reheat Zone temperature will rise sharply as the coke burns in that zone. If coke slips further, the Chlorination Zone temperature will rise sharply as the coke readily burns in that zone.

2. Chlorination Zone Gas Flowrate

The gas flow into the Chlorination Zone is not measured directly but rather calculated from the difference between the total lower air to the Cooling and Drying Zones and the excess air vented from the Drying Zone. This flow is displayed as a point in the DCS with a low flow alarm at 25% of the meter maximum.

Sufficient gas flow is required through the Chlorination Zone in order to insure that the chloride is properly and evenly dispersed onto the catalyst.

In some modes of operation such as low-coke operation, this flow will decrease. Caution should be exercised if the Chlorination Zone flow is allowed to drop below 25% of the design value. This could result in poorly-chlorided catalyst.

Likewise, an increase in Chlorination Zone flow to a value higher than the design rate indicates a high coke burning operation which may require an increase in oxygen concentration or a decrease in catalyst circulation rate.

3. Lower Air Rates

The rate of air flow to the Drying Zone of the Regenerator can be adjusted in proportion to catalyst circulation rate. If the CCR is operating, for example, at 80% of design catalyst circulation rate then the Drying Air rate can be decreased to 80% of design. Continued operation at decreased catalyst circulation rates with 100% of the design drying air rate will result in poor utilization of the chloride injected to the Regenerator.

The rate of air to the Cooling Zone of the Regenerator must always be sufficient to maintain a catalyst temperature of 150°C (300°F) in the Nitrogen Seal Drum.

There are, however, constraints on the extent to which these air rates can be decreased. These are:

(1) The design ratio of air to catalyst must be maintained for proper drying and cooling of the catalyst.
(2) The minimum flow of air through the electric Air Heater must always be satisfied.
(3) The minimum flow of air through the Chlorination Zone must always be satisfied (see item 2 in this section).

These constraints mean that there will be a turndown limit for the lower air rate that should not be exceeded.

4. Lock Hopper Makeup Valve (Learning Valve) Adjustments

If the operating conditions of the CCR Platforming unit (feedrate, pressure) change significantly, it may be necessary to adjust the Makeup Valve ramp curve being used to stabilize the LH Surge Zone/Regen L-Valve Δp and stabilize the regenerated catalyst lift. This is done by one of two methods.

i) Switch to an existing Makeup Valve ramp curve suitable for the new operating conditions, OR
ii) Utilize the Makeup Valve Learning mode.

B. PREVENTIVE MAINTENANCE SCHEDULE

This is a suggested schedule for preventative maintenance during normal operation. It is a general schedule that is intended to help the refinery prepare a specific schedule for a particular unit.

1. Each Shift

a. Check the position of the shutdown bypass switches. (All bypass switches should be in the NORMAL position, not the BYPASS position.)

b. Check that the operation of the Regeneration Tower is in accordance with the General Operating Curve.

c. Check oil levels in Regeneration Blower and Regeneration Cooler Blower.

d. Check for proper cooling water flow (if applicable) and nitrogen purge flow to the seals of the Regeneration Blower.

2. Daily

a. Visually check that the sample flow rate and pressure are correct for all analyzers.

b. Clean the Dust Collector by depressing the reverse jet pushbutton.

c. Check the nitrogen purges to the regeneration gas and reheat gas flow meters.

3. Weekly

a. Check the “zero” and “span” of all analyzers with bottled calibration gas.

NOTE: Use the shutdown bypass switches as needed when calibrating the CCR Nitrogen Header Analyzer and the Burn Zone Oxygen Analyzer. Do not forget to turn the bypass switches back to the NORMAL position after the analyzer calibration. (Refer to the Process Flow and Control Section.)

b. Check the Air Dryer outlet moisture content.

c. Unload the Dust Collector and record the fines collected. Visually inspect for percentage of whole spheres in the fines (20 to 30 wt% whole spheres is the normal range). Send fines sample to lab for size distribution test.

NOTE: For large CCR Units with a design catalyst circulation rate of 4,500 lbs/hr (2040 kg/hr) or more, the Dust Collector may require unloading twice per week.

d. Check the pressure drop across the vent gas filters on the Reduction Zone outlet and Lock Hopper Disengaging Zone outlet (if applicable). Replace or clean the filter elements as needed.

e. Check the Lock Hopper equalization valve packing integrity and add lubrication as necessary.

f. Check Regeneration Blower and Regeneration Cooler Blower for vibration and for bearing temperature (if not continuously monitored).

4. Monthly

a. Check the “zero” on all flow, pressure, and differential pressure transmitters.

NOTE: Use the shutdown bypass switches as needed when calibrating the Burn Zone gas and Drying Zone air flow transmitters. Do not forget to turn the bypass switches back to the NORMAL position after the transmitter calibration. (Refer to the Process Flow and Control Section.)

b. Stop catalyst circulation and check the “zero” and “span” settings on all the nuclear level indicators (amplifier cards).

c. Check the V-ball valve packing integrity and add lubrication as necessary.

5. Quarterly

a. Check the “zero” and “span” of all flow, pressure, and differential pressure transmitters.

b. Check sample line filters to CCR Nitrogen Header H_2/HC analyzer.

c. Perform a Catalyst Fines Survey.

6. Semi-annually

a. Check trip settings of automatic shutdowns. (Maintain a record.)

b. Perform an on-line calibration of the Lock Hopper load size.

c. Replace the filters in the organic chloride injection line.

d. Replace the Air Dryer after-filter.

e. Check the regeneration gas flow rate. Clean the Regenerator screens when the regeneration gas flow rate drops below 90% of the flow rate indicated when the Regenerator screens were clean.

7. Annually

a. Replace the Air Dryer pre-filter and desiccant.

b. Replace the elements in the booster gas coalescer.

C. DUST COLLECTOR CLEANING

1. Reverse Jet Cleaning

During normal operation, the operator cleans the filter elements in the Dust Collector using the reverse jet pushbutton. An alarm sounds when the pressure drop across the Dust Collector is high, about 125 mm H_2O (5 in H_2O), and cleaning is required. The operator may then depress the pushbutton to initiate reverse-jet cleaning.

When the operator depresses the pushbutton, a cleaning sequence occurs automatically. The sequence blows nitrogen backwards through all the elements and dislodges the fines. The fines drop to the bottom of the Dust Collector. The fines stay in the bottom head until they are unloaded into the Fines Collection Pot that is usually performed once per week.

Reverse jet cleaning should be done as soon as the pressure drop alarm sounds. If the pressure drop across the Dust Collector becomes too high, the reverse jet sequence may not be able to clean the filter elements. If the pressure drop changes very significantly before and after cleaning, then operation of the spent catalyst lifting and of the fines removal may be unstable.

After cleaning, the pressure drop across the Dust Collector should return to normal.

2. Unloading

Periodically (usually once per week), the operator must unload the Dust Collector fines into an empty catalyst drum. Fines are transported from the Dust Collector to the Fines Collection Pot. This vessel and its associated piping (Figure VIII-1) are required to safely remove the fines from the elevated pressure of the Dust Collector while the Dust Collector remains in service. This operation is carried out by cycling the Fines Collection Pot through a programmed sequence controlled by the CRCS.

An empty drum should be used each time the Dust Collector is unloaded. The operator must keep in mind that the catalyst fines may be pyrophoric. Care must be taken to minimize their exposure to air during unloading. Ten to twenty minutes before the Dust Collector is emptied, the operator should line-up the hydrogen/hydrocarbon analyzer (which is normally lined-up to the nitrogen header) to the Fines Removal Blower suction line. Continue to monitor the nitrogen leaving the Dust Collector to ensure that there is neither hydrogen nor hydrocarbon present while the Dust Collector is unloaded. Once the unloading sequence is completed, the analyzer should be switched back to its normal service, the N_2 header.

This section outlines the logic requirements for the operation of the Fines Collection Pot System. This explanation has been simplified to include only those items that the operator can check for proper operation. For a complete explanation of the logic refer to the PIC Equipment & Instructions Databook, Chapter 2.19.

The Dust Collector unloading operation consists of cycling the Fines Collection Pot through a sequence of LOAD and UNLOAD steps. The operator starts these steps by turning a handswitch in the field. The steps are monitored and controlled by the CRCS.

Fines Collection Pot stages:

STEP	**OPERATION**
OFF	Normal resting stage between cycles. The Fines Collection Pot always starts the sequence from the OFF stage.
DEPRESS	Depressures the Fines Collection Pot to atmospheric pressure.
UNLOAD	Fines Collection Pot, full of fines, is unloaded into a catalyst drum.
PRESSURE	Pressures the Fines Collection Pot with nitrogen from the spent catalyst lift/elutriation system to match the Dust Collector's pressure.
LOAD	Fines Collection Pot, empty of fines, is loaded with fines from the Dust Collector.

At the end of the UNLOAD step, the cycle can be repeated if more fines unloading is desired. Each stage consists of one step, except the PRESSURE stage which has two steps. There are a total of six steps per cycle.

The Fines Collection System has the following feature:

Fines Collection Pot Switch: The Fines Collection Pot Switch is a field-mounted, three-position handswitch. The three positions of the switch are labeled as “LOAD,” “OFF” (middle-position), and “UNLOAD.” The switch must be turned through the “OFF” position when switching from “LOAD” to “UNLOAD” or back.

“LOAD”
In the “LOAD” position, the CRCS prepares the Fines Collection Pot and loads fines from the dust collector.

“OFF”
In the “OFF” position, the CRCS closes the Fines Collection Pot. Fines cannot be loaded or unloaded.

“UNLOAD”
In the “UNLOAD” position, the CRCS prepares the Fines Collection Pot and unloads fines into a catalyst drum.

Starting the Sequence: The Fines Collection Pot sequence can be started when both of the following conditions have been met: 1) Emergency Stop switch in RUN position, and 2) Valve power available.

Stopping the Sequence: The operator can stop the Fines Collection Pot sequence by placing the field switch in the OFF position. The cycle returns to the OFF stage (Step 0) immediately due to either of the following conditions: 1) Emergency Stop switch in the STOP position, or 2) Valve power becomes unavailable.

UNLOAD SEQUENCE

STEP	OPERATION
OFF	Collection Pot, full of fines at Dust Collector pressure, waits for signal to start sequence. All valves (XV-9,10,11,12) are closed. To proceed to the DEPRESSURE step: Turn the Fines Collection Pot handswitch to the UNLOAD position. All valves must be verified closed by the CRCS.
DEPRESSURE	The Vent valve (XV-11) opens and depressures the Collection Pot to atmosphere through a restriction orifice. The restriction orifice limits the rate of depressuring to avoid fluidizing the dust in the vessel. To proceed to the UNLOAD step: ➢ The pressure in the Collection Pot must be lower than the high switch point (PSH) for the pressure transmitter (PT) which is set near atmospheric pressure. ➢ The Fines Collection Pot pressure transmitter calibration alarm is not actuated. ➢ The pressure differential between the Collection Pot and Dust Collector is above the high-high switch point (PDSH) for the pressure differential transmitter (PDT). ➢ XV-11 verified open, all other valves must be verified closed.
UNLOAD	The Unload valve (XV-12) opens and fines flow by gravity into the catalyst drum below. To proceed to the next step: Turn the Fines Collector Pot Switch to the OFF position.
OFF	All valves close (XV-11,12) or remain closed (XV-9,10). The Fines Collection Pot is empty.

LOAD SEQUENCE

STEP	OPERATION
OFF	Collection Pot, empty of fines at atmospheric pressure, waits for signal to start sequence. All valves (XV-9,10,11,12) are closed. To proceed to the PRESSURE step: ➢ Turn the Fines Collection Pot handswitch to the LOAD position. ➢ All valves must be verified closed by the CRCS.
PRESSURE-1	The Pressure valve (XV-10) opens and pressures the Collection Pot to Dust Collector pressure through a restriction orifice. The pressuring flow also serves to blow back the internal screen at the vessel nozzle. To proceed to the next step: ➢ The pressure differential between the Fines Collection. Pot and the Dust Collector is lower than the high switch point for the PDT. ➢ The pressure differential is near zero. ➢ XV-10 verified open, all other valves must be verified closed by the CRCS.
PRESSURE-2	The Pressure valve (XV-10) closes. To proceed to the next step: The pressure in the Collection Pot must be higher than the high-high switch point for the pressure transmitter. All valves must be verified closed.

LOAD	The Load valve (XV-9) opens and fines flow into the Collection Pot from the Dust Collector. To proceed to the next step: Turn the Fines Collection Pot Switch to the OFF position.
OFF (After Load)	All valves close (XV-9) or remain closed (XV-10,11,12). The Collection Pot is full of fines.

Valve Interlocks

A valve will not open or remain open unless the required interlock conditions are met. These interlocks prevent undesirable or dangerous valve combinations.

Valve Interlock Table

TO OPEN	CLOSED VERIFICATION REQUIRED
XV-9 (LOAD)	XV-10 (PRESSURE), XV-11 (VENT), XV-12 (UNLOAD)
XV-10 (PRESSURE)	XV-9 (LOAD), XV-11 (VENT), XV-12 (UNLOAD)
XV-11 (VENT)	XV-9 (LOAD), XV-10 (PRESSURE)
XV-12 (UNLOAD)	XV-9 (LOAD), XV-10 (PRESSURE)

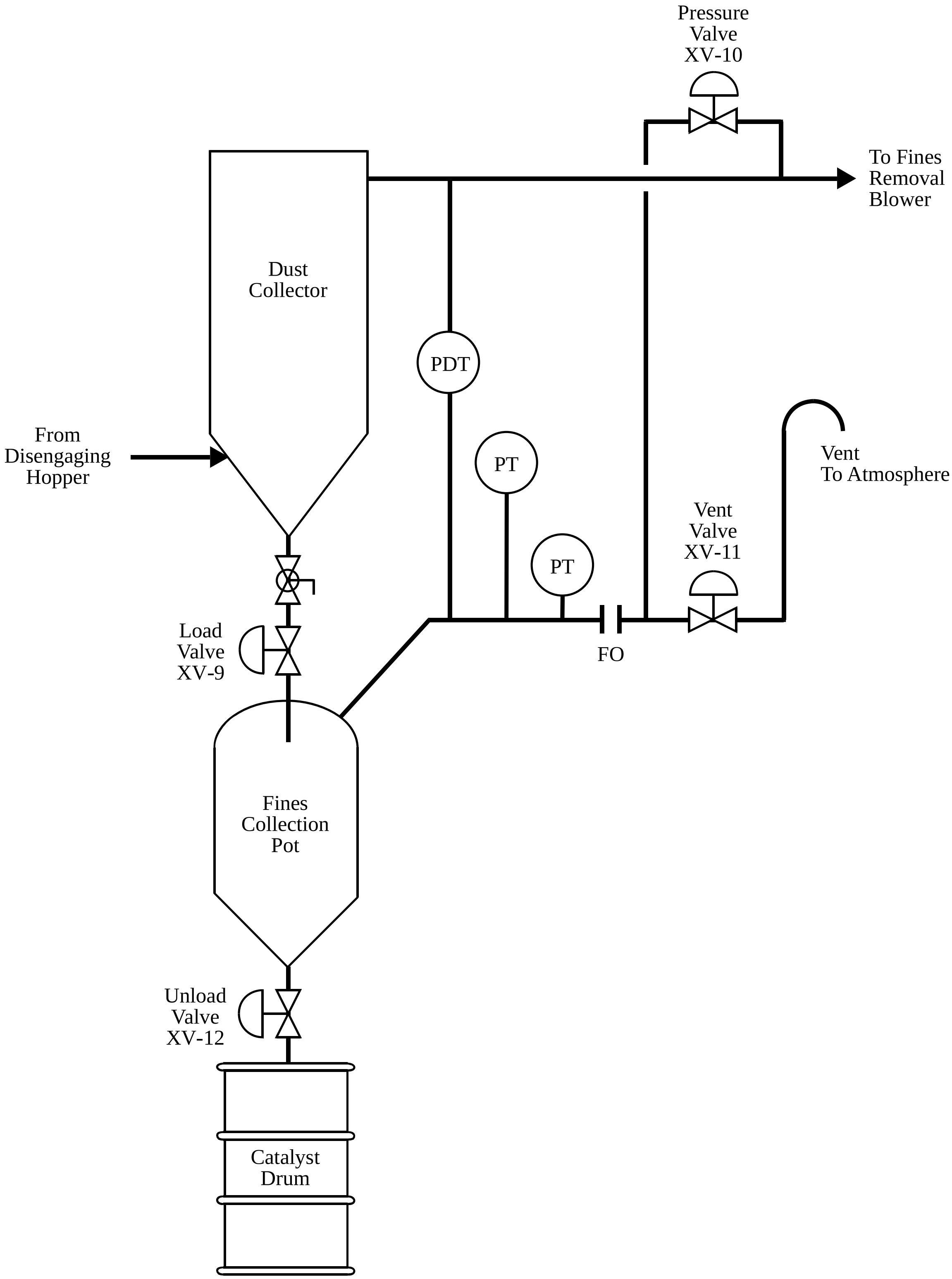
Every time the Dust Collector is unloaded into the catalyst drum via the Fines Collection Pot record the following:

- Date
- Time
- Lock Hopper counts
- Total weight of fines collected
- Percentage of whole pills (>1.2mm or >0.047inch) in fines

In this way a continuous record of fines collected as a function of catalyst circulated can be kept.

Figure VIII-1

Dust Collector and Fines Collection Pot



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D. NORMAL CATALYST ADDITION

This section outlines the procedure for operation of the Catalyst Addition Lock Hopper No. 1 System. This explanation has been simplified to include only those items that the operator should monitor for proper operation. For a complete explanation of the logic, refer to the UOP Process Information and Control (PIC) Equipment and Instructions Databook.

The operator must add fresh catalyst periodically to the Regeneration Section to replenish the inventory as catalyst is removed as fines. Over time, as more and more fines are removed, the catalyst level in the Disengaging Hopper decreases. To keep the normal operating level in the Disengaging Hopper, the operator adds fresh catalyst into the Disengaging Hopper through the spent catalyst lift system using the Catalyst Addition Lock Hopper No. 1 System.

The Catalyst Addition Lock Hopper No. 1 System (Figure VIII-2) consists of a Catalyst Addition Funnel No. 1, Catalyst Addition Lock Hopper No. 1, and four gas-tight valves. The Catalyst Addition Funnel No. 1 is open to the atmosphere and can be filled with catalyst from drums. The Catalyst Addition Lock Hopper No. 1 fills with catalyst and can be pressured up to transfer the catalyst into the spent catalyst lift system. The four logic-operated valves that allow the Catalyst Addition Lock Hopper to be depressured, loaded, pressured up, and unloaded during the addition of catalyst are listed below:

VALVE	TAG
Load Valve	XV-1
Pressure Valve	XV-2
Vent Valve	XV-3
Unload Valve	XV-4

The open and closed positions of these valves are indicated to the CRCS by position switches.

There are several inherent hazards to overcome in order to add catalyst safely from drums into the catalyst transfer system. First, since the catalyst lift system operates under a nitrogen pressure equal to the reactor pressure, it cannot be opened directly to the atmosphere. Second, since the fresh catalyst has no coke and the spent catalyst does, it must be added slowly to avoid an upset in the coke burning operation of the Regeneration Tower. Third, since the Catalyst Addition Lock Hopper should be filled only when it is completely empty (to avoid overfilling and thus closing valves on catalyst), the time allowed for unloading the Catalyst Addition Lock Hopper No. 1 must be coordinated with the cycling of the Lock Hopper. By following these procedures and using the controlled sequence of the CRCS, these tasks are accomplished. In addition to fresh catalyst, whole catalyst pills screened from the fines collected in the Dust Collector can be added using the Catalyst Addition Lock Hopper No. 1 System. This is possible because the coke content of the whole pills from the Dust Collector and the spent catalyst will be roughly the same, and any remaining fines will be removed in the elutriation zone of the Disengaging Hopper.

A second function provided by the Catalyst Addition Lock Hopper No. 1 System is reloading of the Regeneration Tower. Whenever the Regeneration Tower is unloaded for maintenance, the catalyst can be reloaded by using the addition system in conjunction with the Spent Catalyst Lift System.

The catalyst addition operation consists of cycling the Catalyst Addition Lock Hopper No. 1 through a sequence of LOAD and UNLOAD steps. The CRCS operates the Catalyst Addition Lock Hopper No. 1 in a sequence consisting of six stages: Off, Pressure, Unload, Hold, Depressure and Load. Each stage consists of one or more steps. There are a total of 11 steps per cycle. The operator starts these stages by turning a handswitch. The stages are monitored and controlled by the CRCS.

The Catalyst Addition Lock Hopper No. 1 Stages:

STEP	OPERATION
OFF	Normal resting stage between cycles. The Catalyst Addition Lock Hopper No. 1 sequence always starts from the OFF stage.
PRESSURE	Purges and pressures the Catalyst Addition Lock Hopper No. 1 with nitrogen to match the spent catalyst lift system pressure.
UNLOAD	Catalyst Addition Lock Hopper No. 1, full of catalyst, is unloaded into the spent catalyst lift system.
HOLD	Waits for the signal from the field switch to start LOAD.
DEPRESS	Depressures Catalyst Addition Lock Hopper No. 1 to atmospheric pressure.
LOAD	Catalyst Addition Lock Hopper No. 1, empty of catalyst, is loaded with catalyst from the Catalyst Addition Funnel No. 1.

The Catalyst Addition Lock Hopper No. 1 is sized to hold one drum of catalyst. Only one drum should be loaded into the funnel for each LOAD step. At the end of the UNLOAD stage, the cycle can be repeated if more catalyst addition is desired.

The Catalyst Addition System has the following features:

a. **Catalyst Addition Switch:** The Catalyst Addition Switch is a field-mounted, three-position handswitch. The three positions of the switch are labeled as “LOAD,” “OFF” (middle-position), and “UNLOAD.” The switch must be turned through the “OFF” position when switching from “LOAD” to “UNLOAD” or back.

“LOAD”

In the “LOAD” position, the CRCS prepares the Catalyst Addition Lock Hopper No. 1 so the operator can load it with catalyst.

“OFF”

In the “OFF” position, the CRCS closes the Catalyst Addition Lock Hopper No. 1. Catalyst cannot be loaded or unloaded.

“UNLOAD”

In the “UNLOAD” position, the CRCS prepares the Catalyst Addition Lock Hopper No. 1 and unloads catalyst into the spent catalyst lift system.

b. **Lock Hopper Cycle Counter:** The Lock Hopper Cycle Counter of the CRCS counts the number of times the Lock Hopper loads while the Unload Valve of the Catalyst Addition Lock Hopper No. 1 is verified open. Each time the Lock Hopper loads, some catalyst is unloaded from Catalyst Addition Lock Hopper No. 1. In order to empty Catalyst Addition Lock Hopper No. 1, the Lock Hopper must load a number of times equal to the number selected at the CRCS. When the Lock Hopper has cycled the selected number of times, Catalyst Addition Lock Hopper No. 1 is considered to be empty.

NOTE: Catalyst Addition Lock Hopper No. 1 can be confirmed empty by tapping lightly on the side of the vessel. If it is determined to still contain catalyst, repeat the UNLOAD step before conducting the next LOAD step and select a higher number of Lock Hopper cycles at the CRCS.

c. **Spent Catalyst Lift Line Pressure Differential:** The spent catalyst lift line differential pressure is monitored during the UNLOAD step. When the Catalyst Addition Hopper No. 1 is being used to reload the Regeneration Tower, that is when the Lock Hopper is not cycling, the absence of a lift line pressure differential is used as an indication that the Catalyst Addition Hopper No. 1 is empty.

d. **Status Lamps**: The status lamps in the field allow the operator to monitor the loading and unloading of Catalyst Addition Lock Hopper No. 1. There are two field-mounted lamps: CATALYST ADDITION LOCK HOPPER LOAD and CATALYST ADDITION LOCK HOPPER NOT EMPTY. Both status lamps cannot be lit at the same time.

CATALYST ADDITION LOCK HOPPER LOAD

This lamp lights when the CRCS has unloaded the Catalyst Addition Lock Hopper No. 1 and prepared it so the operator can load it with catalyst. The operator may load catalyst only when this lamp is lit and the Catalyst Addition Switch is in the “LOAD” position.

CATALYST ADDITION LOCK HOPPER NOT EMPTY

This lamp lights when the CRCS has not fully unloaded the Catalyst Addition Lock Hopper. The operator is prevented from loading catalyst into the Catalyst Addition Lock Hopper because it needs to be unloaded.

e. **Starting the Sequence**: The Catalyst Addition Lock Hopper No. 1 cycle can be started when the following conditions have been met: 1) The Emergency Stop switch is in the RUN position, and 2) Valve power is available.

To ensure that the catalyst addition hopper is empty, the initial cycle must start with the UNLOAD sequence. The UNLOAD sequence empties the Catalyst Addition Lock Hopper No. 1 to the spent catalyst lift system. If the UNLOAD sequence is successful, the cycle can continue to perform the LOAD sequence. The LOAD sequence prepares the Catalyst Addition Lock Hopper No. 1. so that the operator can load it with catalyst.

f. **Stopping the Sequence**: The operator can stop the Catalyst Addition Lock Hopper No. 1 sequence by placing the field switch in the OFF position during Steps 1 through 7 and 10. If the sequence is in Step 8 or 9 when the field switch is placed in the OFF position, the system will hold in Step 8 until the field switch is placed in the LOAD position.

The sequence returns to the OFF stage (Step 0) immediately on either of the following conditions: 1) Emergency Stop switch in the STOP position, or 2) valve power becomes unavailable.

g. **Valve Interlocks:** The valve interlock system prevents certain valve position combinations that could cause a hazardous situation.

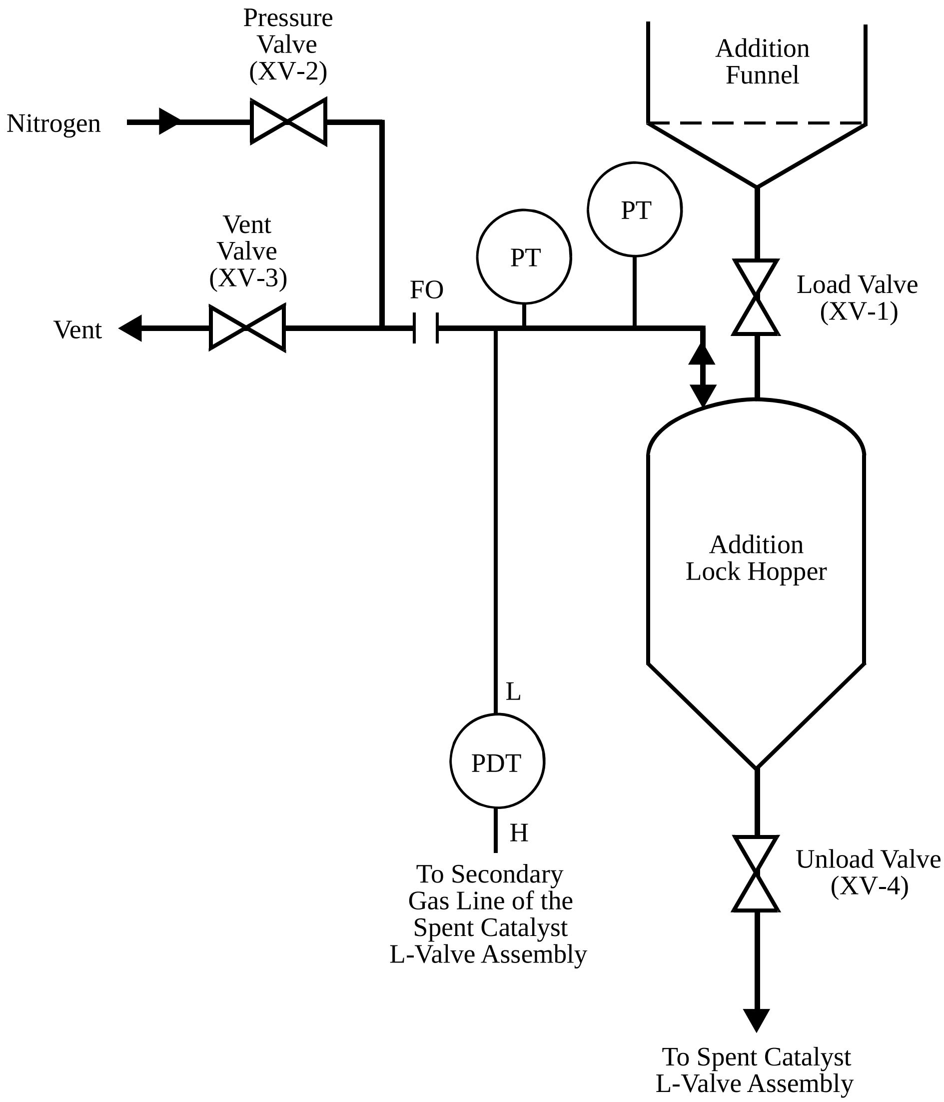
Valve Interlock Table

TO OPEN	CLOSED VERIFICATION REQUIRED
XV-1 (LOAD)	XV-2 (PRESSURE), XV-4 (UNLOAD)
XV-2 (PRESSURE)	XV-1 (LOAD), XV-3 (VENT), XV-4 (UNLOAD)
XV-3 (VENT)	XV-2 (PRESSURE), XV-4 (UNLOAD)
XV-4 (UNLOAD)	XV-1 (LOAD), XV-2 (PRESSURE), XV-3 (VENT)

The following sheets are an outline of the logic steps for catalyst addition:

Figure VIII-2

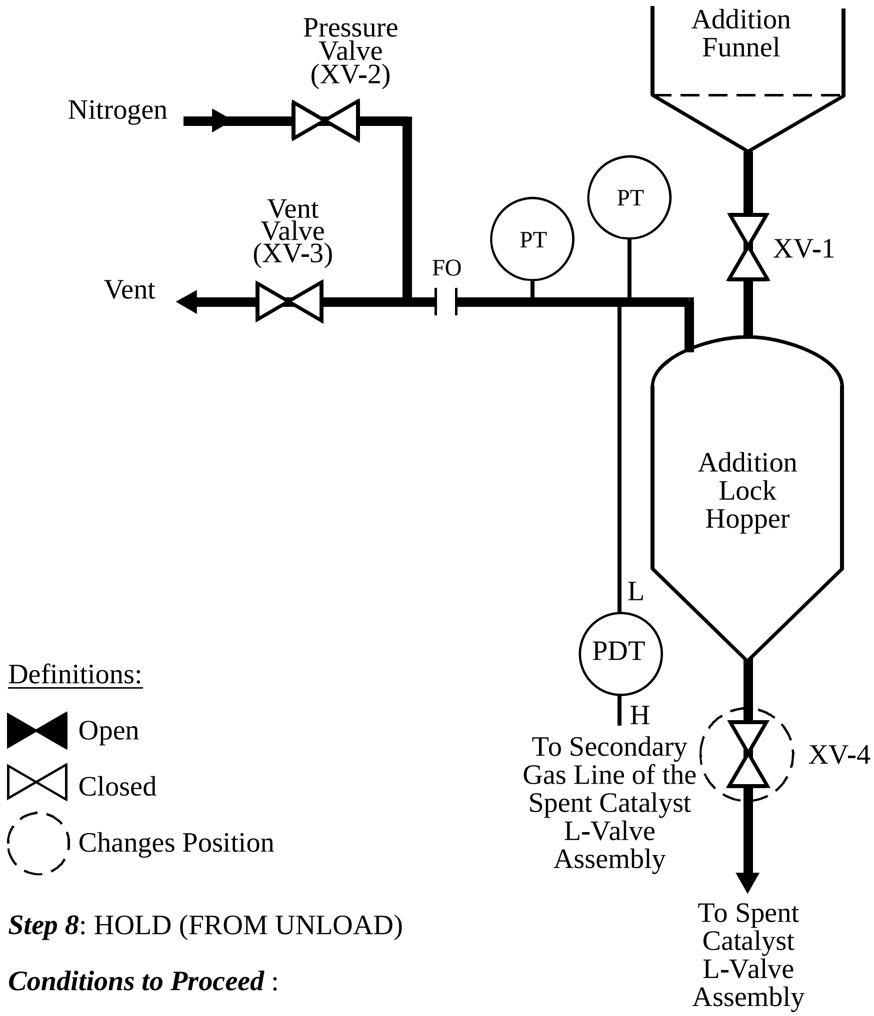
Catalyst Addition Lock Hopper No. 1



CYM-R02-58

Figure VIII-3

Catalyst Addition Controller



Step 8: HOLD (FROM UNLOAD)

Conditions to Proceed :

To Start the Catalyst Addition Lock Hopper Controller:

1. The Lock Hopper Has Successfully Unloaded (See Unload Step).

2. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Closed, XV-4 Closed.

3. Start the Catalyst Addition by Switching the Catalyst Addition Switch from "OFF" to "LOAD" Position.

Remarks

1. The "Not Empty" red indicator lamp turns on.

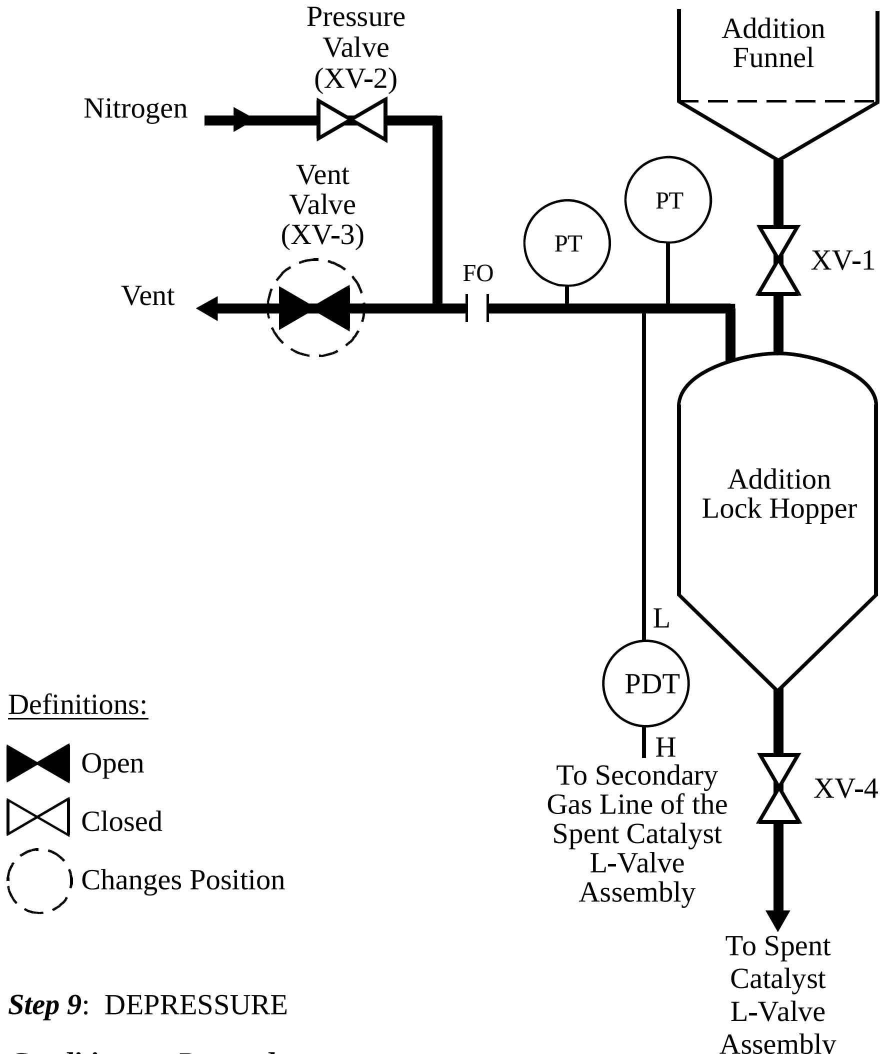
2. The LOAD indicator lamp turns off.

3. Although this is not the start of the logical sequence, it is most commonly the starting point for catalyst addition.

PLT-R00-92
CYM-R02-59

Figure VIII-4

Catalyst Addition Controller



Step 9: DEPRESSURE

Conditions to Proceed :

1. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Open, XV-4 Closed.
2. Both PT Indications below High Setpoint, Pressure Low.
3. PDT Indication above High-High Setpoint, Pressure Differential High.
4. The Catalyst Addition Hopper No. 1 Pressure Transmitter Calibration Alarm is not activated.
5. The field switch is in the LOAD position.

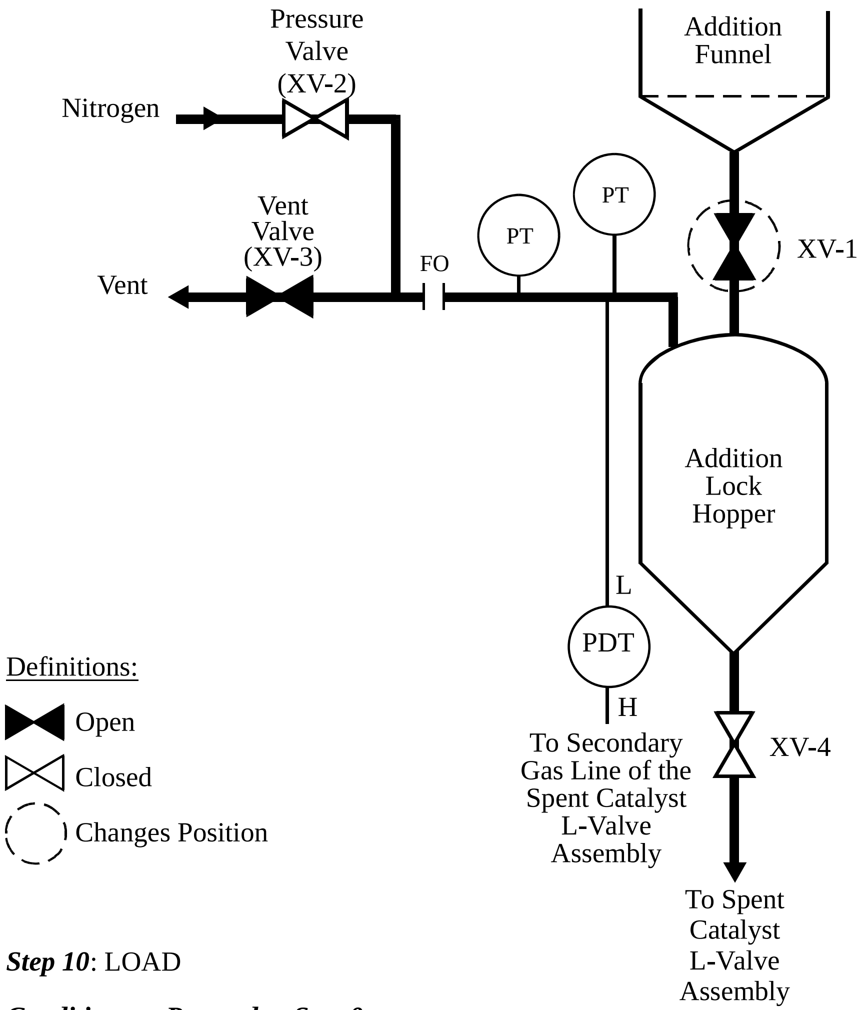
Remarks :

1. If XV-2 or XV-4 Is Not Confirmed Closed, then XV-3 Remains Closed.

PLT-R00-93
CYM-R02-60

Figure VIII-5

Catalyst Addition Control



Step 10: LOAD

Conditions to Proceed to Step 0*:*

1. Valve Positions Confirmed: XV-1 Open, XV-2 Closed, XV-3 Open, XV-4 Closed.

2. The operator moves the field switch from the “LOAD” position to “OFF”

Remarks:

1. The CATALYST ADDITION LOCK HOPPER LOAD Lamp Will Come On When XV-1 Confirms Open.

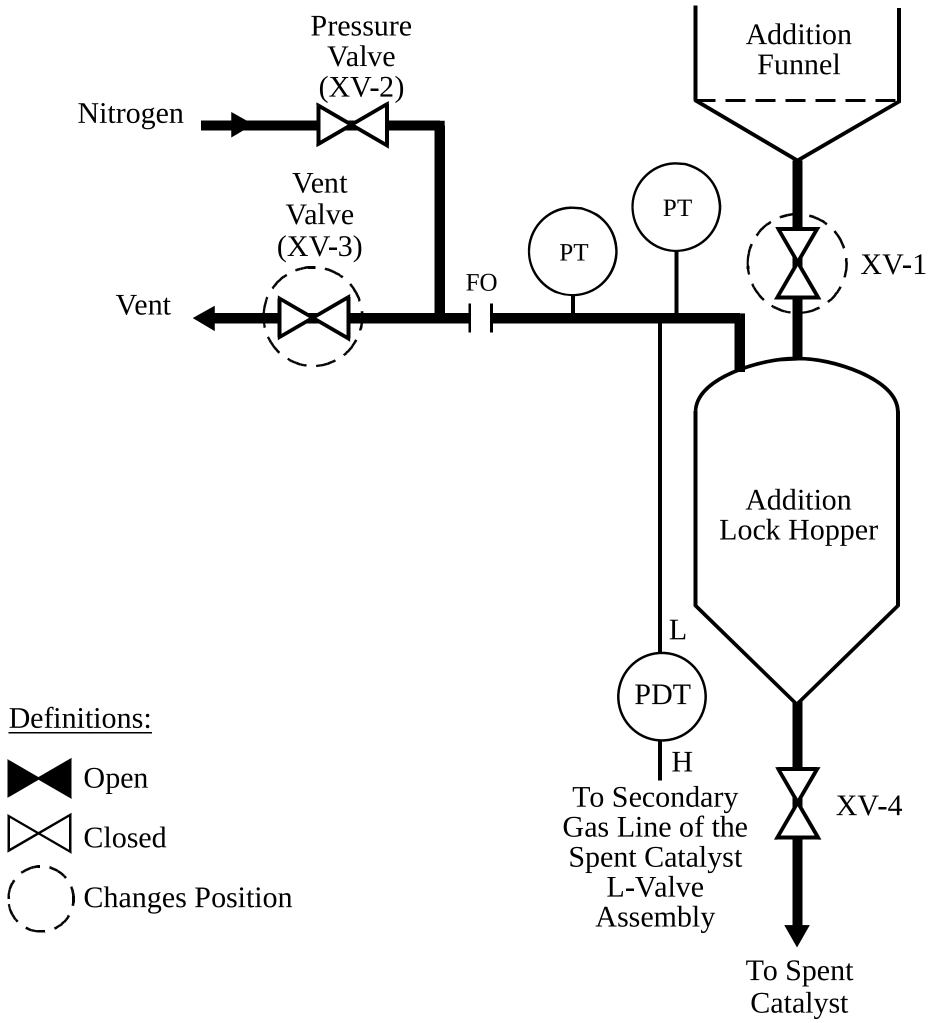
2. Load One Drum of Catalyst into the Addition Funnel. **Do Not Load More Drums into the Funnel than Needed to Fill the Hopper in Order to Prevent Closing XV-1 on Catalyst and Damaging the Valve**. The Catalyst Will Drain into the Addition Hopper. Then, Switch the Catalyst Addition Switch to "OFF."

3. If XV-2 or XV-4 Is Not Confirmed Closed, then XV-1 Remains Closed.

PLT-R00-94
CYM-R02-61

Figure VIII-6

Catalyst Addition Controller



Step 0: OFF (FROM LOAD)

Conditions to Proceed :

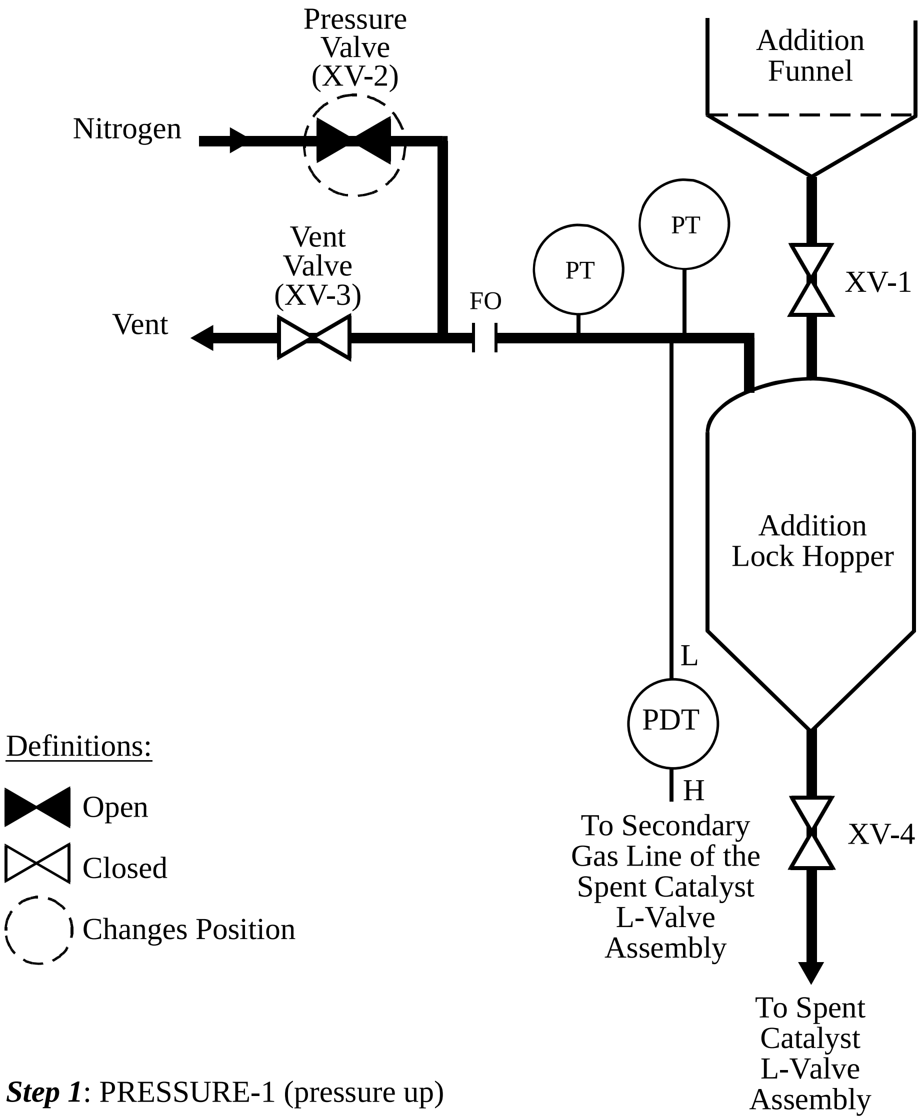
1. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Closed, XV-4 Closed.
2. The Catalyst Flow Pushbutton Must Be in the "RUN" Position.
3. Switch the Catalyst Addition Switch to "UNLOAD."

Remarks :

1. The CATALYST ADDITION LOCK HOPPER LOAD Lamp Turns Off, and the CATALYST ADDITION LOCK HOPPER NOT EMPTY Lamp Turns On when XV-1 and XV-3 ConfirmClosed.

PLT-R00-95
CYM-R02-62

Figure VIII-7
Catalyst Addition Control



Step 1: PRESSURE-1 (pressure up)

Conditions to Proceed :

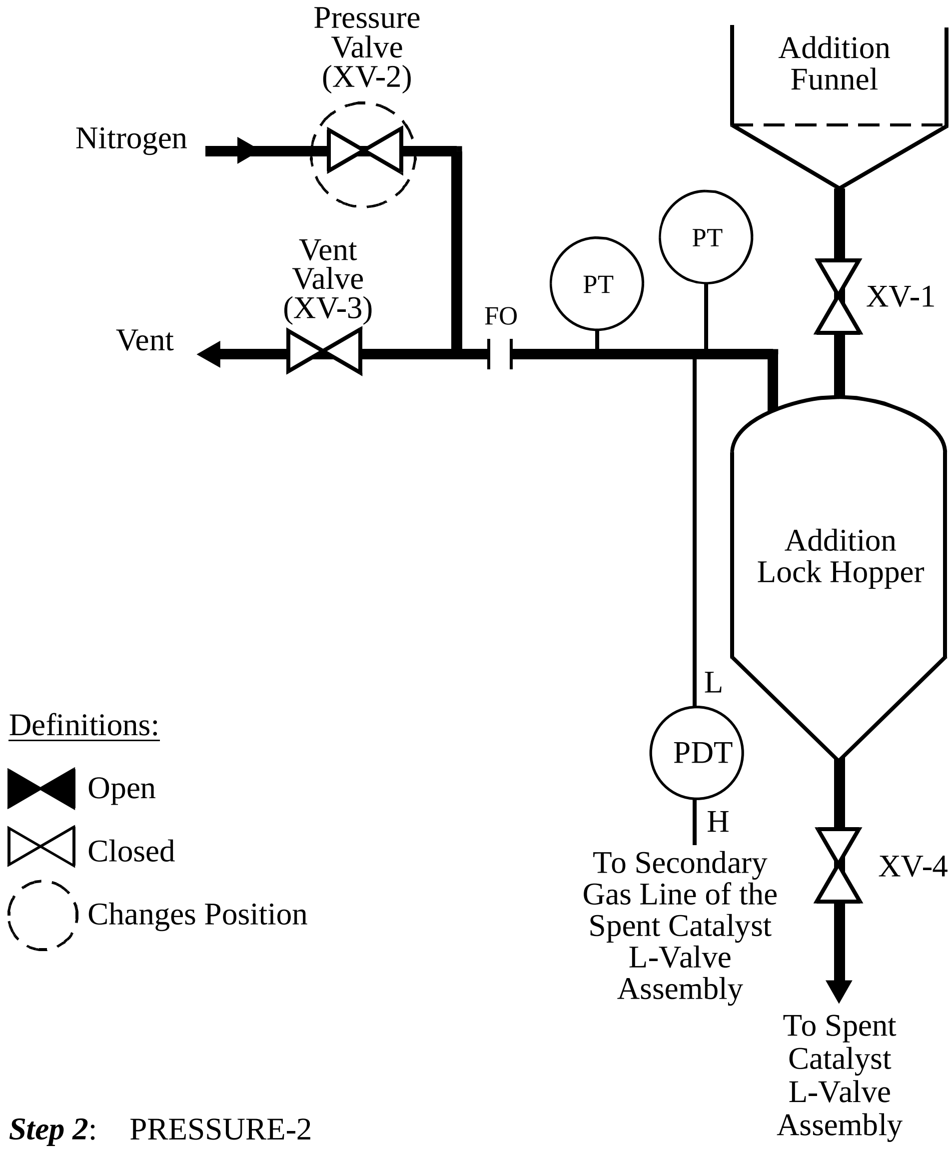
1. Valve Positions Confirmed: XV-1 Closed, XV-2 Open, XV-3 Closed, XV-4 Closed.
2. PDT Indication below High Setpoint, Pressure Differential Low.
3. The field switch remains in the UNLOAD position.

Remarks :

1. If XV-1, XV-3, or XV-4 Is Not Confirmed Closed, then XV-2 Remains Closed.

PLT-R00-96
CYM-R01-63

Figure VIII-8
Catalyst Addition Control



Step 2: PRESSURE-2

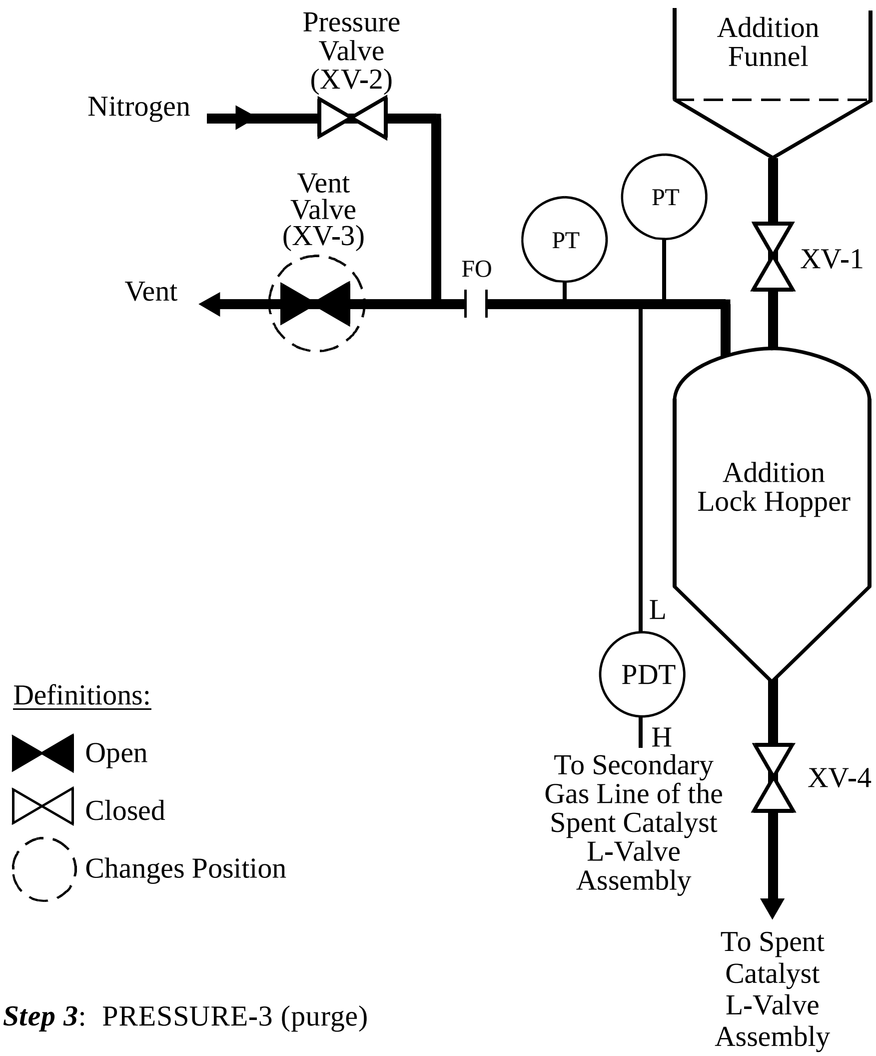
Conditions to Proceed:

1. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Closed, XV-4 Closed.
2. PT Indication Above High-High Setpoint, Pressure High.

PLT-R00-97
CYM-R01-64

Figure VIII-9

Catalyst Addition Controller



Step 3: PRESSURE-3 (purge)

Conditions to Proceed:

1. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Open, XV-4 Closed.
2. Both PT Indications below High Setpoint, Pressure Low.
3. PDT Indication above High-High Setpoint, Pressure Differential High.
4. The Catalyst Addition Hopper No. 1 Pressure Transmitter Calibration Alarm is not activated.
5. The field switch is in the LOAD position.

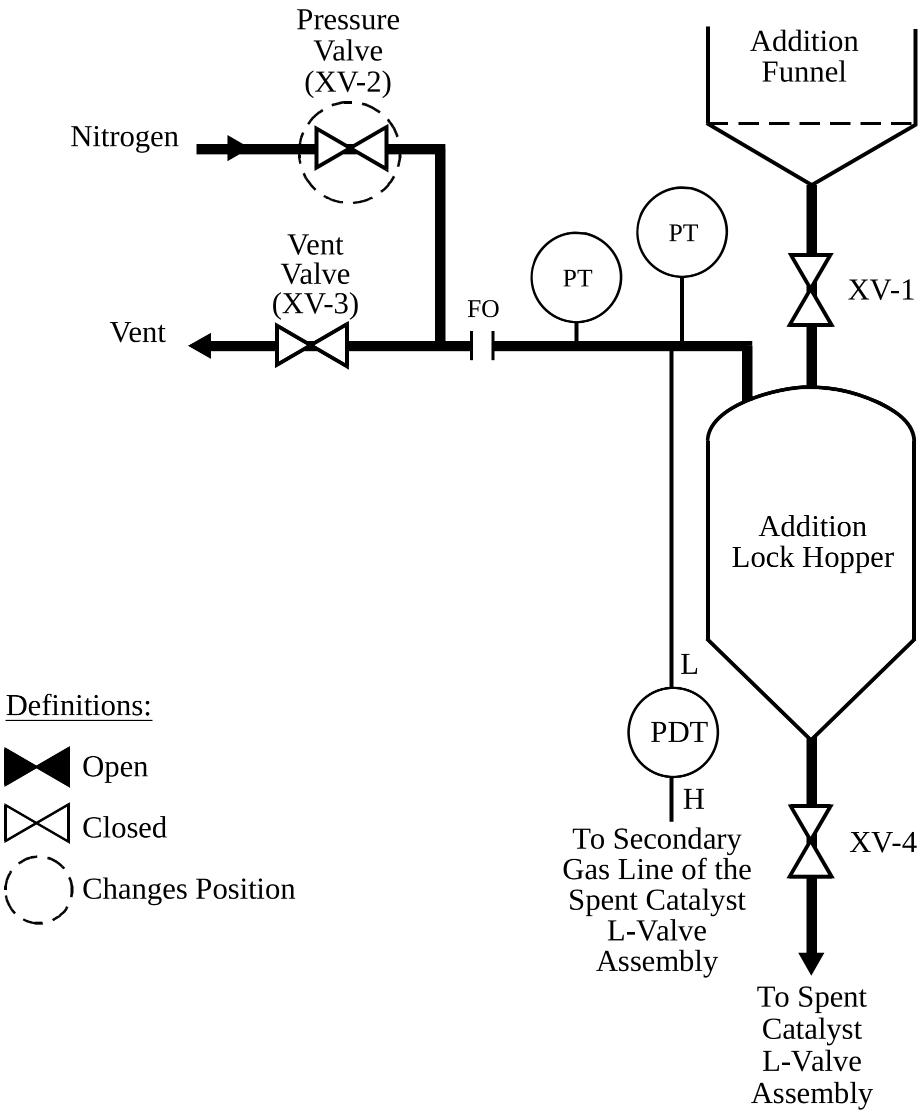
Remarks:

1. If XV-2 or XV-4 Is Not Confirmed Closed, then XV-3 Remains Closed.

CYM-R00-87

Figure VIII-10

Catalyst Addition Control



Step 4: PRESSURE-4

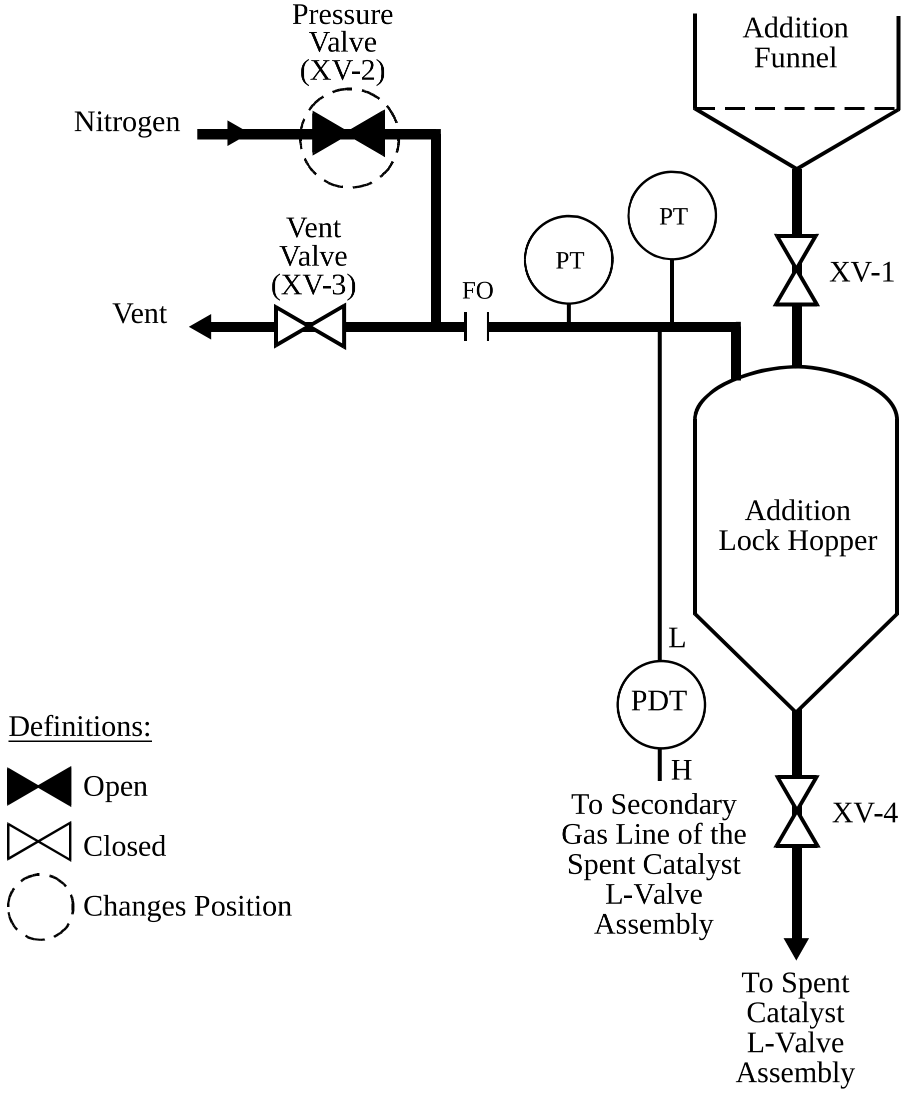
Conditions to Proceed:

1. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Closed, XV-4 Closed.

CYM-R00-88

Figure VIII-11

Catalyst Addition Control



Step 5: PRESSURE-5 (pressure up)

Conditions to Proceed :

1. PDT Indication below High Setpoint, Pressure Differential Low.
2. The field switch remains in the UNLOAD position.

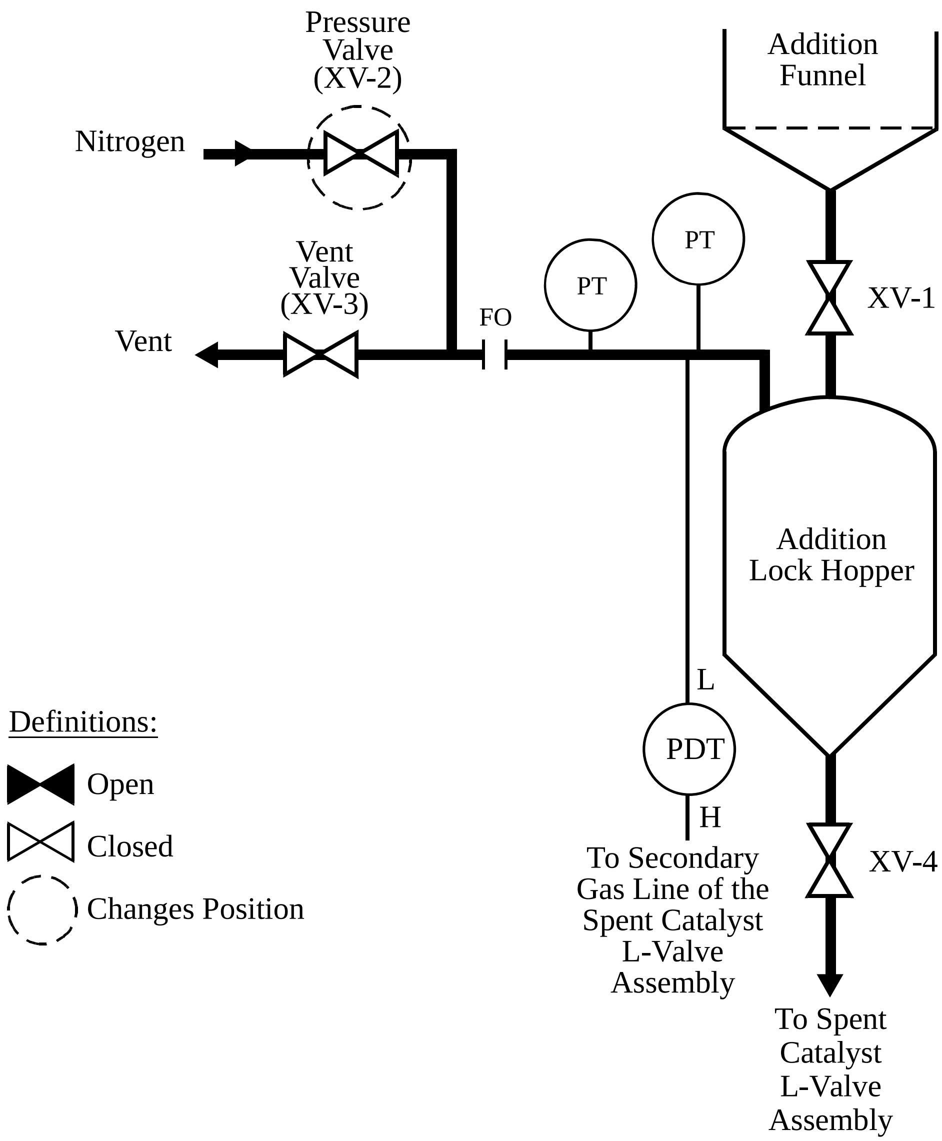
Remarks :

1. If XV-1, XV-3, or XV-4 Is Not Confirmed Closed, then XV-2 Remains Closed.

CYM-R00-89

Figure VIII-12

Catalyst Addition Control



Step 6: PRESSURE-6

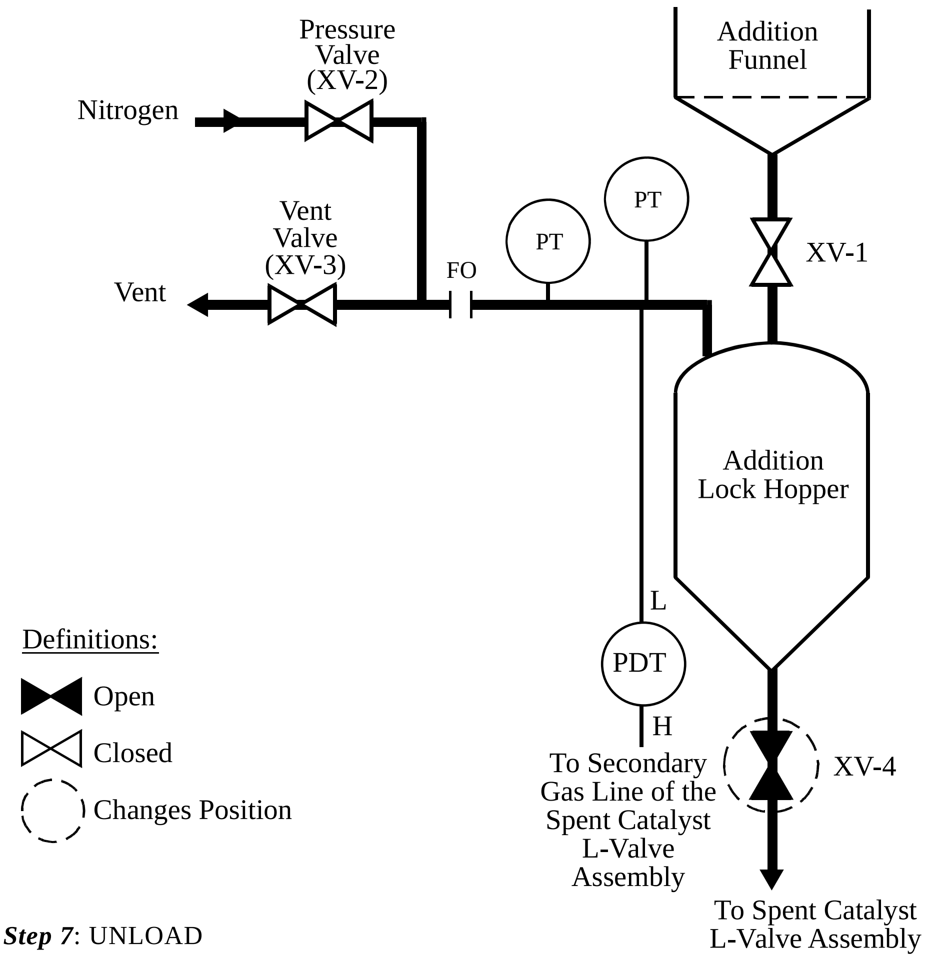
Conditions to Proceed:

1. Valve Positions Confirmed: XV-1 Closed, XV-2 Closed, XV-3 Closed, XV-4 Closed.

CYM-R00-90

Figure VIII-13

Catalyst Addition Control



Step 7: UNLOAD

Conditions to Proceed:

1. Valve Positions Confirmed: XV-4 Open, XV-1 Closed, XV-2 Closed, XV-3 Closed.
2. The Lock Hopper Cycle Counter Has Reached Its Set Value, or Lift Line Differential Pressure Has Dropped Below Setpoint.

Remarks:

1. FRESH CATALYST LOADING, Lock Hopper Cycling. The Lock Hopper Cycle Counter Begins Counting when XV-4 Confirms Open. The Counter Increments by One Each Time the Lock Hopper Fills. When the Counter Has Reached Its Set Value, the CATALYST ADDITION LOCK HOPPER NOT EMPTY Indicator Lamp Will Turn Off.
2. REGENERATION TOWER RELOADING, Spent Catalyst Isolation Closed. When the XV-4 Opens and a High Lift Line Pressure Differential is Indicated, then when the Lift Line Pressure Differential Indication Drops Below Low Setpoint for One Minute, the CATALYST ADDITION LOCK HOPPER NOT EMPTY Indicator Lamp Will Turn Off. For the First Cycle, a High Lift Line Pressure Differential is Not Required, Only a Low Pressure Differential for 5 Minutes.
3. Switch the Catalyst Addition to "OFF".
4. If XV-1, XV-2, or XV-3 Is Not Confirmed Closed, then XV-4 Remains Closed.

PLT-R00-97
CYM-R01-65

E. FILTER CLEANING

Very fine catalyst dust that is carried out with the vent gas from the Reduction Zone or the Lock Hopper Disengaging Zone (in units with a product separator pressure above 35 psi or 241 kPa) is collected in filters.

When the differential pressure across a filter approaches 1 psi (14 kPa), the filter is plugged and its elements need to be replaced or cleaned. Since the standard design includes two filters in parallel, the spare filter (with clean elements) can be brought on-line immediately and the used filter elements can be replaced or cleaned while normal operation continues.

The operator must keep in mind several important factors and precautions when cleaning or replacing the elements in a filter. First, since the filter operates under a pressurized, hydrogen-rich environment, it must be isolated, depressured and nitrogen purged before its housing is opened. Second, since the catalyst dust may be pyrophoric, care must be taken to cool the filter before opening and to minimize exposure to air during the cleaning or replacement of the elements.

The following procedure for replacing elements in a filter is general in nature and is not meant to apply to any one particular unit. The purpose of presenting this general procedure is to assist the refiner in developing a more detailed procedure.

1. Switch to the off-line filter by opening first the outlet and then the inlet valves. This should be done slowly to minimize any pressure upsets further upstream.

2. Isolate the used filter from the process by using the double block and bleed assemblies in the inlet and outlet lines. The block valves should be closed and the bleed valves should be opened to properly isolate.

3. Depressure the used filter to flare through the vent line provided.

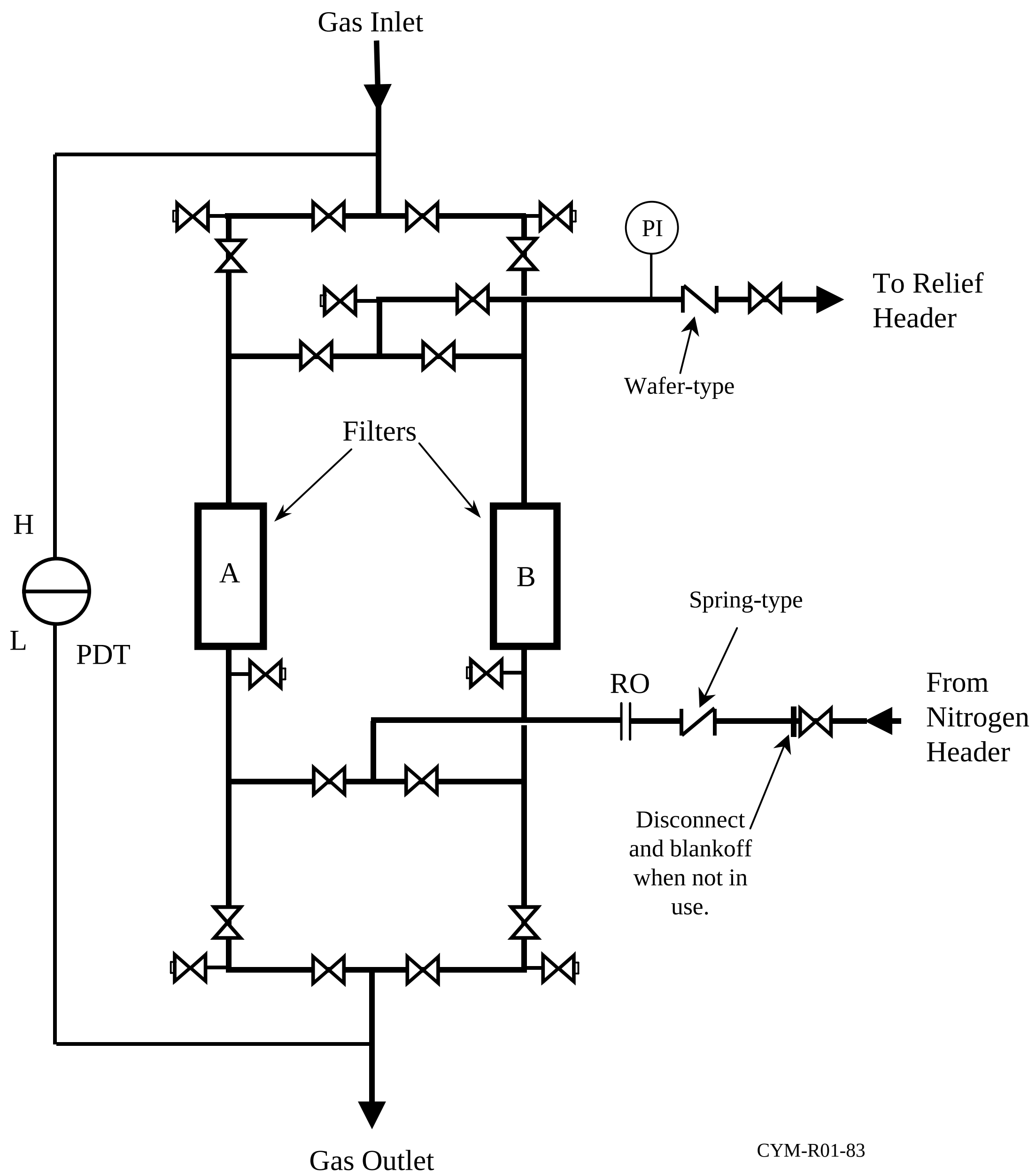
4. Using the nitrogen connection provided, purge the used filter with nitrogen to flare. Purge for sufficient time to remove all hydrogen and to cool the filter to ambient temperature. Cooling is done to prevent the auto-ignition of any iron pyrites that might be present. Isolate the N_2 supply line and the vent line to flare.

5. Open the used filter and carefully remove the elements. Remove any dust or debris from the bottom of the housing. Install new elements (or clean existing ones) and close the filter.

6. Air-free the unused filter by purging with nitrogen to the flare. Stop the N_2 purge and isolate the N_2 supply line and the vent line to the flare.

7. Close the bleed valves in the double block and bleed assemblies at the inlet and outlet of the unused filter. Open the double block valves in the outlet line from the unused filter. Keep the double block valves in the inlet line of the unused filter closed until it is needed.

Figure VIII-14
Reduction Zone and Lock Hopper Off-Gas Filters



F. VENT GAS SCRUBBING SYSTEM

By-products of the regeneration process are hydrochloric acid (HCl) and chlorine (Cl_2). Treating the vent gas for HCl and Cl_2 eliminates structural corrosion and environmental concerns. UOP utilizes a two-stage treating system (see Figure VIII-15). The first stage is a Venturi Scrubber that mixes dilute caustic with regeneration vent gas from the Burn Zone and Drying Zone Vent lines. As the caustic and regeneration vent gas pass through the scrubber, essentially all of the HCl and the majority of the Cl_2 are removed. The combined stream of caustic and Regenerator vent gas then flows to the second stage of treating, the Vent Gas Wash Tower.

A two-stage treating system reduces HCl and Cl_2 to lower levels than can be achieved by a single-stage system. The combined stream (Regenerator vent gas and caustic) enters the Vent Gas Wash Tower near the bottom. The vent gas passes through a shower of caustic and a packed bed washed with caustic. The scrubbed vent gas exits the top of the wash tower and is vented to atmosphere. The caustic leaves the bottom of the wash tower for pH adjustment and recirculation. A small portion of the caustic is sent to disposal.

1. Control Parameters

a) Caustic Flow to the Venturi Scrubber

The caustic flow to the Venturi is on flow control. This is to ensure that there is always sufficient flow of caustic to the venturi to prevent fouling and corrosion.

b) Caustic Flow to the Tower Packing

The caustic flow to the tower packing is controlled by a hand-operated globe valve. The flow rate is set at its design rate to effect the chloride removal in the packed bed. No adjustment to this flow is required other than to maintain the design rate.

c) Caustic Flow to the Spray Nozzle Below the Packed Bed

The caustic flow to below the packed bed is controlled by a hand-operated globe valve. The flow rate is set at its design rate to keep the bottom of the packing and the tower walls wetted with caustic. No adjustment to this flow is required other than to maintain the design rate.

d) Water Flow to the Spray Nozzle Below the Mesh Blanket

The water flow is intermittent and controlled by a hand-operated globe valve. The flow rate and time in operation is determined by what is required to dissolve any salt buildup on the mesh blanket. When the differential pressure across the mesh blanket reaches the high alarm setpoint, start the water flow. Open the globe valve in the mesh blanket wash line and close the normal water addition line to the circulating caustic. Spray the mesh blanket for 15 minutes with water. Then stop the water flow, resume normal water addition to the circulating caustic and check the mesh blanket differential pressure. Repeat this procedure until the differential pressure returns to its clean value.

e) Water Injection to the Circulating Caustic

The water flow is controlled by the liquid level in the Vent Gas Wash Tower. The liquid level is maintained by water injection that replaces the moisture lost due to humidification of the vent gas and the spent caustic drain.

f) Caustic Injection to the Circulating Caustic

The caustic flow is controlled by manually adjusting the pumpstroke of the injection pump. The flow of caustic is adjusted to maintain the total alkalinity of the circulating caustic at 0.35%, which should correspond to a pH level of between 7.5 and 8.5. The pH is monitored continuously by an on-line pH meter. The total alkalinity (NaOH equivalent) is monitored by daily lab analysis of a circulating caustic sample. Increasing the caustic injection will increase the total alkalinity of the circulating caustic.

g) Spent Caustic Withdrawn from the Circulating Caustic

The spent caustic withdrawal is controlled by a hand-operated globe valve in the withdrawal line. The flow of spent caustic is adjusted to maintain the total solids in the circulating caustic at or below 1%. The total solids level of the circulating caustic is monitored by daily lab analysis of a sample. Increasing the spent caustic withdrawal will decrease the total solids of the circulating caustic as more makeup water will be required to maintain liquid level in the Vent Gas Wash Tower. Total solids includes dissolved and suspended solids. There should be essentially no suspended solids present.

2. Overpressure Protection

To protect the Vent Gas Wash Tower from over-pressurization caused by a flooded bed, failure of the level instrument, or a restricted vent line, a liquid leg open to the atmosphere and Vent Gas Wash Tower gas bypass line to atmosphere are provided. The liquid leg is arranged such that if the Vent Gas Wash Tower pressure builds, a high liquid level alarm in the line will shut down the circulating caustic pumps, caustic injection pumps, and water injection pumps. As the Vent Gas Wash Tower pressure builds and pushes the caustic into the liquid leg, the Vent Gas Wash Tower gas bypass line nozzle will be exposed and allow vent gas to bypass the tower. A siphon breaking vent is provided in the liquid leg to prevent the entire caustic inventory of the tower from being educted out through the liquid leg.

3. Diversion Valves

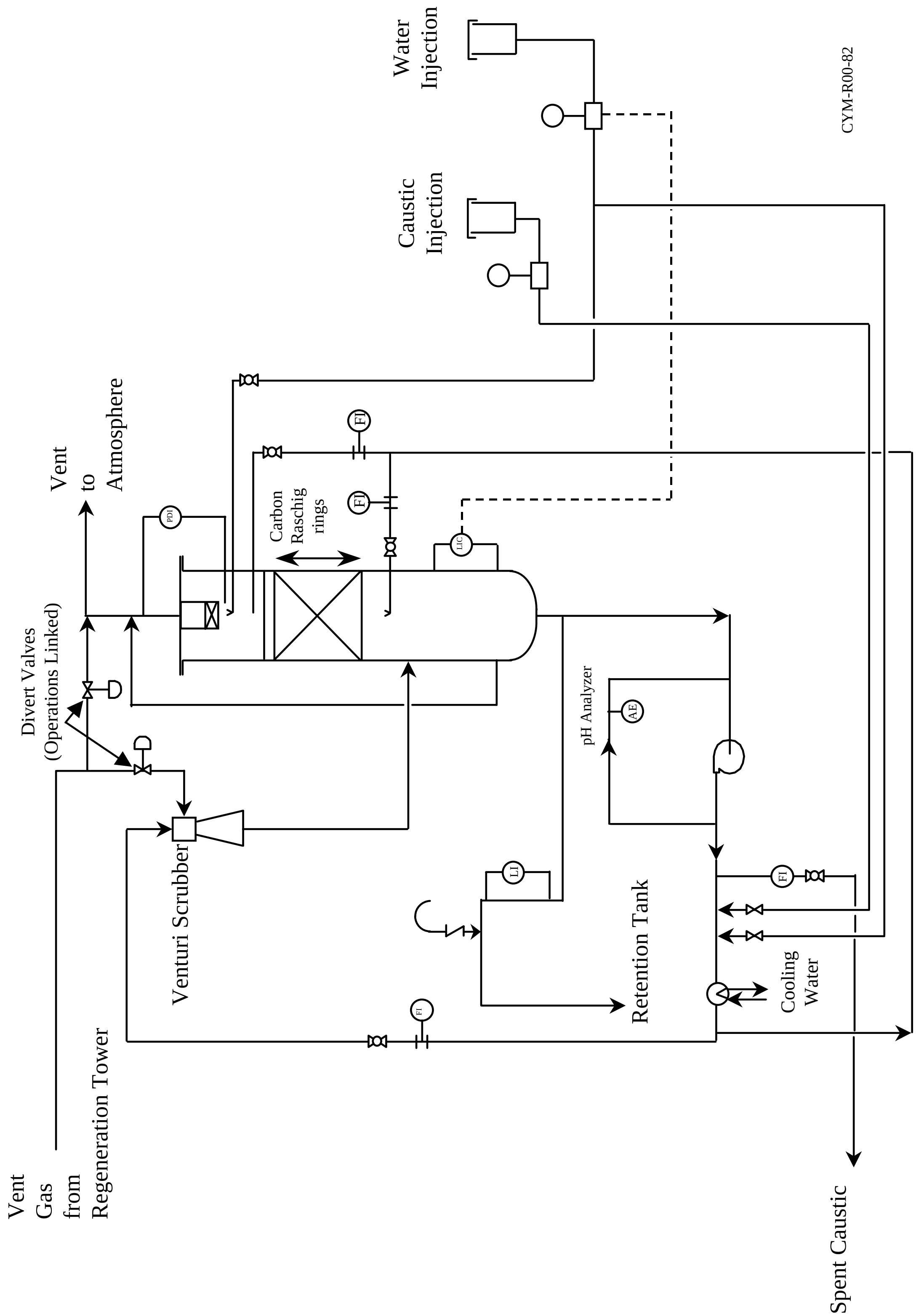
To protect the Vent Gas Wash Tower from rapid corrosion and to protect against possible combustion of the carbon Raschig ring packing, the vent gas is bypassed around the Vent Gas Wash Tower if the circulating caustic flow is lost. The circulating caustic flowing into the Venturi Scrubber normally cools the vent gas before entering the wash tower. If this flow is lost, a valve in the Vent Gas Wash Tower bypass opens and a valve in the vent line upstream of the Venturi Scrubber is closed. In the event this shutdown is activated, the Regenerator also is shut down to protect the environment from HCl and Cl_2 emissions.

4. pH Control and Corrosion Concerns

It is very important to monitor and control the pH and total alkalinity of the circulating caustic. If the caustic is allowed to become acidic, rapid corrosion of the vent gas scrubbing system can result.

In the event that proper pH control is not maintained, the Venturi Scrubber is the area where corrosion is most likely to be found. The line downstream of the Venturi Scrubber to the bottom of the Vent Gas Wash Tower can also show corrosion. These areas, and the walls of the VGWT, should be examined during turnarounds.

Figure VIII-15
CycleMax Regeneration Tower Vent Gas Treating
Venturi Scrubber and Vent Gas Wash Tower



CAUTION NOTES FOR THE CYCLEMAX CCR UNIT

CAUTION:
All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

CAUTION:
Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

CAUTION:
All upstream piping and equipment must be purged with inert gas before isolating the relief gas header from the line to the knockout drum and flare.

IX. ANALYTICAL

A. LABORATORY TEST SCHEDULE

This is a recommended laboratory test schedule for startup and normal operation. It is a general schedule to be followed if a specific schedule is not included as part of the Engineering Agreement or the Guarantee Agreement.

STREAM NAME / TEST	TEST METHOD NUMBER	FREQUENCY NORMAL	FREQUENCY STARTUP
Regeneration Tower Drying Air			
Moisture	UOP 344 or Dew Point Analyzer	2/W	3/W
Spent Catalyst			
Carbon, SOx Extraction	UOP 602 & 703	3/W	As Required
Chloride	UOP 291 & 275	3/W	As Required
Size Distribution(1)	UOP 333	1/W	1/W
Regenerated (Oxidized) Catalyst			
Carbon	UOP 703	3/W	As Required
Chloride	UOP 291 & 275	3/W	As Required
*Surface Area	UOP 874	Occas.	Occas.
*H_2/Pt	UOP 817	Occas.	Occas.
*Alumina Types	UOP 905	Occas.	Occas.
*Trace Metal Impurities	UOP 303 (ICP)	Occas.	Occas.
Size Distribution(1)	UOP 333	Occas.	Occas.
Vent Gas from Wash Tower			
HCL	Detector Tube	As Required	
Spent Caustic			
pH (pH meter)	ASTM D-1293	1/D	1/D
Total Alkalinity	UOP 209 & 210	1/D	1/D
Total Solids	Boil Away or APHA 2540	1/D	1/D
Lift Gas Blower Discharge			
Composition	Portable Analyzer	As Required	
Fines Drum			
Size Distribution(1)	UOP 333	1/W	1/W

STREAM NAME **FREQUENCY**

TEST	TEST METHOD NUMBER	NORMAL	STARTUP
Reduced Catalyst			
Chloride	UOP 291 & 275	As Required	
*H_2/Pt	UOP 817	As Required	

*Because this analysis measures a proprietary property of the catalyst, only the catalyst manufacturer may perform this analysis. The analysis is optional, but UOP recommends that it be performed four to six times per year, to help monitor the performance of the unit. Contact your UOP representative if you want to make arrangements for UOP to perform this analysis (or any of the other listed analyses) on a UOP catalyst.

(1) The apparatus of UOP 333 should be modified. The following U.S. standard sieve series screens are required:

U.S. No. 14	0.056 inch opening
U.S. No. 16	0.047 inch opening
U.S. No. 18	0.039 inch opening
U.S. No. 20	0.033 inch opening
U.S. No. 30	0.023 inch opening

Eight-inch diameter screens are sufficient.

In addition to this schedule, it is recommended that a composite sample of oxidized catalyst be collected and retained during the first, third, and fifth regeneration cycles, and during every fifth cycle thereafter. A composite sample is made by combining samples taken at regular intervals over the duration of regenerating a complete turnover of the catalyst inventory. A composite sample of a regeneration cycle is more representative of the entire catalyst inventory than one individual sample.

B. SAMPLE LOCATIONS

The locations of the sample points in the CycleMax Regeneration Section are:

Sample	**Location**
Spent catalyst	Disengaging Hopper – catalyst outlet
Regenerated catalyst	Nitrogen Seal Drum – catalyst outlet
Reduced catalyst	Lower Reduction Zone
Catalyst fines	Dust Collector – fines outlet
Drying air	Air Dryer – outlet
Vent gas	Wash Tower – gas outlet
Spent caustic	Wash Tower – caustic outlet
Nitrogen lift gas	Lift Gas Blower – gas outlet

Care must be exercised when collecting samples because the lines that are being sampled are pressurized and catalyst samples may be hot.

C. SPENT AND REGENERATED CATALYST SAMPLING PROCEDURE

The catalyst samples that are collected most frequently are the spent catalyst and the regenerated catalyst. At each location, there is a catalyst sample pot (Figure V-27). This sample pot will collect a catalyst sample volume of about 500 cc (one pint).

To collect a sample with the sample pot, use the following procedure:

1. Ensure that all four valves are closed, that the sample pot is empty, and that it is depressured to atmospheric pressure.

2. Open valve No. 2 to pressure up the sample pot.

3. Open valve No. 1 for 10 seconds to fill the restriction funnel and the transfer line with catalyst. Then close valve No. 1.

4. Allow 30 seconds for the restriction funnel to drain. Then close valve No. 2.

5. Open valve No. 3 slowly to depressure the sample pot.

6. Open valve No. 4 to collect catalyst.

7. Close valve nos. 3 and 4.

8. Repeat steps 2-7 to collect a live sample.

Steps 2-7 are repeated in the procedure because some of the catalyst that is first obtained from the sampler may have been stagnant in the sample line. The catalyst obtained the second time will be a better sample because it is more representative of the flowing catalyst in the line.

NOTE: Valve No. 2 and valve No. 4 should never be open at the same time as this would allow the escape of high pressure gas and could injure the operator. A valve interlock system is specified to prevent the simultaneous opening of these two valves.

D. REDUCED CATALYST SAMPLING PROCEDURE

A catalyst sample that is taken less frequently is the reduced catalyst. At this location, there is a special catalyst sampling device manufactured by UOP PIC (Figure V-28). This device is designed to safely remove catalyst from the Reduction Zone, which is under a pressurized hydrogen atmosphere. The detailed procedure for installation and catalyst sampling is found in the operating manual provided by the vendor.

E. SAMPLE SHIPPING PROCEDURE

1. Documentation and Procedures

Included at the end of this chapter are the standard procedures and forms to be used when shipping any samples to UOP for laboratory analyses.

2. Sample Containers

a. Octane Loss

It has been found that sample collection in clear bottles, which are left exposed to sun light (or ultraviolet lighting) either direct or indirect, and whether or not the sample has been treated with oxidation inhibitors, will result in a severe loss of octane rating within a very short time. Every effort must therefore be made to see that only the brown or amber sample bottles are used for daily samples and more important that all samples shipped to UOP for analysis are taken in amber bottles, are kept in a cool dark place until packaged for shipment, and are shipped as soon as possible after sampling.

It appears the mechanism for octane loss is peroxide formation. When air saturated samples are exposed to ultraviolet light, peroxides are formed. Peroxides are pro knock compounds that thermally decompose at temperatures lower than the desired combustion temperatures in engines.

b. Plastic

It has been found that hydrotreated kerosene sample when stored in a plastic sample bottle would have 2 to 3 times the sulfur content after 10 days than it had the first day. It appears the plastic container increased the sulfur content of the sample. Therefore, plastic containers should be avoided for sampling naphtha streams.

c. Polyethylene Caps

There have been found to be problems associated with the shipment of liquid samples shipped in standard laboratory vials with conical polyethylene caps. It has been found, through controlled tests, that samples cannot only permeate out of the containers in the question, but that the samples can actually cross- permeate between samples.

Tests were performed with the type of vials generally available in the laboratory using caps with liners of various materials. In a typical test, a vial containing only benzene and a vial containing only orthoxylene were placed together in a sealed jar for a period of time. The jars were heated to 40°C (a very possible shipping temperature) to speed the permeation. Tests were done both with the vials in an upright position and with the vials lying on their side so that the liquid would contact the caps. The common conical polyethylene lined caps cross-permeated from 0.50 to 4% under these conditions. Paper lined caps produced terrible results. Corks and Teflon linings worked well until they were tipped over, at which point these containers also produced terrible results. The best caps found thus far are the foil lined caps. The aluminum foil lined caps cross-permeate only slightly and the tin foil lined caps do not cross-permeate at all.

The following recommendations are made: If possible, keep the samples cool. Temperature does affect the permeation rate through some materials. Use tin foil lined caps when available and keep the samples as far apart as possible so they will have less tendency to cross-permeate.

General Letter for Domestic Samples (from within the USA)

Revised August 1, 1999

Following are the general procedures to be used when sending sample(s) to UOP for analysis, with the exception of SPA Catalyst samples, which will continue to be handled as before.

Information:

1. Please complete the attached Form and Fax it to UOP in Des Plaines, IL at (847) 391-2253 when the samples are shipped. Please note that completing this form will minimize delays in sample analysis.

Samples:

1. Label samples clearly with refinery name, location, sample description, and date collected.

2. Ship samples to:

UOP LLC
Sample Receiving
50 E. Algonquin Road
Des Plaines, Illinois 60017-5016

Attn: Technical Service Sample Coordinator

3. We recommend that samples be shipped by Federal Express or Emery. US Mail may be used for non-hazardous samples when expedited service is not required. Samples must be classified for "IATA" or "DOT" regulations and MUST be accompanied by the appropriate Material Safety Data Sheet (MSDS). The MSDS should include CAS numbers for identification per TSCA (Toxic Substances Control Act).

4. Include a copy of the attached Form with the samples.

5 Hand carrying of samples to UOP without proper documentation is illegal. Therefore, UOP employees and customers are to refrain from transporting any samples by this method, from any refinery to any UOP laboratory or office.

DOMESTIC
Analytical Requisition Form - UOP Technical Service

TO: UOP Technical Service Sample Coordinator **Phone 847-391-2620 FAX: 847-391-2253**

UOP Technical Service Contact ____________________ Phone _____________ Fax _____________

Customer: Refinery ____
Address ____
Contact Name ____________________ Phone _____________ Fax _____________

Liquid & Gas Sample(s)

Description	Analysis Required:	Check if MSDS is Included	Rush or Standard

Catalyst & Adsorbent Sample(s):

Process or unit: ____________________ Sample Location: ____________________

Catalyst Type	Regenerated or Coked	Analysis Required	Check if MSDS is Included	Rush or Standard

Billing Information:
Address: ____
____
____
____

Attention: ____

Sample Shipping Information:
Shipped Via: ____
Phone Number of Carrier: ____
Airwaybill No.: ____

General Letter for International Samples (from outside of the USA)

Revised August 1, 1999

In order to comply with U.S. regulatory laws outlined by the Environmental Protection Agency (EPA) and United States Customs, UOP LLC must assure that all chemical substances imported into the United States adhere to the following procedures.

IMPORTANT: The use of a freight forwarder (e.g. Burlington Air Express (BAX) or Emery Worldwide) or commercial cargo airline is preferred. Please note that UOP, as importer, must provide the TSCA (Toxic Substances Control Act) Certification. Only for samples sent by freight forwarder or commercial cargo airlines, UOP will provide the TSCA Certification directly to our Customs Broker.

Overnight couriers (e.g. DHL, FedEx, UPS) may be used only if the written TSCA certification - authorized, signed and dated by UOP - is obtained prior to shipment (i.e. UOP provides this form. Shipper must provide the remaining information) and physically included with the documentation shipped with the package.

All samples should be routed through Chicago's O'Hare International Airport.

1. All imports must have the following documentation:
    - Bill of Lading (also known as a Master Airwaybill) which includes vessel/flight information. The Bill of Lading must state: "Customs clearance by Circle International". The Bill of Lading description field must begin with the words "**TSCA Certified Chemical Sample.**"
    - *Pro forma invoice* (Attachment 2a and 2b: a blank form and example).
    - TSCA Certification (Attachment 3 example).
    - Analytical Requisition Form (Attachment 4)
    - Material Safety Data Sheet (MSDS) if the sample material is regulated as hazardous by IATA, IMO or DOT.

2. The documentation listed in Item 1 must include the following information:
    On the Proforma Invoice:
    - Shipper's name, address, contact name, phone number and fax number.
    - Importer's name, address, contact name, phone number and fax number (this must include the UOP contact person within the U.S.). UOP has provided this information except for Contact Person
    - Consignee/Delivery name, address, contact name, phone number and fax number (this must include the actual delivery location). UOP has provided this information.
    - Approximate market value (for Customs purposes), for each item, in U.S. Dollars.
    - Sample descriptions in English.
    - Packing details – the number and types of containers.
    - Net weights and Gross weights for each item, in kilograms.
    - Country of origin. This is the country where the sample was taken.

On the TSCA Certification Form:

- Sample description in English, UOP has provided this information.
- Date the sample is to be shipped, in English.

On the International Analytical Requisition Form:

- Shipper's name, address, contact name, phone number and fax number.
- Sample shipping information: Carrier and flight information, phone number of the carrier, airwaybill no.
- Fill in all pertinent sample and analytical request information as required.

3. All samples must be prepared according to the hazardous materials shipping regulations of the International Air Transportation Association (IATA), if shipped by air, or International Maritime Organization (IMO) if shipped by sea.

4. Prior to shipping, the UOP Tech Service Sample Coordinator must be notified of all imports before their arrival in the United States. **Please fax a copy of the Pro Forma Invoice, the Bill of Lading, TSCA Certificate, and the Analytical Requisition Form to the UOP Technical Service Sample Coordinator at 847-391-2253. In addition, include a copy of all the documents inside the package, with the samples.** UOP will then ensure proper Customs and TSCA clearance.

Failure to send samples with the proper documentation and information will result in a delay of Customs clearance or refusal of the sample.

Attachment 2a

Pro-Forma Invoice

INTERNATIONAL SHIPPER/EXPORTER (NAME & ADDRESS)

Contact Name: ______________________________
Contact Phone No.__________ Fax No. ___________

Invoice No:
Invoice Date:

Terms: Pro-Forma Invoice
Reference No:

DESCRIPTION	AMOUNT
*** NO CHARGE INVOICE *** QUANTITY:____ ____ DESCRIPTION OF SAMPLE(S):__________________________ ____ PACKED IN _____________ BOX(ES) GROSS WEIGHT:_____________ KGS. COUNTRY OF ORIGIN (where sample was taken) _____________ MARKS: AS ADDRESSED IMPORTER OF RECORD UOP LLC 25 EAST ALGONQUIN RD. DES PLAINES, IL 60017 ATTN: ____________________ UOP Contact Name CONSIGNEE / DELIVERY ADDRESS: UOP LLC SAMPLE RECEIVING 50 EAST ALGONQUIN RD. DES PLAINES, ILLINOIS 60017-5016 ATTN: UOP Tech Service Sample Coordinator ____________________________ Refinery Representative Signature ____________________________ Refinery Representative Name: please print I HEREBY CERTIFY THAT THIS INVOICE IS TRUE AND CORRECT.	US DOLLARS $ __________ **MARKET VALUE --** DECLARED FOR CUSTOMS CLEARANCE PURPOSES ONLY
ORIGINAL INVOICE	

Attachment 2b
Example

Pro-Forma Invoice

INTERNATIONAL SHIPPER/EXPORTER (NAME & ADDRESS)

Mountain View Refining
1000 Mountain View Dr.
Boulder City
Refining Country
Contact Name: Joe R. Engineer
Contact Phone No. (12) 3 456 -7890 Fax No. (12) 3-098-7654

Invoice No:
Invoice Date:

Terms: Pro-Forma Invoice
Reference No:

DESCRIPTION	AMOUNT
*** NO CHARGE INVOICE *** QUANTITY: Three 1 liter catalyst samples DESCRIPTION OF SAMPLE(S): R-134 CCR Platforming Catalyst Two regenerated samples and one spent sample PACKED IN 1 BOX(ES) GROSS WEIGHT: 3.5 KGS. COUNTRY OF ORIGIN (where sample was taken) Refining Country MARKS: AS ADDRESSED IMPORTER OF RECORD UOP LLC 25 EAST ALGONQUIN RD. DES PLAINES, IL 60017 ATTN: Robert S. UOP ~~UOP Contact Name~~ CONSIGNEE / DELIVERY ADDRESS: UOP LLC SAMPLE RECEIVING 50 EAST ALGONQUIN RD. DES PLAINES, ILLINOIS 60017-5016 ATTN: UOP Tech Service Sample Coordinator *Joe R. Engineer* Joseph R. Engineer Refinery Representative Signature Refinery Representative Name: please print I HEREBY CERTIFY THAT THIS INVOICE IS TRUE AND CORRECT.	US DOLLARS $ __________ **MARKET VALUE --** DECLARED FOR CUSTOMS CLEARANCE PURPOSES ONLY
ORIGINAL INVOICE	

Attachment 3

TSCA CERTIFICATION FORM

Example Form

To: Area Director of Customs

Date: August 23, 1999

Description of Sample: R-134 CCR Platforming Catalyst: Spent

Only one of the following should be selected:

(X) ***TSCA Positive Certification***

I certify that all chemical substances in this shipment comply with all applicable rules or orders under TSCA and that I am not offering a chemical substance for entry in violation of TSCA or any applicable rule or order under TSCA.

Angelo P. Furfaro

Signature (Authorized UOP LLC employee)

ANGELO P. FURFARO

Printed Name (Authorized UOP LLC employee)

Attachment 4

International Analytical Requisition Form - UOP Technical Service

TO: UOP Technical Service Sample Coordinator Phone 847-391-2620 FAX: 847-391-2253

UOP Technical Service Contact ____________________ Phone 847-391-________ Fax 847-391-2253

Customer: Refinery ____
Address ____
Contact Name ______________________ Phone ____________ Fax ____________

Liquid & Gas Sample(s)

Description	Analysis Required:	Check if MSDS is Included	Rush or Standard

Catalyst & Adsorbent Sample(s):

Process or unit: ________________________ Sample Location: ________________________

Catalyst Type	Regenerated or Coked	Analysis Required	Check if MSDS is Included	Rush or Standard

Billing Information:
Address: ____
____
____
____
Attention: ____

Sample Shipping Information:
Shipped Via: ____
Phone Number of Carrier: ____
Airwaybill No.: ____

X. TROUBLESHOOTING

A. TROUBLESHOOTING GUIDE

The following troubleshooting guide does not cover all abnormal situations that may occur. It is intended to be a guide to some of the upsets that may occur and to describe an appropriate response to those situations.

Process Symptoms	Possible Cause	Response
1. **Rapid decline or loss of Regeneration Gas flow**	_ Regeneration Blower failure	Check for a mechanical defect including a review of the blower bearing box temperatures, vibration, and motor amperage.
	_ High differential pressure in the Regenerator Burn Zone circuit.	Plugging of Burn Zone inner or outer screen. Refer to item 2 below. Differential pressure across the various equipment in the Burn Gas loop has increased due to foreign matter or mechanical defect.

<table>
<tr><th>Process Symptoms</th><th>Possible Cause</th><th>Response</th></tr>
<tr><td rowspan="3">2. Rapid Burn Zone screen plugging</td><td>– High fines and chips in the catalyst stream to the Regenerator</td><td>Verify proper elutriation in the Disengaging Hopper.

Inspect the mechanical condition and operations of the catalyst transfer equipment, including both catalyst lift lines, for any possible causes for increased catalyst breakage. Possible causes include:
• Protrusions in lift gas lines
• V-ball or B-ball valve malfunctions (incomplete opening)
• High lift gas velocities
• Catalyst fluidization in the Regenerator, Lock Hopper, or Reduction Zone due to very high velocity or blocked catalyst flow path leading to void spaces in these zones
• High differential pressure between the Disengaging Hopper and the Regenerator

If the plugging is severe and the coke burn is affected a CCR shutdown for screen cleaning will be necessary.</td></tr>
<tr><td>– Loss of catalyst to Regeneration Tower</td><td>Check the catalyst transfer pipes from the Disengaging Hopper to the Regenerator for plugging. Check the catalyst level in the Disengaging Hopper since a low level could cause catalyst fluidization in the Regeneration Tower.</td></tr>
<tr><td>– Breach in the Regenerator inner or outer screen</td><td>Immediate CCR shutdown for repairs.</td></tr>
</table>

Process Symptoms	Possible Cause	Response
3. **Increase in fines production**	_ Obstruction in catalyst lift line	See Possible Cause #1 for Process Symptom #2.
	_ High lift gas velocity	Check lift gas flows
	_ Improper operation of the Elutriation system	Perform fines survey and adjust the elutriation gas rate accordingly.
	_ High lift line catalyst flux	Do not exceed the design catalyst circulation rate and maintain steady lift line differential pressures
	_ V-ball or B-ball valve malfunctions	Check for proper position and smooth movement of these valves
	_ High gas flows into the Reduction Zone, Chlorination Zone, Drying Zone, Cooling Zone, Nitrogen Seal Drum, or Lock Hopper Purge Zone leading to catalyst fluidization	Check that these flows are not substantially higher than the design.
	_ Damage to catalyst caused by misoperation of the Regenerator Burn Zone	Phase damage to the catalyst due to high temperature exposure can lead to increased fines generation. Follow the General Operating Curve for the Burn Zone operation. If catalyst damage is suspected, have UOP test the catalyst for phase damage.
	_ Low catalyst levels in the Reduction Zone or Disengaging Hopper	Maintain these levels in the normal operating ranges

Process Symptoms	Possible Cause	Response
4. **Plugging of O_2 analyzer return line**	– Accumulation of salts or corrosion products	A decrease in sample gas flow causes an automatic shutdown of the Regenerator. Clear the debris from the sample return line according to refinery safety practices. Improve the steam tracing and insulation on the line. Steam tracing objective temperature should be 138 °C or higher. Make sure tracing is in contact with as much pipe surface as possible to eliminate dead spots where plugging can occur. Make the sample return line as short as possible.

Process Symptoms	Possible Cause	Response
5. **Flat (abnormal) Burn Zone temperature profile**	_ High catalyst circulation rate or high catalyst coke content	Check the maximum allowable circulation rate according to the General Operating Curve and adjust accordingly. Adjust the operating conditions in the reactors section to establish a suitable coke laydown rate
	_ Low concentration of O_2 in the Burn Zone	Compare the peak temperature in the Burn Zone to that observed when previously operating at the current oxygen concentration. The peak temperature should be nearly the same if the analyzer reading is correct. Recalibrate the O_2 analyzer and verify adequate sample gas flow to the analyzer.
	_ Burn Zone Screen plugging	See process Symptom #2.
	_ No coke in the Regenerator Burn Zone	This can occur after a CCR shutdown when the catalyst circulation is stopped but air continues. If all temperatures are low and the O_2 analyzer is functioning correctly, discontinue air addition, circulate catalyst into the Burn Zone, then restart the air in according to the Black Burn startup procedure.

Process Symptoms	Possible Cause	Response
6. **Low chloride content on regenerated catalyst**	_ Laboratory error	Repeat sample analysis and investigate laboratory test procedures
	_ Organic chloride pump failure	Check mechanical condition and operation of the injection pump. Check that the pump internal spillback (if applicable) is not malfunctioning.
	_ Contamination of the organic chloriding agent	Take a sample of the organic chloride and have it analyzed against the properties of the chloriding agent. Check a chloriding agent sample for the presence of water. Water should be insoluble in the organic chloride and easy to detect. Replace with new supply of organic chloride.
	_ Chloride line leaks	Leak test the injection line
	_ Drying Air is wet	Check that the Air Dryer outlet contains <5 vol-ppm water. Check air dryer operation. Check desiccant and replace annually with activated alumina.
	_ Low spent catalyst chloride content due to water upset in the Platforming Unit	Check difference between spent and regenerated catalysts. Correct the water problem in the reactor section. Increase chloride injection as required to return to normal.
	_ Sight glass calibration changed or incorrectly performed	Recalibrate sight glass.

Process Symptoms	Possible Cause	Response
7. **Reduction Zone high bed temperatures or high skin temperatures**	_ Exothermic reactions in the Reduction Zone caused by high concentration of heavier (C4+) hydrocarbons in the reduction gas	Conduct a Hot Shutdown of the Regenerator and shutdown the Reduction Gas Heaters No.1 and No. 2 until the exotherm is controlled. Take a sample of the booster gas and analyze for heavy hydrocarbons. If the concentration of C_4+ is higher than normal, lower the inlet temperature to the Lower Reduction Zone by 50 °C and restart. Restore the normal Lower Reduction Zone inlet temperature when the concentration of heavy hydrocarbons in the reduction gas has returned to normal.
	_ Poor spent catalyst lifting rate control	Consult your instrument engineer or UOP for solution.
8. **Decreased flowrate of regenerated catalyst to the Reduction Zone**	_ Insufficient differential pressure between the Lock Hopper Surge Zone and the Regenerated Catalyst L-valve.	Improve the operation of the Makeup Gas Valve which supplies gas to the Lock Hopper Surge Zone by conducting adaption mode cycles or otherwise modifying the Makeup Valve ramp table.
	_ Physical obstruction below the Lock Hopper or in the lift line	Check the position of the manual valves below the Lock Hopper. Clear the obstruction.

Process Symptoms	Possible Cause	Response
9. **Loss of catalyst seal in the Lock Hopper (inability to load or unload the Lock Hopper Zone)**	– Obstruction present in any of the Lock Hopper standpipes and restriction orifices	Check load and unload times and compare with baseline data. Check the operating pressures on each zone. If an obstruction is present, a CCR shutdown and subsequent inspection of the Lock Hopper will be necessary.
	– Equalization valves are no longer opening and/or closing according to the Ramp program in the CRCS	Check equalization valve function. Compare opening and closing times to past operation.

Process Symptoms	Possible Cause	Response
10. **Loss of Spent or Regenerated Catalyst Nitrogen Bubble (isolation systems frequently close)**	_ Nitrogen supply problems	Check nitrogen header pressure for value and stability.
	_ Excessive catalyst circulation	Check catalyst circulation rate is not above 100% of design.
	_ Instrumentation	Check if it is upper or lower bubble that has the problem. Check all instrumentation, including: • Stability of Regenerator pressure control • Stability of Lock Hopper Disengaging Zone pressure. This can be affected by Fuel Gas Drum pressure (where applicable) or by pressure swings in the Product Separator of the Platforming Unit. • Ramping rate for the lift line differential pressure controllers
	_ Obstruction in line	If an obstruction is present, a CCR shutdown and subsequent inspection of the N_2 addition point will be necessary. Consult with UOP before doing any work.

B. REGENERATOR BURN ZONE TOP TI

It is normal for the temperature at the top of the Burn Zone (Burn Zone TI #1) to fluctuate by 5~10˚C (9~18˚F) as cold catalyst flows through the transfer lines from the Disengaging Hopper into the top of the Regenerator. If these fluctuations are higher, however, the top of the inner screen may be damaged over the life of the screen.

The catalyst standpipe at the inlet of the Lock Hopper (Disengaging Zone) has been designed to control the magnitude of the temperature cycles at the top of the inner screen through a wide range of catalyst circulation rates. Even still, increasing the catalyst circulation rate will decrease the magnitude of these cycles and visa versa. It is important that this standpipe be constructed properly and that the holes in the standpipe are clear of any debris. If the temperature cycles at the top of the Burn Zone increase, then the holes in the “fluted” standpipe of the Lock Hopper (Disengaging Zone) could be blocked. A shutdown to inspect and clean the standpipe would be recommended if the top burn zone TI #1 cycle has increased by more than 5°C from the cycle observed right after the initial startup.

C. REDUCTION ZONE OFF-GAS TEMPERATURE

The off-gas from the Reduction Zone contains hydrochloric acid and water vapor. At the high temperatures in the Reduction Zone, these do not cause any problems. When the temperature of this gas is decreased, water vapor can condense creating severe corrosion problems.

After the gas is cooled in the Reduction Gas Exchanger, the temperature of the gas returning to the Platforming Unit should be monitored. The normal operating temperature at the outlet of the exchanger is 66°C (150°F) which is at a safe temperature above the water dew point of the gas. If this temperature should decrease below the normal operating temperature, there is a bypass around the tubeside of the exchanger that can be used to decrease the cooling of the off-gas. There is a low temperature alarm on the TI in this line to alert the operator that the temperature is becoming too low.

D. LIFT AND ELUTRIATION GAS RATES

1. Lift Gas Flow

The total lift gas flowrate should always be set to give the design lift line superficial gas velocity regardless of the catalyst circulation rate. For the Spent Catalyst Lift Line this is 25~30 feet/sec (7.6~9.1 m/sec) and for the Regenerated Catalyst Lift Line this is 30~35 feet/sec (9.1~10.7 m/sec). Even at the same gas flowrate, this velocity can change with variations in lift gas temperature, pressure and, for the Regenerated Catalyst Lift Line, lift gas molecular weight.

The operator should regularly check that the superficial gas velocities are within these target ranges so that the lift systems can operate correctly. Lower velocity will cause lifting problems usually seen as ΔP surges in the lift line. Higher velocity will lead to excessive catalyst fines generation.

2. Elutriation Gas Flow

The elutriation gas flowrate should be adjusted based on catalyst fines removal efficiency. If an excessive amount of fines are present in the spent and/or regenerated catalyst samples, the elutriation gas flowrate should be increased. This will cause the amount of whole pills in the dust dump to increase. The normal target for the elutriation gas flowrate is that which gives 20~30% whole pills in the dust collector.

Just as with the lift lines, the elutriation gas superficial velocity (measured in the elutriation pipe) can change with gas temperature and pressure. The elutriation gas superficial velocity should hence be checked to insure that the required elutriation rate is actually being maintained. The approximate elutriation gas superficial velocity should be 1.8 m/s (5.9 ft/sec). The best way of determining the optimum elutriation gas flowrate is to perform a Catalyst Fines Survey as detailed in Chapter XIII.

E. PLATFORMING UNIT TURNDOWN

When the Platforming unit has a total gas recycle gas compressor (net gas compressor suction is taken from the recycle gas compressor discharge), the control of the ∆P between the Reduction Zone and Reactor #1 must be adjusted when the Platforming unit feedrate is significantly reduced.

At decreased Platforming unit throughput, the reactor circuit ∆P decreases. The pressure at the inlet to Reactor #1 will hence decrease. With the recycle gas compressor suction pressure set at the separator pressure, the compressor discharge pressure will decrease accordingly. Meanwhile, the same Reduction Gas flow is used and so the ∆P in the Reduction Zone off-gas line will remain the same. Since the Reduction Zone off-gas is returning to the recycle gas compressor discharge (which is nearly the same as the Reactor #1 inlet pressure), the off-gas flow will decrease. The Reduction Zone off-gas control valve will open fully trying to maintain the ∆P between the Reduction Zone and Reactor #1.

To properly adjust for this situation, the setpoint of the Reduction Zone / Reactor #1 ∆P controller should be increased. The Reduction Zone is then at a sufficiently high pressure to permit the flow of the Reduction Zone off-gas to the net gas system. This ∆P setpoint can be increased to a maximum of **150%** of the design differential setpoint.

If, after increasing the ∆P setpoint to 150% of design, the hydraulics are still preventing good control of the Reduction Zone off-gas flowrate (and the Reduction Zone / Reactor #1 ∆P), then the Reduction Zone off-gas destination must be changed. The Reduction Zone off-gas can be re-routed to the Platforming Separator. When the Reduction Zone off-gas is flowing to this destination, the Reduction Zone / Reactor #1 ∆P controller can be set at its normal operating value. Rerouting the Reduction Zone off-gas to the Product Separator should be avoided, if possible, since the off-gas contains higher moisture content that will increase the moisture content of the recycle gas for the period that the Reduction Zone off-gas is re-routed.

F. OXYGEN ANALYZER

The oxygen analyzer is of paramount importance to the safe and efficient operation of the Regeneration Tower. Careful attention to its operation and regular maintenance of the analyzer are extremely important to insure the continued operation of the instrument.

A continuous sample flow is required for operation of the instrument. There is a flow indicator on the sample return line with a low flow shutdown switch. The sample flow is required not only to protect the internals of the analyzer but also to prevent any liquid condensing or debris from plugging the sample line.

If the regeneration gas is allowed to cool in the sample lines, water will condense in the return line from the analyzer back to the process. The chlorides will dissolve in the water and corrode the sample line. Not only will this cause mechanical problems but the corrosion products will plug the sample line, stopping the sample flow and shutting down the Regeneration Tower. For this reason, proper heat tracing of the sample line is vital to the continued operation of the analyzer. The block valve at the return to the process is a particular area where inadequate heat tracing can cause cooling of the sample gas and associated problems.

After an extended CCR shutdown, the O_2 analyzer should be re-calibrated. When the O_2 analyzer is exposed to 100% nitrogen for a period of time, it can go too far off-scale. In this case, upon re-start, the O_2 analyzer will read low. This can be verified by comparing the O_2 reading and peak burn temperatures. If the peak burn temperature is high but the oxygen analyzer reading is low, the analyzer should be re-calibrated.

XI. NORMAL SHUTDOWN

A. AUTOMATIC SHUTDOWN

The Catalyst Regeneration Control System (CRCS) prevents improper or unsafe conditions by executing an automatic shutdown. There are four automatic shutdowns: a Hot Shutdown, a Cold Shutdown, a Contaminated Nitrogen Shutdown and a Protection PES Hardware Shutdown. Each shutdown has its own specific usage, causes, and results. Discussed below are Hot Shutdown, Cold Shutdown and Contaminated Nitrogen Shutdown. Since the Protection PES Hardware Shutdown is more closely related with Instrumentation, a detailed description of this shutdown can be found by referring to the Process Information and Controls Equipment and Instructions Databook (Section 2.5).

For all of the systems in the Regeneration section, Table XI-1 shows the actions that occur during a shutdown of that system and the events that might have caused that shutdown.

1. Hot Shutdown

A Hot Shutdown occurs when the conditions in the Regeneration Section require that catalyst regeneration be stopped but not that the Regeneration Section be cooled, nor that the Isolation Systems be closed. This avoids delays in reheating the Regenerator Section prior to restarting. It also minimizes valve wear and catalyst attrition.

When any of the Hot Shutdown alarms sound, the CRCS will initiate actions in the Regeneration Section as detailed in Table XI-1.

2. Cold Shutdown

A Cold Shutdown occurs when the conditions in the Regeneration Section require that catalyst regeneration be stopped, the Regeneration Section be cooled, and the Isolation Systems be closed. This reduces the temperatures in the Regeneration Section and prevents cross-mixing of the hydrogen/hydrocarbon environment of the reaction section and the oxygen-containing environment of the Regeneration Section.

When any of the Cold Shutdown alarms sound, when the Regenerator Run/Stop Pushbutton is pushed, or when the Emergency Stop Switch is turned, the CRCS initiates actions in the Regeneration Section as detailed in Table XI-1.

3. Contaminated Nitrogen Shutdown

A Contaminated Nitrogen Shutdown occurs when the independent nitrogen header is contaminated, requiring that catalyst regeneration be stopped, the Regeneration Section be cooled, and the Isolation Systems be closed. In addition, the Contaminated Nitrogen Shutdown prevents contaminated nitrogen from entering the lower section of the Regeneration Tower by closing the Nitrogen Valve (XV-15), the Pressure Valve of the Regenerated Catalyst Isolation System (XV-23), and the control valve for the nitrogen purge to the Nitrogen Seal Drum.

When a Contaminated Nitrogen Shutdown occurs, the CRCS not only initiates four actions but also begins a Cold Shutdown that then leads to a Hot Shutdown. Detailed in Table XI-1 are the actions that take place in the event of a Contaminated Nitrogen Shutdown:

Table XI-1: Quick-Reference CRCS Shut-Down Guide

ACTIONS	CAUSES
Hot Shutdown	
1. N_2 to regenerator valve opens 2. Air to regenerator valve closes 3. Lower Air (Tie Line) valve closes 4. Chloride injection valve closes 5. Chloride injection pump stops 6. Lock Hopper Cycle stops (catalyst flow control switched to "OFF") 7. Spent Catalyst lifting stops as lift line ΔP setpoint is set to zero 8. Regenerated Catalyst lifting stops as lift line ΔP setpoint is set to zero	General 1. Cold Shutdown: Regeneration Run/Stop is in "STOP" condition 2. Catalyst Flow System is tripped/interrupted Isolation Systems 3. Spent Catalyst Isolation System closes unless the closing is caused by a low Reduction Zone level switch (clears after 1 min) 4. Regenerated Catalyst Isolation System closes (clears after 1 min) Catalyst Lift Lines 5. Regenerated Catalyst lift line temperature is >190°C 6. Regenerated Catalyst lift gas flow is below low flow trip point (restarts when flow is restored for >10 min) 7. Spent Catalyst lift gas flow is below low flow trip point (restarts when flow is restored for > 10 min) Regeneration Tower 8. One or more Regeneration Tower bed temperatures are above the shutdown settings. 9. Regeneration Gas from the Regeneration tower temperature is >565°C 10. Air flow to the Air Heater is Low (Unless Bypassed) 11. Gas flow to the Regeneration Heater is Low (Unless Bypassed) 12. Regeneration Heater outlet temperature is >500°C 13. Regeneration Gas O_2 Analyzer sample flow shows "Low Flow" (unless bypassed) or "analyzer malfunction" alarm for in-situ analyzers 14. Regeneration Gas O_2 is > 1.3 mol-% (unless bypassed) Disengaging Hopper 15. Disengaging Hopper continuous level is > 90% 16. Disengaging Hopper level switch shows "Empty" Catalyst Collector 17. Recycle Gas to Catalyst Collector Purge exchanger is below the low flow trip point (restarts when flow is restored for >10 min) 18. Gas temperature from the Catalyst Collector Purge Gas Exchanger is >200°C Reduction Zone 19. Any Reduction Zone Bed Temperature is >543°C Lock Hopper

<table>
<tr><th>ACTIONS</th><th>CAUSES</th></tr>
<tr><td></td><td>20. Lock Hopper Level Switch Failure System trips (LHZ upper level switch shows catalyst level and lower level switch shows no level for > 2 sec.)
21. Lock Hopper Equalization Valve Malfunction System trips (upper and lower equalization valves both Not Closed for > 2 sec.)
22. LH Long Cycle: Too much time has passed between LH cycles. This clears after one minute.
23. 2 consecutive Lock Hopper Slow or Fast Unload/Load Alarms
24. 2 consecutive Short Cycles (LH Surge Zone level <40% before the end of the LH cycle). This clears after one minute.
<u>VGWT</u>
25. Circulating Caustic flow to the vent gas wash tower is below the low flow trip point</td></tr>
<tr><td colspan="2" align="center">Cold Shutdown – Regenerator Run/Stop in “Stop” Mode</td></tr>
<tr><td>1. Hot Shutdown
2. Air and Regeneration Heaters shutdown
3. Spent and Regenerated Catalyst Isolation systems close</td><td>1. Emergency Stop Switch is in “STOP” position
2. Regenerator Run/Stop Switch is in “STOP” position
3. N_2 Analyzer detects contamination (Unless Bypassed -see Contaminated Nitrogen s/d)
4. Spent Catalyst Isolation System – either upper or lower valve does not confirm closed (after allowed time) after being commanded to close.
5. Regenerated Catalyst Isolation System – either upper or lower valve does not confirm closed (after allowed time) after being commanded to close.
6. N_2 Header pressure is below low pressure trip point
7. A Protection PES Hardware Shutdown
8. Valve power monitor detects valve power out of range</td></tr>
<tr><td colspan="2" align="center">Contaminated Nitrogen Shutdown</td></tr>
<tr><td>1. Initiates Cold Shutdown.
2. Stops the N_2 purge to N_2 Seal Drum.
3. Stops the N_2 purge to Regeneration Tower.
4. Stops the N_2 purge to Regenerated Catalyst isolation system.</td><td>1. Nitrogen Header H_2/HC is > 0.5% H_2
2. Nitrogen Header H_2/HC is < 7.5% HC</td></tr>
<tr><td colspan="2" align="center">Nitrogen to Regeneration Tower</td></tr>
<tr><td>System turns on and N_2 valve opens</td><td>1. Hot Shutdown condition exists
2. Emergency Stop Switch in “STOP” position</td></tr>
<tr><td>System turns off and N_2 valve closes</td><td>1. N_2 Analyzer detects contamination (see Contaminated Nitrogen s/d)
2. N_2 On/Off Switch is in “OFF” position</td></tr>
<tr><td colspan="2" align="center">Lower Air to Regeneration Tower</td></tr>
<tr><td>System turns off and Lower Air</td><td>1. Hot Shutdown condition exists</td></tr>
</table>

ACTIONS	CAUSES
valve closes	2. Lower Air On/Off Switch is in "OFF" position
Total Combustion Air to Regeneration Tower	
System turns off and Air valve closes when	1. Hot Shutdown condition exists 2. Air On/Off Switch is in "OFF" position
Chloride System	
1. Chloride valve closes 2. Chloride Injection Pump stops	1. Hot Shutdown condition exists 2. Air Heater outlet temperature is <460°C 3. Regeneration Gas Heater outlet temperature is <410°C 4. N_2 to Regenerator - valve is not verified closed. 5. Chloride Injection flow is below low flow trip point for > 30 sec. 6. Chloride Injection On/Off Switch is in "OFF" position
Spent Catalyst Isolation System	
System closes causing: 1. Isolation valves to close. 2. N_2 Purge valve to open.	1. Cold Shutdown (Regenerator Run/Stop is in "STOP" condition) 2. Spent Catalyst Isolation Open/Close Switch in "Close" position 3. Reduction Zone Level Switch shows "empty". 4. Rx. Purge/Secondary lift gas ΔP is below low ΔP trip point for > 5 sec. (typical value).
Regenerated Catalyst Isolation System	
System closes causing: 1. Isolation valves to close. 2. N_2 Purge valve to open.	1. Cold Shutdown (Regenerator Run/Stop is in "STOP" condition) 2. Regenerated Catalyst Isolation Open/Close Switch in "Close" position 3. N_2 Seal Drum/Regenerator ΔP is <50mm H_2O for >5 sec. (typical value). 4. N_2 Seal Drum/Lock Hopper ΔP is <50mm H_2O for >5 sec. (typical value).
Reduction Gas Heater No. 1	
Stops	1. Any Reduction Zone bed temperature is >543°C 2. Reduction gas heater skin temperature is >700°C 3. Reduction gas flow to heater is below low flow trip point. 4. Heater is in "Stop" mode. 5. Emergency Stop Switch is turned to "Stop"
Reduction Gas Heater No. 2	
Stops	1. Any Reduction Zone bed temperature is >543°C 2. Reduction gas heater skin temperature is >700°C 3. Reduction gas flow to heater is below low flow trip point 4. Heater is in "Stop" mode. 5. Emergency Stop Switch is turned to "Stop"
Regeneration Heater	
Stops	1. Cold Shutdown (Regenerator Run/Stop is in

ACTIONS	CAUSES
	“STOP” condition) 2. Regeneration gas flow to heater is below low flow trip point 3. Regeneration gas heater skin temperature is >700°C. 4. Heater is in “Stop” mode. 5. Emergency Stop Switch is turned to “Stop”.
Air Heater	
Stops	1. Cold Shutdown (Regenerator Run/Stop is in “STOP” condition) 2. Air flow to heater is below low flow trip point 3. Air heater skin temperature is >700°C 4. Heater is in “Stop” mode. 5. Emergency Stop Switch is turned to “Stop”
Spent Catalyst Flow Interrupt	
Closes Spent Catalyst Secondary Lift Gas valve	1. Emergency Stop Switch is in “STOP” condition 2. Reduction Zone Level is < 10% on the continuous level instrument.
Regenerated Catalyst Flow Interrupt	
Closes Regenerated Catalyst Secondary Lift Gas valve	1. Emergency Stop Switch is in “STOP” condition 2. Lock Hopper Surge Zone Level is < 10%
Regenerated Catalyst Lift Line	
Closes Regenerated Catalyst Lift Line Isolation valve	1. Emergency Stop Switch is in “STOP” condition 2. Reduction Gas to Reduction Gas Heater #1 is below low flow trip point **AND** Regenerated Catalyst Lift Gas Flow is below low flow trip point 3. Regenerated Catalyst Lift Line Skin Temperature is >190°C 4. Regenerated Catalyst Lift Line Isolation Open/Close Switch is in “Close” position
Reduction Zone/Reactor No. 1 ΔP System	
1. Reduction Zone Vent valve closes. 2. Recycle Gas purge to Reduction Zone (Standby gas) valve opens. 3. Booster Gas to Reduction Zone valve remains open. (manual reset required to restore normal operation.)	Reduction Zone/Reactor #1 ΔP is below low ΔP trip point.
1. Booster Gas to Reduction Zone valve closes 2. Reduction Zone Vent valve remains open. 3. Recycle Gas purge to Reduction Zone (Standby	Reduction Zone/Reactor #1 ΔP is above high ΔP trip point.

ACTIONS	CAUSES
gas) valve remains closed. (manual reset required to restore normal operation.)	
Vent Gas Wash Tower Bypass System	
1. Vent gas to VGWT divert valve closes. 2. VGWT bypass divert valve opens. (manual reset required to restore normal vent gas routing to VGWT.)	Circulating Caustic flow is below low flow trip point.
Inventory Mode	
1. Closes Regenerated Catalyst Isolation N_2 pressure valve 2. Opens Regenerated Catalyst upper and lower isolation valves.	1. Regenerator Run/Stop is in “STOP” condition. 2. Inventory Switch is in “INVENTORY” condition.

B. MANUAL SHUTDOWN

The manual shutdown procedures may be used for a planned shutdown or for a shutdown necessitated by an event like one of the following:

1. Sudden rise in the temperature indication at the bed thermocouples in the Burn Zone, the Reheat Zone, the Chlorination Zone, the Burn Zone outlet, or the Drying Zone outlet.

2. Malfunctioning oxygen analyzer.

3. Loss of the electric heaters.

4. Cooling water failure.

5. Platforming reactor section shutdown.

Obviously, the events listed above do not cover all of the possibilities for a manual shutdown, but most other failures result in an immediate automatic shutdown.

Information regarding instrument air failure, serious leaks, etc. is contained in Emergency Procedures.

1. Hot Shutdown

If the shutdown is only going to be for a short duration (no more than 36 hours), maintain the heat input to the Regeneration Section. Proceed as follows:

a. Stop catalyst flow by depressing the Catalyst Flow Off Pushbutton.

NOTE: The Lock Hopper stops cycling and the Lift line ΔP setpoints are reset to zero.

b. Start a nitrogen purge to the Regeneration Tower by depressing the Nitrogen On Pushbutton.

NOTE: Chloride injection to the Chlorination Zone stops automatically: XV-16 closes; the Chloride Injection Pump shuts down.

c. Stop air addition to the Regeneration Tower by depressing the Air Off Pushbutton.

d. Close the Lower Air Supply Line Valve by depressing the Lower Air Supply Line pushbutton to closed. Block in the manual valve in the air line upstream of the Air Valve (XV-13).

e. Set the Catalyst Flow Setpoint at 0% (or as low as possible) to prevent the carbon profile in the Burn Zone of the Regeneration Tower from being accidentally disturbed during the shutdown.

f. Close the excess air vent hand-control valve in manual. Set the nitrogen flow to the Air Heater at the design rate of nitrogen for startup.

g. Block in the organic chloride drum, pump discharge, and manual valve downstream of the Chloride Valve (XV-16).

2. Cold Shutdown

If the Regeneration Section shutdown is to last for a long period (or if vessels or lines are to be opened), proceed as follows:

a. Complete steps (a) through (e) of the Manual Hot Shutdown procedure in the previous section.

b. Decrease the outputs of the two temperature controllers for the electric heaters (Regeneration Heater and Air Heater) to cool the gas temperatures at a rate of 100°F/hr (55°C/hr). Switch off the heaters when 0% output is reached.

NOTE: The inlet temperature controller for the Burn Zone is split-ranged to the Regeneration Heater (50-100%) and the Regeneration Cooler (50%). The output will be decreased slowly from 100% down to 50% for zero output to the Regeneration Heater.

c. Block in the organic chloride drum, pump discharge, and manual valve downstream of the Chloride Valve (XV-16).

d. Close the excess air vent hand-control valve in manual. Set the nitrogen purge to the Air Heater at the design rate of nitrogen for startup.

e. Continue to cool the tower until all temperatures are down to 400°F (205°C) or as low as the Regeneration Blower will allow. Then shut down the Regeneration Blower and Cooler Blower.

f. Continue the design rate of nitrogen purge for startup through the Air Heater until all temperatures are down to 95°C (200°F).

g. Reduce the nitrogen purge via the Air Heater to as low a rate as possible while maintaining Regeneration Tower pressure control. Maintain the Spent Catalyst and Regenerated Catalyst Isolation Systems closed. The purges to the Air Heater and the Nitrogen Seal Drum should keep the Regeneration Tower air-free.

h. During the period the regeneration section is not in operation, start addition of chloride compound and water into the feed to the CCR Platforming Unit. For all UOP R-30 and R-130 series Platforming catalyst, typical addition rates are 0.5 wt-ppm Cl and 4 wt-ppm H_2O on a fresh feed basis. Water addition is not normally required unless the regenerator is shut down for more than five days.

i. On a regular basis, transfer enough catalyst out of the bottom of the last reactor until a "fresh" sample of spent catalyst from the last reactor reaches the spent catalyst sample location. Sample the spent catalyst to monitor not only the chloride content but also the increasing coke level. Adjust the chloride addition rate as needed to maintain the desired Cl level on the spent catalyst.

NOTE: Black Catalyst Startup to be used when restarting.

CAUTION NOTES FOR THE CYCLEMAX CCR UNIT

CAUTION:
All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

CAUTION:
Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

CAUTION:
All upstream piping and equipment must be purged with inert gas before isolating the relief gas header from the line to the knockout drum and flare.

XII. EMERGENCY PROCEDURES

The following situations necessitate immediate shutdown of the Regeneration Section as described below. These items supplement the conditions that would require a manual shutdown.

In any of the following situations: air addition to the Regeneration Tower must be stopped IMMEDIATELY. When an automatic shutdown is initiated, the CRCS should stop air addition automatically by closing the Air Valve (XV-13). In any case, to ensure that no air addition does occur, close the manual block valve in the air line upstream of the Air Valve (XV-13) IMMEDIATELY.

A. POWER FAILURE

Upon power failure, all electrical equipment around the CCR will stop. This includes all motor-driven pumps, the net gas compressors, all air blowers and the electric heaters. Depending on the extent of the power failure, a plant-wide shutdown is usually necessary.

The CRCS will initiate a Hot Shutdown of the CCR due to low Regeneration gas flow. Due to the low differential between the Reduction Zone and Reactor #1 caused by the loss of Booster gas, standby recycle gas will be routed to the Reduction Zone.

The operator should insure that the Regenerator Run/Stop button is in “Stop” mode such that both isolation systems will close. The CCR should then be shut down in accordance with the Cold Shutdown procedures.

B. INSTRUMENT AIR FAILURE

Upon instrument air failure, all control valves in the Regeneration Section move to the fail-safe positions. In most cases, the fail-safe position is the closed position. However, the two Regeneration Tower vent control valves (i.e., the Burn Zone vent and the excess air vent) stay in the positions they were in at the time of the instrument air failure in order to minimize system pressure swings. The control valves for nitrogen to the Air Heater, recycle gas purge to the Catalyst Collector and standby recycle gas to the Reduction Zone will fail open to maintain purge flows to these areas. It may therefore be necessary to restrict the nitrogen flow to the Regeneration Tower to prevent over-pressure of the tower.

All logic-operated valves in the Regeneration Section will also move to the fail-safe positions upon instrument air failure. For both isolation systems, the two isolation valves in the catalyst line will close and the nitrogen purge valve will open to isolate the Regeneration Tower. These actions will initiate a Hot Shutdown. The Air Valve (XV-13) will close and the Nitrogen Valve (XV-15) will open to purge the Regeneration Tower with nitrogen.

Complete the shutdown of the Regeneration Section in accordance with the manual Cold Shutdown Procedure. Attempt to maintain the Regenerator pressure at its normal operating pressure.

C. PLANT AIR FAILURE

Upon plant air failure, the combustion air flow to the Air Heater may be lost suddenly. This will initiate an automatic Hot Shutdown. Complete the shutdown of the unit in accordance with the manual Hot Shutdown Procedure.

D. RECYCLE COMPRESSOR FAILURE

Upon Recycle Compressor failure, recycle gas flow to the Reduction Zone atop the Platforming reactor and to the Catalyst Collector at the bottom of the Platforming reactor will also be lost. These purges keep these areas free of naphtha (to prevent coking) and should be restarted as soon as possible.

Restart the Recycle Compressor as soon as possible (see CCR Platforming General Operating Manual Emergency Procedures).

If the Recycle Compressor cannot be restarted, shutdown the Platforming reactor section in accordance with UOP shutdown procedures.

Complete the shutdown of the Regeneration Section in accordance with the manual Cold Shutdown procedure.

E. BOOSTER COMPRESSOR FAILURE

Upon Booster Compressor failure, booster gas flow to Regenerated Catalyst L-Valve Assembly will be lost suddenly. This will initiate an automatic Hot Shutdown. Also, booster gas flow will be lost to the Reduction Gas Heaters, causing them to shutdown. Standby recycle gas to the reduction zone should begin automatically.

Maintain recycle gas flow to the Reduction Zone atop the Platforming reactors and to the Catalyst Collector at the bottom of the Platforming reactors.

Complete the shutdown of the Regeneration Section in accordance with the manual Hot Shutdown Procedure. Because of the loss of flow, however, the Reduction Gas Heaters will not be in operation.

If catalyst has slumped to fill the Lock Hopper Surge Zone, restart the Regenerator using the Black Catalyst Startup procedure.

F. FUEL GAS FAILURE

Units with the Lock Hopper venting to the fuel gas drum will be affected by problems with the pressure control of that system. As the fuel gas pressure fluctuates, the pressures of the Regeneration Tower and the Lock Hopper may fluctuate too. Since pressure changes, especially if rapid, will affect both catalyst regeneration and catalyst circulation, shutdown the Regeneration Section in accordance with the Cold Shutdown Procedure. Monitor the pressure of the Regeneration Tower and the Lock Hopper closely to maintain normal operating pressures. If necessary, control the Regeneration Tower pressure in manual or isolate the Lock Hopper from the Fuel Gas Drum after stopping the flow of makeup gas to the Lock Hopper Surge Zone.

G. COOLING WATER FAILURE

Upon cooling water failure, cooling to the Regeneration Blower and to the Circulating Caustic Cooler will be lost suddenly. Shut down the Regeneration Section in accordance with the Cold Shutdown Procedure.

H. EXPLOSION, FIRE, LINE RUPTURE, OR SERIOUS LEAK

Do the following if possible:

a. Turn the Emergency Stop switch to the Stop position.

b. Isolate the affected area of the unit. Block in the high pressure hydrogen system (booster gas) as required to accomplish this.

   Maintain the booster gas supply as lift gas (if possible) to the Reduction Zone via the Regenerated Catalyst L-Valve Assembly. If lift gas to the Reduction Zone must be stopped, maintain standby recycle gas flow to the Reduction Zone atop the Platforming reactors and to the Catalyst Collector at the bottom of the Platforming reactors.

c. Complete the shutdown of the Regeneration Section in accordance with the manual Cold Shutdown procedure when time permits.

I. CCR NITROGEN FAILURE

Loss of nitrogen to the Regeneration Section is a serious emergency. The Regeneration Section cannot be safely operated without a constant supply of nitrogen at the design pressure and purity. Restart nitrogen to the Regeneration Section as soon as possible.

Upon nitrogen failure, the nitrogen header pressure to the Regeneration Section will be lost suddenly. This will initiate an automatic Cold Shutdown. Also, all of the nitrogen purge gas flows to the Regeneration Section will eventually be lost.

Close the manual valve in the air supply line to the Regeneration Section upstream of the Air Valve (XV-13).

Complete the shutdown of the Regeneration Section in accordance with the manual Cold Shutdown procedure. However, there will be no nitrogen purge to the Air Heater to cool the Regeneration Tower, and the Regeneration Tower will cool more slowly.

Maintain operation of the Regeneration Blower. The Regeneration Tower and Disengaging Hopper will gradually depressure through the seals of the Regeneration Blower.

After a loss of nitrogen, ensure that the nitrogen header is purged of any contaminants before resuming the nitrogen supply to the Regeneration Tower.

NOTE: In the event of loss of nitrogen to the Regeneration Tower, the operator should insure that all the valves in the vent line are open to the atmosphere (if VGWT is bypassed). This is to prevent the cooling catalyst pulling a vacuum on the tower.

CAUTION NOTES FOR THE CYCLEMAX CCR UNIT

CAUTION:

All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

CAUTION:

Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

CAUTION:

All upstream piping and equipment must be purged with inert gas before isolating the relief gas header from the line to the knockout drum and flare.

XIII. SPECIAL PROCEDURES

A. REGENERATOR COKE BURN TEST PROCEDURE

A Regenerator Coke Burn Test quantifies the maximum coke burning potential of the Regeneration Tower. The result of this test is a specific operating guideline chart, similar to the General Operating Curve, but representing the full coke-burning potential of the as-built Regeneration Tower.

A Regenerator Coke Burn Test consists of first circulating catalyst with a high coke content (typically 8 wt%) through the Burn Zone and then testing to determine how much of the coke is combusted. The testing is done at several different Burn Zone conditions. However, all of the testing is done with the Regeneration Tower in black burn conditions (i.e., upper air injection only, nitrogen to the Drying and Cooling Zones).

Black burn conditions are required for the Coke Burn Test for two reasons. First, under certain Coke Burn Test conditions, a significant amount of the coke being circulated through the Burn Zone may not be completely burned. With an all-nitrogen atmosphere in the Chlorination, Drying and Cooling Zones, any residual coke (above 0.1 wt-% coke) on the catalyst exiting the Burn Zone will not cause overheating and damage to catalyst and equipment. Second, black burn conditions permit measurement of an important variable: the Burn Zone oxygen utilization. The Burn Zone oxygen utilization is calculated using the Burn Zone outlet oxygen concentration of the Regeneration Gas, and this is representative of the Regeneration Gas exiting the Burn Zone bed only during black burn conditions.

An operating guideline chart representing the full coke burning potential of the Regeneration Tower can be constructed based on the results of the Coke Burn Tests. To be conservative, this chart should be based on an oxygen utilization factor lower than the utilization factor actually measured. In spite of this conservatism, such a chart will generally establish greater coke burning potential for the Regeneration Tower than that afforded by the General Operating Curve.

Aside from evaluating the maximum coke burning potential of the Regeneration Tower, the Regenerator Coke Burn Tests offer an excellent opportunity to characterize operating temperature profiles exhibited by the Burn Zone catalyst bed thermocouples for known coke burning rates and residual coke contents. Profiles such as these will provide a basis for comparing profiles observed during normal operation.

For further information and the current coke burn test procedure contact the UOP Platforming Technical Service Department.

B. CATALYST FINES SURVEY PROCEDURE

In order to achieve optimum performance of both the reactor and regeneration sections of the CCR Platforming Unit, it is essential that catalyst fines be efficiently removed from the circulating catalyst inventory. In this regard, a fines survey should be conducted periodically to check the performance of the elutriation system. Based on the results of these surveys, elutriator velocity should adjusted. The elutriation gas flow is set to maximize the removal of material under 0.047 inches and at the same time limit whole sphere carryover to the Dust Collector to a tolerable level, typically 20-30 wt%. The duration of a fines survey is generally eight hours.

A recommended catalyst fines survey procedure along with example calculations is found below.

1. Prior to the Survey:

a. Thoroughly blow down the Dust Collector and Fines Collection Pot.

b. Install an empty, tared 55-gallon drum to collect fines beneath the Fines Collection Pot.

c. Set the elutriation gas flow at the desired rate. Set the total nitrogen lift gas flow to the Spent Catalyst L-Valve Assembly at the design rate to achieve target gas velocity in the lift pipe.

d. Line out the catalyst levels in the Reduction Zone and the Disengaging Hopper.

e. Record the number of transfer cycles on the Lock Hopper cycle counter.

2. During the Survey:

a. Maintain steady elutriation gas flow and lift gas flows to provide constant elutriator velocity.

b. Maintain steady Reduction Zone and Disengaging Hopper catalyst levels.

c. Collect three 500cc (cubic centimeter) composite samples of Disengaging Hopper product catalyst.

3. At the Conclusion of the Survey:

a. Record the number of transfer cycles on the Lock Hopper cycle counter.

b. Thoroughly blow down the Dust Collector and Fines Hopper.

c. Determine the net weight of fines collected during the survey.

d. Collect a 500 cc sample of the fines drum material.

e. Determine the size distribution of the Disengaging Hopper product catalyst and fines drum material using laboratory analysis method UOP-333.

NOTE: The apparatus section of UOP 333 should be modified as explained in Laboratory Test Schedule in Section IX.

f. Compute the percent removal of the various particle sizes as follows:

(1) Based on the number of transfer cycles of the Lock Hopper cycle counter compute the total weight of catalyst fed to the Disengaging Hopper during the survey.

NOTE: If the Reduction Zone or Disengaging Hopper levels were not steady throughout the test then attempt to compensate for any differential level. If the level deviations were substantial, it would be best to repeat the test.

(2) Compute the total weight of Disengaging Hopper product by subtracting the total fines weight from the total Disengaging Hopper catalyst feed weight (calculated in (1) above).

(3) Compute the weight of the various size ranges making up the Disengaging Hopper product and fines streams by multiplying the UOP-333 results by the respective total stream weights.

(4) Compute the weight of the various size ranges making up the Disengaging Hopper feed by adding the weight breakdowns on the Disengaging Hopper product and fines streams.

(5) Compute removal of the various size ranges by dividing the weights of each size range contained in the fines stream by the corresponding weights contained in the Disengaging Hopper feed stream. Convert fractions to percent.

g. On five-cycle semi-log graph paper, plot percent removal on the log scale versus average particle size on the linear scale.

An example of typical fines survey calculations is presented below:

Example XIII-1: Fines Removal Calculation

Given the following plant data:

Lock Hopper transfers during fines survey	96
Lock Hopper load size	251.5 lbs
Total fines and whole pills collected during fines survey	5.9 lbs
Total fines collected during fines survey	4.1 lbs

Fines and D.H. sample size breakdown as follows:

Table XIII-1: Size Breakdown

Size U.S Sieve #.	**Fines** Wt-%	**D.H. Product** Wt-%
14	19.06	99.98
16	10.89	0.016
18	18.47	0.0037
20	4.12	0.0001
30	8.56	0.0001
Pan	38.9	0.0001

Compute the fines removal efficiency during the survey as follows:

(1) **Total catalyst circulated during survey period (M_T)**
M_T = (96)*(251.5) = 24144 lbs

(2) **Total D.H. Product (M_D)**
M_D = 24144 - 5.9 = 24138.1 lbs

(3) **Calculated spent catalyst size breakdown**
For each size range:

Fines + D.H. Product = Spent Catalyst

i.e., for 14 mesh:
(19.06% * 5.9) + (99.98% ∗ 24138.1) = 24134.40

Table XIII-2: Size Breakdown By Analysis

Size	Fines		D.H. Product		Spent Catalyst
U.S Sieve #.	Wt-%	lbs	Wt-%	lbs	lbs
14	19.06	1.125	99.98	24133.27	24134.40
16	10.89	0.643	0.016	3.862	4.505
18	18.47	1.090	0.0037	0.893	1.983
20	4.12	0.243	0.0001	0.024	0.267
30	8.56	0.505	0.0001	0.024	0.529
Pan	38.9	2.295	0.0001	0.024	2.319
TOTAL		5.9		24138.1	24144.0

(4) **Fines removal efficiency**

For each size range:

$$\frac{\text{Fines}}{\text{Spent Catalyst}} \times 100\% = \text{wt-\% Removal}$$

i.e., For 14 mesh:

$$\frac{1.125}{24134.40} \times 100\% = 0.0047\%$$

Table XIII-3: Size Removal Efficiency

Size U.S Sieve #.	**Ave. Particle Size** (Inches)	**Wt-%** **Removed**
14	0.0550	0.0047
16	0.0505	14.3
18	0.0425	55.0
20	0.0360	91.0
30	0.0280	95.4
Pan	0.0230	99.0

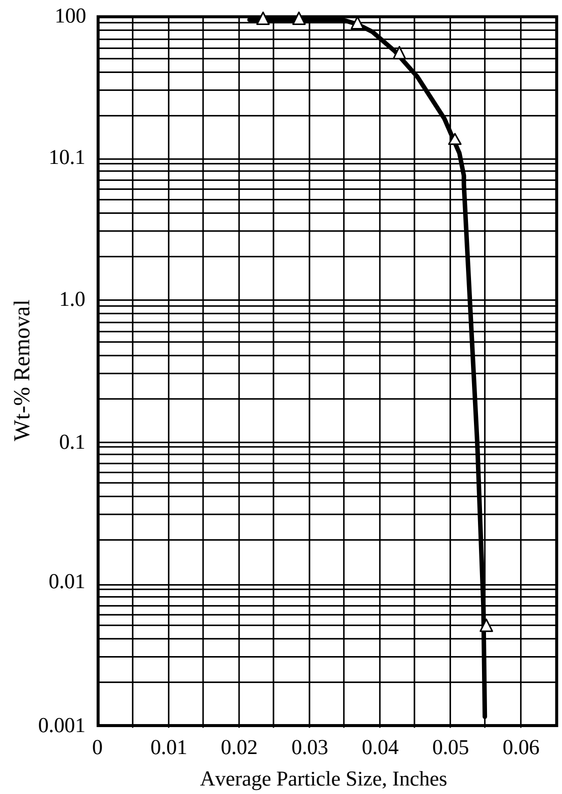
(5) **Graph results (Figure XIII-1).**

4. Interpretation of the Data

Figure XIII-1 shows a typical case of fines removal efficiency. Every unit should be capable of achieving this level of fines removal.

In order to choose the "best" elutriation gas velocity, fines surveys should be performed over a 0.6 m/sec (2 ft/sec) span in elutriation gas velocity at 0.1 m/sec (0.25 ft/sec) increments. As the elutriation gas velocity increases, more total catalyst fines are removed. At some point, the amount of fines (defined as catalyst on U.S. Sieve No. 18 and smaller) removed remains constant with increasing elutriation gas velocity. At gas velocities above this point, the increase in catalyst and fines removed is solely due to an increase in the catalyst removed (U.S. Sieve No. 16 and larger). Therefore, the optimum gas velocity would be at this point of maximum fines removal without excessive catalyst removal. Refiners who choose to operate below this optimum gas velocity for the sake of minimizing whole catalyst removal do so at the expense of more frequent Regenerator centerscreen cleaning. Note that catalyst and fines weights are on a volatile-free basis.

Figure XIII-1
Fines Removal vs. Average Particle Size



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C. SAFEING PROCEDURES

Safeing procedures are designed to isolate various sections of the unit from the rest of the process during normal operation. These procedures are not written for the purpose of preparing vessels for entry. The following safeing procedures are general in nature and are not intended to apply to any one particular unit. The purpose in presenting these general procedure outlines is to assist the refiner in developing more detailed procedures for their particular unit.

1. Reduction Gas System Safeing Procedure

The Reduction Gas System includes the Reduction Gas supply line (including Reduction Gas Heaters No. 1 and No. 2) and the Reduction Gas outlet line (including the Reduction Gas Exchanger and filters). To perform maintenance on any equipment in this system, the whole system must be isolated, depressured and inerted.

The following procedure outlines a general procedure for carrying out this operation. This outline is written with the assumption that the Regeneration Section has been operating under normal conditions.

a. Shut down the Regeneration Section manually in accordance with the Cold Shutdown procedure. This includes cooling down and stopping Reduction Gas Heaters No. 1 and 2.

   NOTE: It is not necessary to cool the Regeneration Tower down to 200°C (400°F) in order to continue isolation of the Reduction Gas System.

b. Close the manual V-Valve in the catalyst outlet line underneath the Lock Hopper and wait for catalyst lifting (from the Regenerated Catalyst L-Valve Assembly) to finish.

c. Close the manual B-Valve underneath the Lock Hopper.

Unless the Platforming Unit is shut down, maintain the flow of lift gas through the Regenerated Catalyst Lift Line to the Reduction Zone. This will be the only purge gas to the Reduction Zone while the reduction gas and standby recycle gas lines are isolated.

d. Isolate the Reduction Gas system from the reactor section, net gas section, and the booster gas section. Use double-block and bleed valve assemblies where they are provided.

(1) Close the double-block and bleed assembly at the Reduction Gas supply line near the outlet of the Booster Gas Coalescer.

(2) Close the single-block valves at the outlets of both Reduction Gas Heaters No. 1 and No. 2. A single-block valve is used in these locations due to heat loss considerations in the piping downstream of the heaters. Blinds should be inserted at these points once the system is depressured.

(3) Close the double block and bleed assembly in the standby recycle gas purge line to the lower Reduction Zone inlet.

(4) Close the double-block and bleed assembly on the Reduction Gas outlet line located at the reactor vessel.

(5) Isolate the Reduction Gas outlet line at the pressure differential control valve at the outlet of the Reduction Zone off gas filters.

e. Depressure the section of the Reduction Gas system between the Booster Gas Coalescer and the check valve located upstream of the Reduction Gas Heaters to flare using the vent line in the Reduction gas supply line near the Booster Gas Coalescer.

f. Depressure the section of the Reduction Gas System between the check valve located upstream of the Reduction Gas Heaters and the reactors to atmosphere (at safe location) using the vent line in the lower Reduction Zone inlet line.

g. Depressure the Reduction Gas outlet line between the reactor and the pressure differential control valve using the vent provided at the filters.

h. Purge the Reduction Gas supply system of hydrogen and hydrocarbons by pressuring with nitrogen and venting.

(1) Connect a temporary nitrogen line to the Reduction Gas line close to the Booster Gas Coalescer.

(2) Pressure the Reduction Gas supply System to ~3.5 kg/cm^2 (50 psi) with nitrogen.

(3) Depressure the section of the Reduction Gas System between the Booster Gas Coalescer and the check valve located upstream of the Reduction Gas Heaters to flare using the vent line in the Reduction gas supply line near the Booster Gas Coalescer.

(4) Depressure the section of the Reduction Gas System between the check valve upstream of the Reduction Gas Heaters and the reactors to atmosphere (at safe location) using vent line in the lower Reduction Zone inlet line.

(5) Repeat purging until combustibles measurements are less than 0.1 vol%.

(6) Keep the system under a slight positive nitrogen pressure for the maintenance.

(7) Install blinds as needed for maintenance consistent with the refinery safety practice.

i. Purge the Reduction Gas outlet line with nitrogen from the purge point located at the double-block and bleed assembly to the relief header via the vents at the filters.

j. After the maintenance has been completed, the equipment has been reinstalled, and the blinds removed from the lines, the system can be air freed by the purging procedure given above.

k. Pressure the system back up to operating pressure by slowly opening the isolation valves in the Reduction Gas supply line.

l. Open the double-block and bleed assemblies closed earlier in this procedure.

m. Commission the reduction gas flow.

n. Restart the Regeneration Section in accordance with either the Black Catalyst Startup procedure or the White Catalyst Startup procedure, whichever applies.

2. Booster Gas System Safeing Procedure

The Booster Gas System includes the Booster Gas Coalescer, Booster Gas Heater and associated piping. To perform maintenance on any equipment in this system, the whole system must be isolated, depressured and inerted.

The following procedure outlines a general procedure for carrying out this operation. This outline is written with the assumption that the Regeneration Section has been operating under normal conditions.

a. Shut down the Regeneration Section manually in accordance with the Cold Shutdown procedure. This includes cooling down and stopping Reduction Gas Heaters No. 1 and 2.

   NOTE: It is not necessary to cool the Regeneration Tower down to 200°C (400°F) in order to continue isolation of the Booster Gas System.

b. Close the manual V-Valve in the catalyst outlet line underneath the Lock Hopper and wait for catalyst lifting (from the Regenerated Catalyst L-Valve Assembly) to finish.

c. Close the manual B-Valve underneath the Lock Hopper.

d. Stop regenerated catalyst lift gas flow by closing the primary and secondary lift gas control valves in manual. Isolate these control valves with the double block & bleeds.

e. Stop steam flow to the Booster Gas Heater by closing the steam condensate control valve in manual.

f. Stop the Booster Gas supply to the Lock Hopper Surge Zone by closing the PDV and Make-Up valves. Isolate these control valves with the double block & bleeds.

g. Stop the Booster Gas supply to the Reduction Gas system by closing the double-block and bleed valve assembly in the Reduction Gas supply line. Close the control valves in the upper and lower Reduction Gas lines.

h. Stop the Booster Gas supply to the system by closing the Booster Gas inlet valves to the Booster Gas Coalescer. Close the coalescer drain valves.

   The loss of the reduction gas and lift gas flows should signal the Regenerated Catalyst Lift Line Valve to close, and for the standby recycle gas valve to open to supply purge gas to the Reduction Zone. The shutoff valve in the Reduction Gas outlet line should also close. Verify that these actions have occurred.

i. Slowly depressure the Booster Gas System to the Platforming Separator via the drain line from the Booster Gas Coalescer.

j. Evacuate the Booster Gas System and pressure with nitrogen.

(1) Connect the ejector manifold to the Booster Gas line downstream of the coalescer.

(2) Commission the ejector and evacuate the system to at least 600 mm Hg (24 in Hg) vacuum.

(3) Connect a temporary nitrogen line to a convenient point in the system. Break the vacuum and pressure up the system to 0.35 kg/cm^{2}g (5 psig) with nitrogen using the temporary line.

(3) Repeat evacuation and purging until combustibles measurements are less than 0.1 vol%.

(4) Keep the system under a slight positive nitrogen pressure for the maintenance.

(5) Install blinds as needed for maintenance consistent with the refinery safety practice.

k. After the maintenance has been completed, the equipment has been reinstalled, and the blinds removed from the lines, the system can be air freed by the evacuation and purging procedure given above.

l. Pressure the system back up to operating pressure by slowly opening the isolation valves in the Booster Gas supply line to the coalescer and the coalescer drain valves.

m. Open the double-block and bleed assemblies closed earlier in this procedure.

n. Commission the steam to the Booster Gas Heater as well as lift gas and reduction gas flows.

o. Restart the Regeneration Section in accordance with either the Black Catalyst Startup procedure or the White Catalyst Startup procedure, whichever applies.

3. Lock Hopper System Safeing Procedure

The Lock Hopper system includes the Lock Hopper and its associated piping along with the regenerated catalyst lift line. To perform maintenance on the Lock Hopper, the whole system must be isolated, depressured and inerted.

The following procedure outlines a general procedure for carrying out this operation. This outline is written with the assumption that the Regeneration Section has been operating under normal conditions.

a. Shut down the Regeneration Section manually in accordance with the Cold Shutdown procedure.

b. Isolate the Lock Hopper System from the reactor section, net gas section, and the Regeneration Tower. Use double-block and bleed valve assemblies where they are provided.

   (1) Close the double-block and bleed assembly at both the primary and secondary lift gas control valves.

   (2) Close the double-block and bleed assembly at the PDV and Makeup gas control valves which supply booster gas to the Lock Hopper Surge Zone.

   (3) Close the double-block and bleed assembly at the Lock Hopper vent (off-gas) line from the Disengaging Zone.

   (4) Close the Regenerated Catalyst lift line isolation valve (atop the reactor stack) by pressing the Regenerated Catalyst Lift Line Valve Pushbutton.

   (5) Close the Regenerated Catalyst Isolation System (above the Lock Hopper) by pressing the Regenerated Catalyst Isolation Close Pushbutton.

c. Slowly depressure the Lock Hopper system to the flare using the vent line on the upper equalization line.

d. Evacuate the Lock Hopper system and break with nitrogen.

(1) Connect the ejector manifold to the secondary lift gas line downstream of the control valve.

(2) Commission the ejector and evacuate the system to the best vacuum possible. Nitrogen will still be leaking in through the Regenerated Catalyst Isolation System so a full vacuum will not be possible but every effort should be made to purge all hydrogen from the vessel at this point.

(3) Break the vacuum and pressure up the system to 0.35 kg/cm^{2}g (5 psig) with nitrogen from the addition line provided on the Lock Hopper gas outlet line.

NOTE: There is catalyst in the L-Valve assembly since the manual valves below the Lock Hopper are not closed. The screens in the lift gas lines will prevent any catalyst from being removed from the system by the evacuations.

(4) Repeat evacuation and purging until combustibles measurements are less than 0.1 vol%.

(5) Maintain a small nitrogen purge on system during the period of maintenance if possible.

e. Positively isolate the Lock Hopper from the Regeneration Tower by inserting a blind below the lower valve of the Regenerated Catalyst Isolation system (directly above the Lock Hopper).

f. If further purging is required, repeat the evacuation and purging of the Lock Hopper system as above. This time a full vacuum of 24 inches (600 mm) Hg will be possible.

g. Verify that the Regenerated Catalyst lift line isolation valve (atop the reactor stack) is not leaking (passing). Swing the spectacle blind above the valve to the closed position.

h. Install other blinds as needed for maintenance consistent with the refinery safety practice.

i. Perform all necessary maintenance.

j. After the maintenance has been completed, the equipment has been reinstalled, and the blinds removed from the lines, the system can be air freed by the evacuation and purging procedure given above.

k. Pressure the system back to operating pressure by opening the control valve then slowly opening the isolation valve on the secondary lift gas line.

l. Open the double-block and bleed assemblies and isolation valves closed in step (b) of this procedure.

m. Restart flows of makeup and vent gases to and from the Lock Hopper.

n. Restart the Regeneration Section in accordance with either the Black Catalyst Startup procedure or the White Catalyst Startup procedure, whichever applies.

4. Regenerated Catalyst Lift Line Safeing Procedure

The Regenerated Catalyst lift line includes the lift line from the lift gas control valves to the top of the reactors. To perform maintenance on any equipment in this system, the whole system must be isolated, depressured, and inerted.

The following procedure outlines a general procedure for carrying out this operation. This outline is written with the assumption that the Regeneration Section has been operating under normal conditions.

a. Shut down the Regeneration Section manually in accordance with the Hot Shutdown procedure.

b. Isolate the lift line from the reactor, Lock Hopper, and Booster Gas System. Use double-block and bleed assemblies where they are provided.

   (1) Close the manual V-Valve in the catalyst outlet line from the Lock Hopper and wait for catalyst lifting (from the Regenerated Catalyst L-Valve Assembly) to finish.

   (2) Close the manual B-Valve underneath the Lock Hopper.

   (3) Close the double-block and bleed assembly at both the primary and secondary lift gas control valves.

   (4) Close the Regenerated Catalyst lift line isolation valve (atop the reactor stack) by pressing the Regenerated Catalyst Lift Line Valve Pushbutton.

c. Depressure the lift line to flare using the vent line at the secondary lift gas line.

d. Evacuate the lift line and pressure with nitrogen.

   (1) Connect the ejector manifold to the secondary lift gas line downstream of the control valve.

   (2) Commission the ejector and evacuate the system to at least 600 mm Hg (24 in Hg) vacuum. Break the vacuum and pressure up the system to 0.35 kg/cm^{2}g (5 psig) with nitrogen from the purge point downstream of the primary lift gas control valve.

(3) Repeat the evacuation and purging until combustibles measurements are less than 0.1 vol%.

(4) Maintain a small nitrogen purge on system during the period of maintenance if possible.

e. After verifying that the valves are not leaking (passing), blind the lines at the Regenerated Catalyst lift line valve (atop the reactor stack) and below the manual valves under the Lock Hopper.

f. Install other blinds as required to perform maintenance consistent with the refinery safety practice.

g. Perform all required maintenance.

h. After the maintenance has been completed, the equipment has been reinstalled, and the blinds removed from the lines, the system can be air freed by the evacuation and purging procedure given above.

i. Pressure the system back to operating pressure by opening the control valve then slowly opening the isolation valve on the secondary lift gas line.

j. Open the double-block and bleed assemblies and isolation valves closed earlier in this procedure.

k. Restart the Regeneration Section in accordance with either the Black Catalyst Startup procedure or the White Catalyst Startup procedure, whichever applies.

5. Regeneration Section Air System and Nitrogen Lift System Safeing Procedure

The Regeneration Section air and nitrogen systems include the Regeneration Tower, Disengaging Hopper, their associated piping, and the nitrogen lift circuit. To perform maintenance on any equipment in this system, the system must be isolated, depressured, and inerted. This system should not be evacuated. Maintenance inside the Regeneration Tower requires the unloading of catalyst. In this case, follow the Catalyst Unloading and Reloading Procedure later in this chapter. In most other cases, the following procedure outlines a general procedure for preparing the Regeneration Section air system for maintenance:

a. Shut down the Regeneration Section manually in accordance with the Cold Shutdown procedure. This closes the Spent Catalyst and Regenerated Catalyst Isolation Systems, isolating the Regeneration Section air system from the Regeneration Section hydrogen system. To perform maintenance on the Spent Catalyst Isolation System valves, isolate the system by closing the manual valves in the catalyst outlet line from the Catalyst Collector below the reactors and closing the blind below the valves.

b. Slowly depressure the Regeneration Tower through the Burn Zone vent valve. This will also depressure the Disengaging Hopper and nitrogen circuit. Depressure at a maximum rate of 20 kPa (3psig) per minute. Maintain the differential pressure between the Disengaging Hopper and the Regeneration Tower between zero and the normal operating differential pressure.

CAUTION: Rapid depressurization of the Regenerator could cause catalyst fluidization in the Regenerator.

c. Verify that all sections have been depressured then keep the system under a slight positive nitrogen pressure.

d. Install other blinds as required to perform maintenance consistent with the refinery safety practice.

e. At this point, maintenance procedures can be performed on the equipment in the air system. The maintenance procedures will vary depending on the particular piece of equipment involved. In any case, the procedures should minimize the ingress of ambient air and any moisture into the air system.

CAUTION: Be aware that nitrogen will continue to flow into this system at the Spent Catalyst Isolation System and other locations unless isolated.

f. After the maintenance has been completed, the equipment has been reinstalled, and the blinds have been removed, the Regeneration Section can be prepared for restarting in accordance with the Final Startup Preparation Procedure.

g. Restart the Regeneration Section in accordance with either the Black Catalyst Startup Procedure or the White Catalyst Startup Procedure, whichever applies.

D. CATALYST UNLOADING AND RELOADING PROCEDURES

The following procedures for unloading and reloading the Regeneration Tower are general in nature and are not meant to apply to any one particular unit. The purpose in presenting these general procedure outlines is to assist the refiner in developing more detailed procedures for his particular unit.

Some maintenance procedures require that the catalyst be unloaded from the Regeneration Section while the Platforming reactor section remains in operation. Cleaning the screens in the Regeneration Tower is an example of such a procedure. The catalyst is first unloaded from the Regeneration Tower into catalyst drums at grade, and then reloaded via the Catalyst Addition Lock Hopper No. 1, while the reactor section remains in operation.

1. Regeneration Tower Catalyst Unloading

The following outlines a general procedure for unloading catalyst from the Regeneration Tower. This procedure is written with the assumption that the Regeneration Tower is operating under normal white burn conditions (lower air only):

a. Stop catalyst circulation by depressing the Catalyst Flow Off Pushbutton. Let the Reduction Zone and the Disengaging Hopper levels stabilize.

b. Close the manual V-ball, only, below the Catalyst Collector.

c. Place the secondary gas flow control to the Spent Catalyst L-Valve Assembly off cascade from the lift pipe pressure differential controller. Slowly start secondary gas flow to clear catalyst from the catalyst transfer line below the closed V-ball valve and the lift pipe.

d. Close the manual B-valve below the Catalyst Collector.

e. Press the Regeneration Stop Button. This will perform the following:

   (1) Close both isolation systems.
   (2) Shut the power off to the Regeneration Gas Heater, and the Air Heater.
   (3) Close both catalyst flow interrupt systems.
   (4) Stop catalyst addition.
   (5) Start nitrogen addition to the Regeneration Tower.
   (6) Stop air addition to the Regeneration Tower.
   (7) Stop chloride injection to the Regeneration Tower.

f. Put the nitrogen addition valve in manual and close it. To stop the nitrogen flow.

g. Stop the Fines Removal Blower and the Lift Gas Blower.

h. Continue Regeneration Gas Blower operation to cool catalyst in the Burn Zone down to approximately 150°C (300°F).

   NOTE: If the Regeneration Gas Blower has two speeds, switch to low speed when the blower suction temperature has decreased to the appropriate temperature as recommended by the blower vendor.

i. Stop the Regeneration Gas Blower and the Cooler Blower.

j. Connect the catalyst withdrawal line at the outlet of the Regeneration Tower.

k. Locate sufficient clean, dry catalyst drums to contain the catalyst from the Disengaging Hopper and Regeneration Tower. Catalyst will be unloaded at grade from the exit of the catalyst withdrawal line.

l. Open the valve at the bottom of the catalyst withdrawal line and unload catalyst into drums. The flow of cool nitrogen to the Regenerator Cooling Zone should continue and can be adjusted to adequately cool the catalyst being unloaded for safe handling.

m. When approximately 80% of the catalyst in the Disengaging Hopper and the Regeneration Tower has been unloaded, reduce the Regeneration Tower pressure to below 0.35 kg/cm^2g (5 psig). This will prevent high pressure nitrogen from exiting the tower when the catalyst level drops.

n. Close the valves in the catalyst withdrawal line when the line clears of catalyst.

o. Cool the Regeneration Tower with the design nitrogen purge to the Cooling Zone until all temperatures are below 38°C (100°F).

p. Reduce nitrogen flow to the Regeneration Tower to the minimum required to maintain pressure control.

q. Maintain the Regeneration Tower under a slight positive pressure with nitrogen until preparations for vessel entry are started.

2. Catalyst Reloading

Catalyst is usually reloaded into the Disengaging Hopper through the top manway using a crane just as in the catalyst loading procedure in the Commissioning section (Chapter VI).

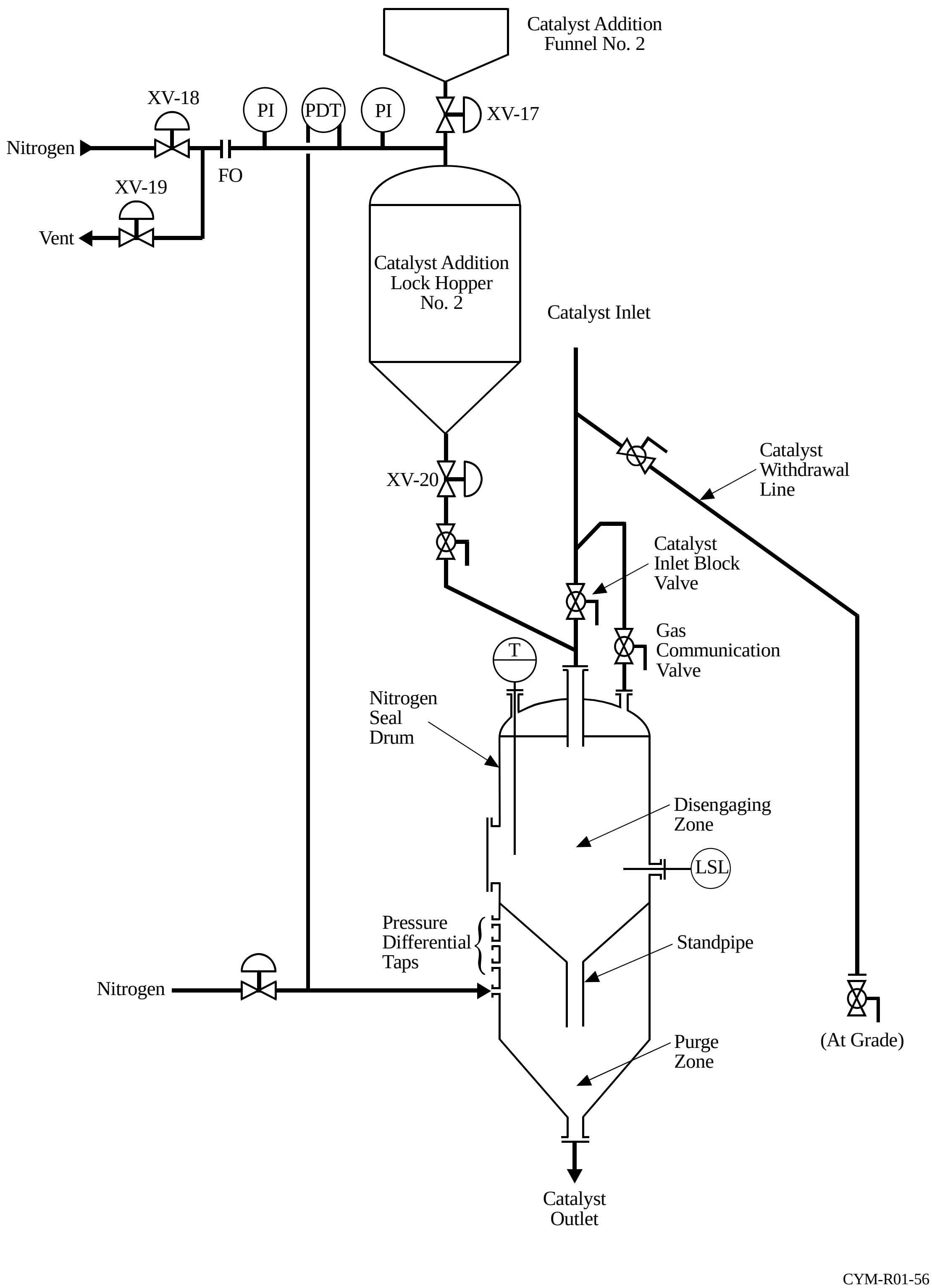
If a crane is unavailable, contact UOP for a procedure using the normal catalyst addition system.

E. CATALYST CHANGEOUT ON-THE-FLY

The following procedure, nicknamed "changeout on-the-fly," allows for a total catalyst replacement while maintaining Platforming Unit operations. This procedure is particularly useful when a refiner finds the need to replace old CCR Platforming catalyst with a new load between scheduled unit turnarounds. The basic principle of the changeout procedure is that while the Platforming Unit and Regeneration Section continue normal operation, old catalyst is continuously withdrawn and replaced with fresh catalyst. The old catalyst is removed below the Regeneration Tower allowing the coke to be combusted before unloading. The fresh catalyst is added just below the withdrawal point, at the Nitrogen Seal Drum, via Catalyst Addition Lock Hopper No. 2. At the Nitrogen Seal Drum a special valve and piping arrangement are used to allow for the catalyst replacement while maintaining normal gas communication between the Regeneration Tower and the Nitrogen Seal Drum. This arrangement is shown in Figure XIII-2.

Figure XIII-2

Catalyst Changeout on-the-Fly System



1. Procedure

The following procedure outlines a general procedure for carrying out this operation. This outline is written with the assumption that the Regeneration Section has been operating under normal conditions.

a. Install and commission necessary changeout on-the-fly equipment and piping around the Nitrogen Seal Drum. This includes the Catalyst Addition Funnel No. 2, Catalyst Addition Lock Hopper No. 2 and associated piping, the catalyst withdrawal line, the gas communication line at the Nitrogen Seal Drum, and the level indicator on the Nitrogen Seal Drum.

b. Reduce the catalyst circulation to a maximum of 1500 pph, or to the maximum rate that catalyst drums can be supplied to the Catalyst Additional Funnel No. 2. The Platforming Unit severity may need to be reduced such that the coke production is consistent with the new catalyst circulation rate. To prevent a loss of performance in the Platforming Unit the spent catalyst coke level should be kept below 7 wt-% throughout the changeout.

c. Switch operation of the Regeneration Tower from White Burn mode to Black Burn mode.

d. Stop the Air Heater, while maintaining the normal Burn Zone inlet temperatures, to maximize catalyst cooling as it leaves the Regenerator.

e. In order to minimize nuisance shutdowns, the setpoints for the pressure differential controllers can be increased. This will reduce the chance of low pressure differential causing a shutdown and will aid in purging air from the fresh catalyst loaded into the unit.

f. Commence the Catalyst Addition Lock Hopper (#2) sequencing as detailed below. Wait for the “Load” indicator light and then load a drum of fresh Platforming catalyst into the addition funnel.

g. At the same time as step (f), open the manual B-valve below XV-20, open the gas communication valve above the Nitrogen Seal Drum, and close the manual block valve in the catalyst inlet line just above the Nitrogen Seal Drum.

h. Continue loading fresh catalyst into the Nitrogen Seal Drum via the Catalyst Addition Funnel and Catalyst Addition Lock Hopper No. 2. The logic for this system's operation is detailed below.

i. Once catalyst addition is progressing smoothly, begin catalyst removal via the catalyst withdrawal line. Open fully the block valve at the top of the withdrawal line. Open the valve at the bottom of the withdrawal line to set a catalyst withdrawal rate consistent with the catalyst addition rate.

j. The old catalyst should be loaded directly into catalyst drums at grade. The unloaded catalyst should be free of coke, as the Regeneration Tower is still in a modified Black Burn mode, and cooled to such a point as to permit safe handling. The flow of nitrogen to the Cooling Zone can be adjusted to adequately cool the catalyst.

k. Continue the catalyst addition and withdrawal until the entire catalyst inventory has been replaced.

l. Once catalyst addition is completed, close the block valve at the top of the catalyst withdrawal line and allow the line to drain.

m. Close the block valve in the catalyst addition line just below XV-20.

n. Open the manual block valve in the catalyst inlet line just above the Nitrogen Seal Drum. Close the gas communication valve above the Nitrogen Seal Drum.

o. Disconnect and blankoff changeout on-the-fly equipment and piping.

p. Restore normal pressure differential setpoints on the pressure differential controllers around the Nitrogen Seal Drum.

q. Resume desired catalyst circulation rate and Platforming Unit severity.

For further details on this procedure, contact UOP Technical Services department.

2. Logic Requirements

This section outlines the logic requirements for the operation of the Catalyst Addition System. This explanation has been simplified to include only those items that the operator can check for proper operation. For a complete explanation of the logic, refer to the manual for the UOP PIC Catalyst Regeneration Control System (CRCS).

The Catalyst Addition System No. 2 (Figures XIII-2~9) consists of a Catalyst Addition Funnel, Catalyst Addition Lock Hopper, and four valves. The Catalyst Addition Funnel is open to the atmosphere and can be filled with catalyst from drums. The Catalyst Addition Lock Hopper fills with catalyst and can be pressured up to transfer the catalyst into the Catalyst Transfer System. The four logic-operated valves that allow the Catalyst Addition Lock Hopper to be depressured, loaded, pressured up, and unloaded during the addition of catalyst are listed below:

VALVE	TAG
Load Valve	XV-17
Pressure Valve	XV-18
Vent Valve	XV-19
Unload Valve	XV-20

The open and closed positions of these valves are indicated by position switches.

There are several inherent hazards to overcome in order to add catalyst safely from drums into the Nitrogen Seal Drum. First, since the Seal Drum operates under a nitrogen pressure of about 2.5 kg/cm^{2}g (35 psig), it cannot be opened directly to the atmosphere. Second, since the Addition Lock Hopper should be filled only when it is completely empty (to avoid overfilling and thus closing valves on catalyst), the time allowed for unloading of the Catalyst Addition Lock Hopper must be coordinated with the catalyst circulation. By the addition procedures and through the controlled sequence of the CRCS, the Catalyst Addition System accomplishes these tasks.

The catalyst addition operation consists of cycling the Catalyst Addition Lock Hopper No. 2 through a sequence of LOAD and UNLOAD steps. The operator starts these steps by turning a handswitch. The steps are monitored and controlled by the CRCS.

The two basic steps of the catalyst addition are:

STEP	**OPERATION**
LOAD	Catalyst Addition Lock Hopper, empty of catalyst, is depressured and loaded with catalyst from the Addition Funnel.
UNLOAD	Catalyst Addition Lock Hopper, full of catalyst, is pressured up with nitrogen and unloaded into the Nitrogen Seal Drum.

At the end of the UNLOAD step, the cycle can be repeated if more catalyst addition is desired.

The Catalyst Addition System has the following features:

a. **Catalyst Addition Switch:** The Catalyst Addition Switch is a field-mounted, three-position handswitch. The three positions of the switch are labeled as “LOAD,” “OFF” (mid-position), and “UNLOAD.” The switch must be turned through the “OFF” position when switching from “LOAD” to “UNLOAD” or back.

“LOAD”

In the “LOAD” position, the CRCS prepares the Catalyst Addition Lock Hopper so the operator can load it with catalyst.

“OFF”

In the “OFF” position, the CRCS closes the Catalyst Addition Lock Hopper. Catalyst cannot be loaded or unloaded.

“UNLOAD”

In the “UNLOAD” position, the CRCS prepares the Catalyst Addition Lock Hopper and unloads catalyst into the Nitrogen Seal Drum.

b. **Nitrogen Seal Drum Level Indicator:** The level in the Seal Drum is monitored during the UNLOAD step. A low level in the Seal Drum indicates that it can accept a drum of catalyst without overfilling. If the Seal Drum overfilled, then the Unload valve would close on catalyst.

c. **Status Lamps**: The status lamps aid the operator in loading and unloading the Catalyst Addition Lock Hopper. There are two field-mounted lamps: CATALYST ADDITION LOCK HOPPER LOAD and CATALYST ADDITION LOCK HOPPER NOT EMPTY. Both status lamps cannot be lit at the same time.

CATALYST ADDITION LOCK HOPPER LOAD

This lamp lights when the CRCS has unloaded the Catalyst Addition Lock Hopper and prepared it so the operator can load it with catalyst. The operator may load catalyst only when this lamp is lit and the Catalyst Addition Switch is in the “LOAD” position.

CATALYST ADDITION LOCK HOPPER NOT EMPTY

This lamp lights when the CRCS has not fully unloaded the Catalyst Addition Lock Hopper. The operator is prevented from loading catalyst into the Catalyst Addition Lock Hopper because it needs to be unloaded.

d. **Automatic Shutdown Sequence**: All four logic-operated valves close automatically when a Cold Shutdown or Contaminated Nitrogen Shutdown occurs. Any of the four valves that are open when the shutdown occurs will close, regardless of the step the Catalyst Addition Lock Hopper is in. After any automatic shutdown the operator must restart operation in the UNLOAD sequence to ensure that the addition hopper has fully unloaded before proceeding.

e. **Valve Interlocks:** The valve interlock system prevents certain valve position combinations that could cause a hazardous situation.

If the Pressure Valve or the Unload Valve is not confirmed closed, then the Vent Valve and the Load Valve cannot be opened. This temporarily halts the LOAD step. When the Pressure Valve and the Unload Valve confirm closed, the catalyst addition sequence resumes.

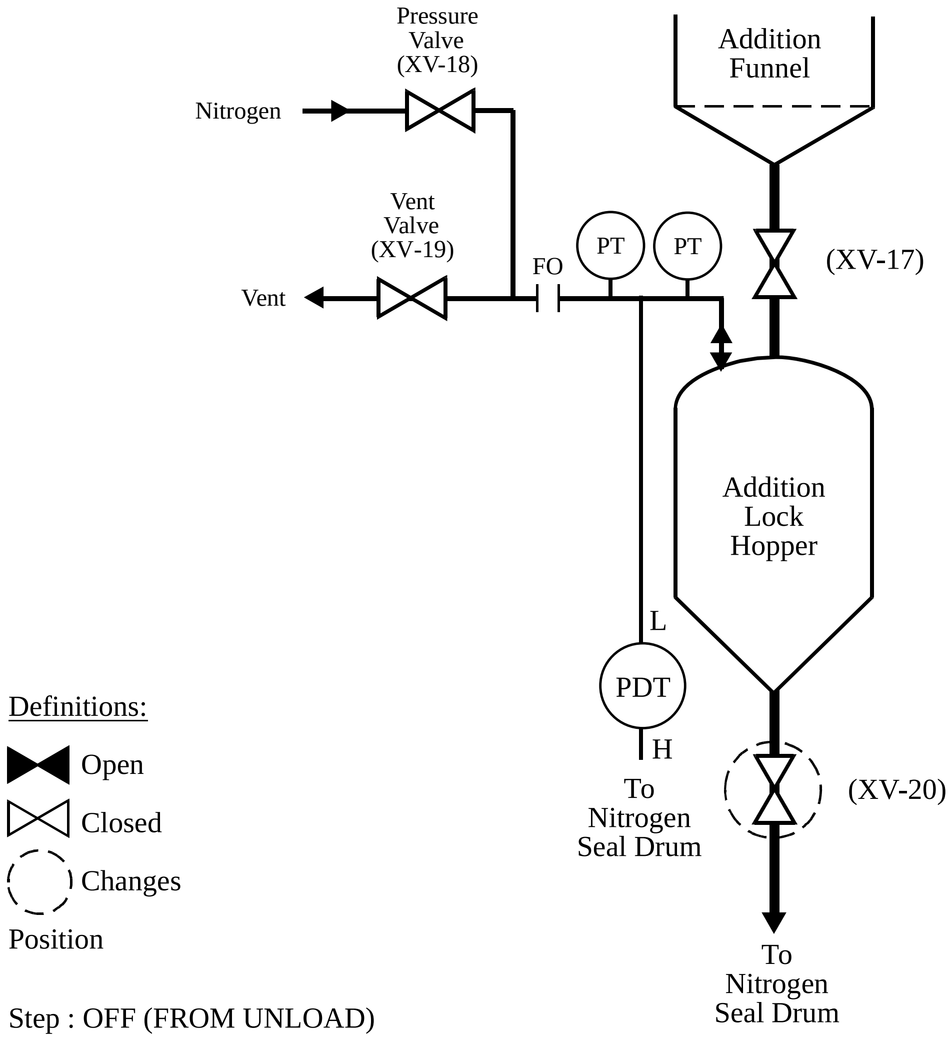
If the Vent Valve or the Load Valve is not confirmed closed, then the Pressure Valve and the Unload Valve cannot be opened. This temporarily halts the UNLOAD step. When the Vent Valve and the Load Valve confirm closed, the catalyst addition sequence resumes.

The following sheets are an outline of the logic steps for catalyst addition:

Figure XIII-3

Catalyst Addition Controller

Changeout on-the-Fly



Step : OFF (FROM UNLOAD)

Conditions to Proceed :

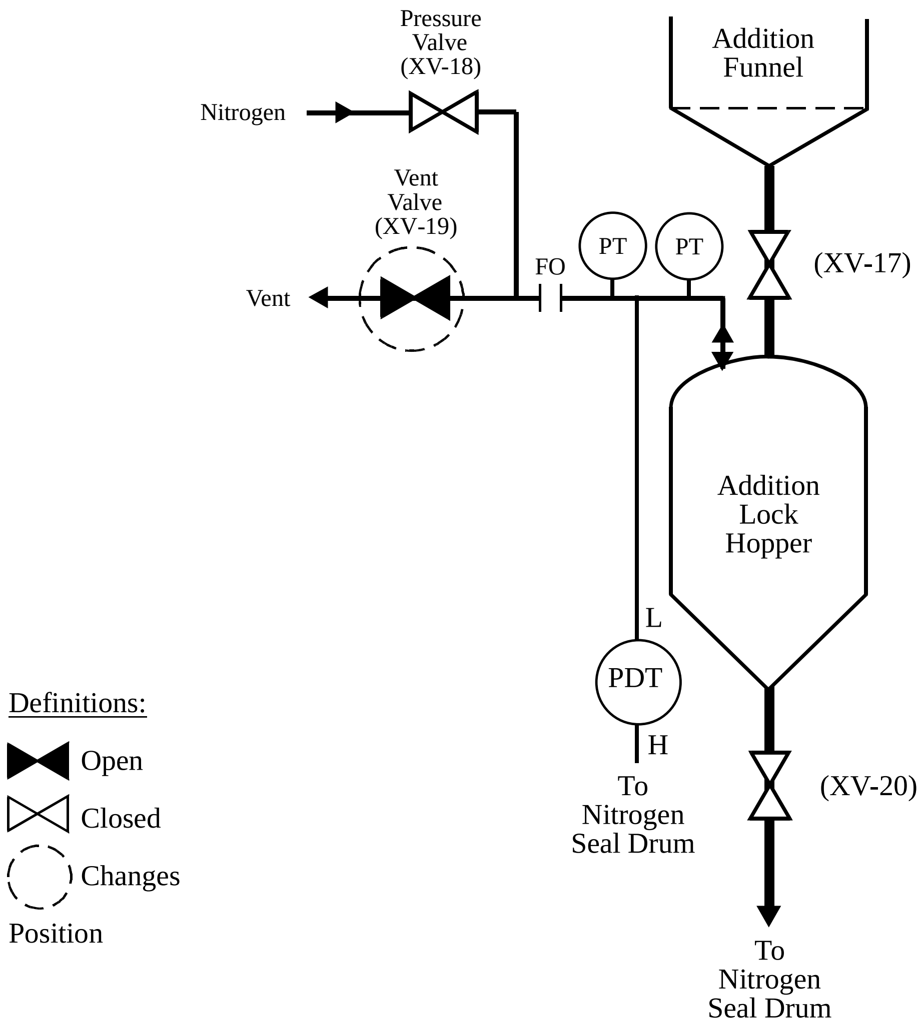
To Start the Catalyst Addition Lock Hopper Controller:

1. The Regenerator Must Not Be in a Cold Shutdown, or Contaminated Nitrogen Shutdown.
2. The Catalyst Addition Lock Hopper Has Successfully Unloaded (See Unload Step).
3. Valve Positions Confirmed: XV-17 Closed, XV-18 Closed, XV-19 Closed, XV-20 Closed.
4. Start the Catalyst Addition by Switching the Catalyst Addition Switch from "OFF" to "LOAD" Position.

PLT-R00-92
CYM-R01-67

Figure XIII-4

Catalyst Addition Controller
Changeout on-the-Fly



Step : LOAD (DEPRESSURING)

Conditions to Proceed :

1. Valve Positions Confirmed: XV-17 Closed, XV-18 Closed, XV-19 Open, XV-20 Closed.
2. PT Indication below High Setpoint, Pressure Low.
3. PDT Indication above High-High Setpoint, Pressure Differential High.

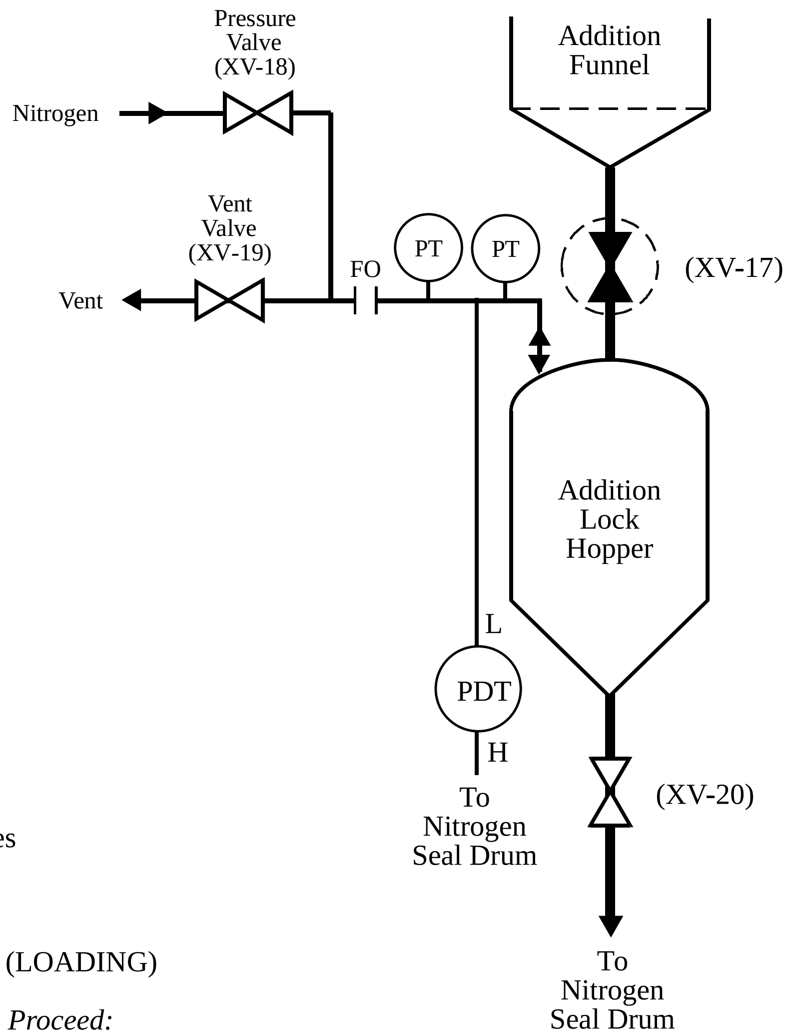
Remarks :

1. If XV-18 or XV-20 Is Not Confirmed Closed, then XV-19 Remains Closed.

PLT-R00-93
CYM-R01-68

Figure XIII-5

Catalyst Addition Control
Changeout on-the-Fly



Definitions:

Open

Closed

Changes Position

Step : LOAD (LOADING)

Conditions to Proceed:

1. Valve Positions Confirmed: XV-17 Open, XV-18 Closed, XV-19 Open, XV-20 Closed.

Remarks:

1. The CATALYST ADDITION LOCK HOPPER LOAD Lamp Will Come On When XV-17 Confirms Open.

2. Load One Drum of Catalyst into the Addition Funnel. Do Not Load More Drums into the Funnel than Needed to Fill the Hopper in Order to Prevent Closing XV-17 on Catalyst and Damaging the Valve. The Catalyst Will Drain into the Addition Hopper. Then, Switch the Catalyst Addition Switch to "OFF."

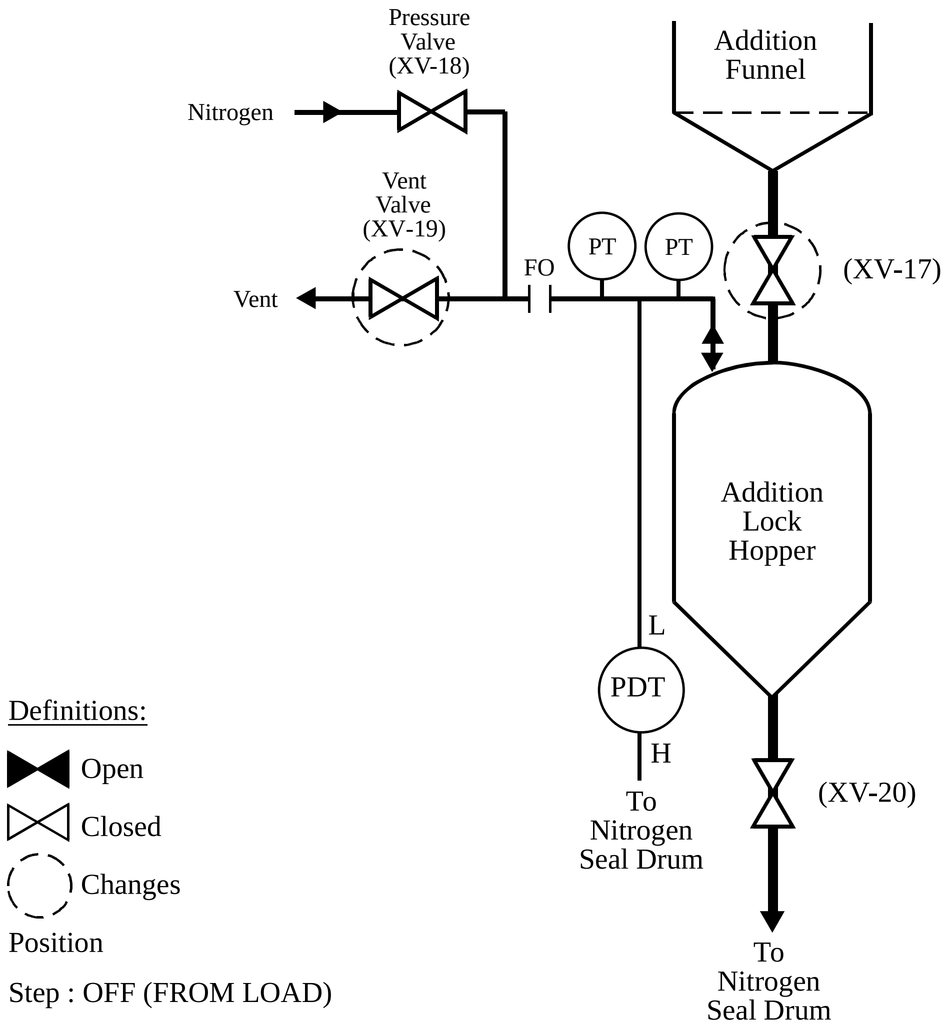
3. If XV-18 or XV-20 Is Not Confirmed Closed, then XV-17 Remains Closed.

PLT-R00-94
CYM-R01-69

Figure XIII-6

Catalyst Addition Controller

Changeout on-the-Fly



Step : OFF (FROM LOAD)

Conditions to Proceed :

1. Valve Positions Confirmed: XV-17 Closed, XV-18 Closed, XV-19 Closed, XV-20 Closed.
2. The Regenerator Must Not Be in a Cold Shutdown or Contaminated Nitrogen Shutdown.
3. The Catalyst Flow Pushbutton Must Be in the "RUN" Position.
4. Switch the Catalyst Addition Switch to "UNLOAD."

Remarks :

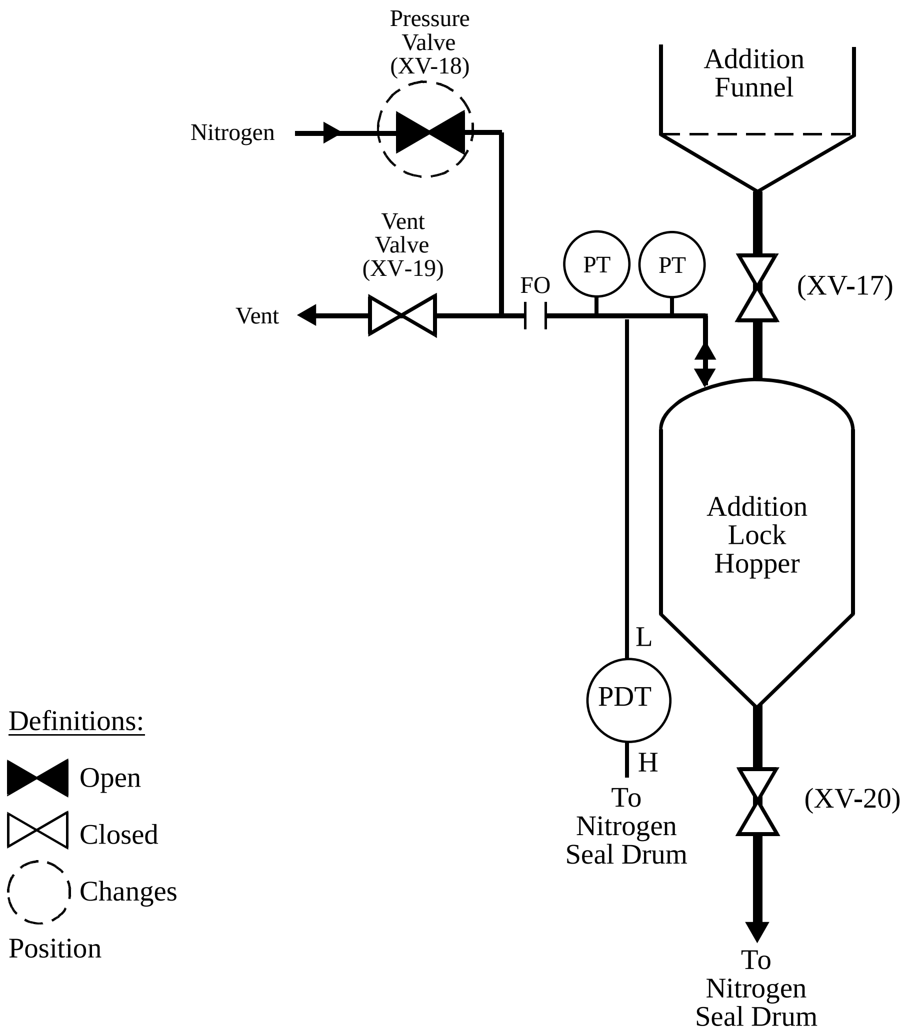
1. The CATALYST ADDITION LOCK HOPPER LOAD Lamp Turns Off, and the CATALYST ADDITION LOCK HOPPER NOT EMPTY Lamp Turns On when XV-17 and XV-19 Confirm Closed.

CYM-R01-70

Figure XIII-7

Catalyst Addition Control

Changeout on-the-Fly



Step : UNLOAD (PRESSURING-1)

Conditions to Proceed :

1. Valve Positions Confirmed: XV-17 Closed, XV-18 Open, XV-19 Closed, XV-20 Closed.
2. Level in the Nitrogen Seal Drum Below Level Indicator
3. PDT Indication below High Setpoint, Pressure Differential Low.

Remarks :

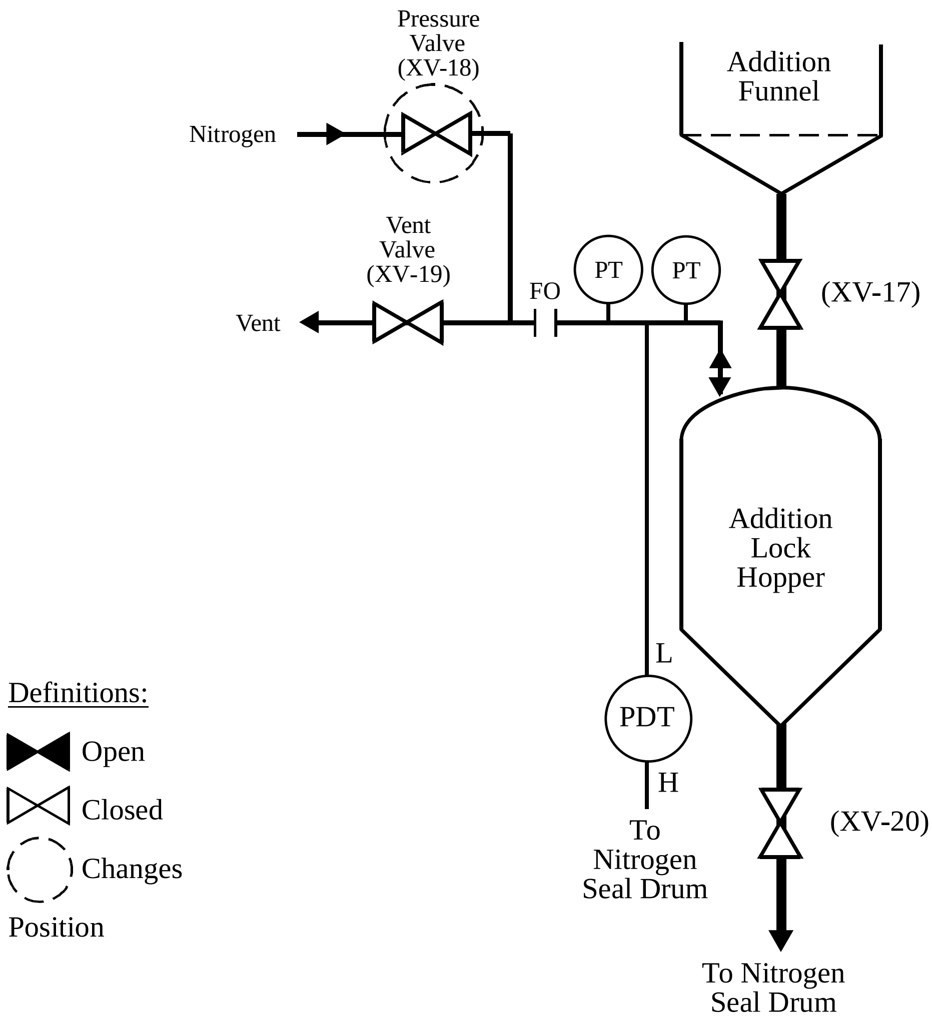
1. If XV-17, XV-19, or XV-20 Is Not Confirmed Closed, then XV-18 Remains Closed.

PLT-R00-96
CYM-R01-71

Figure XIII-8

Catalyst Addition Control

Changeout on-the-Fly



Step : UNLOAD (PRESSURING-2)

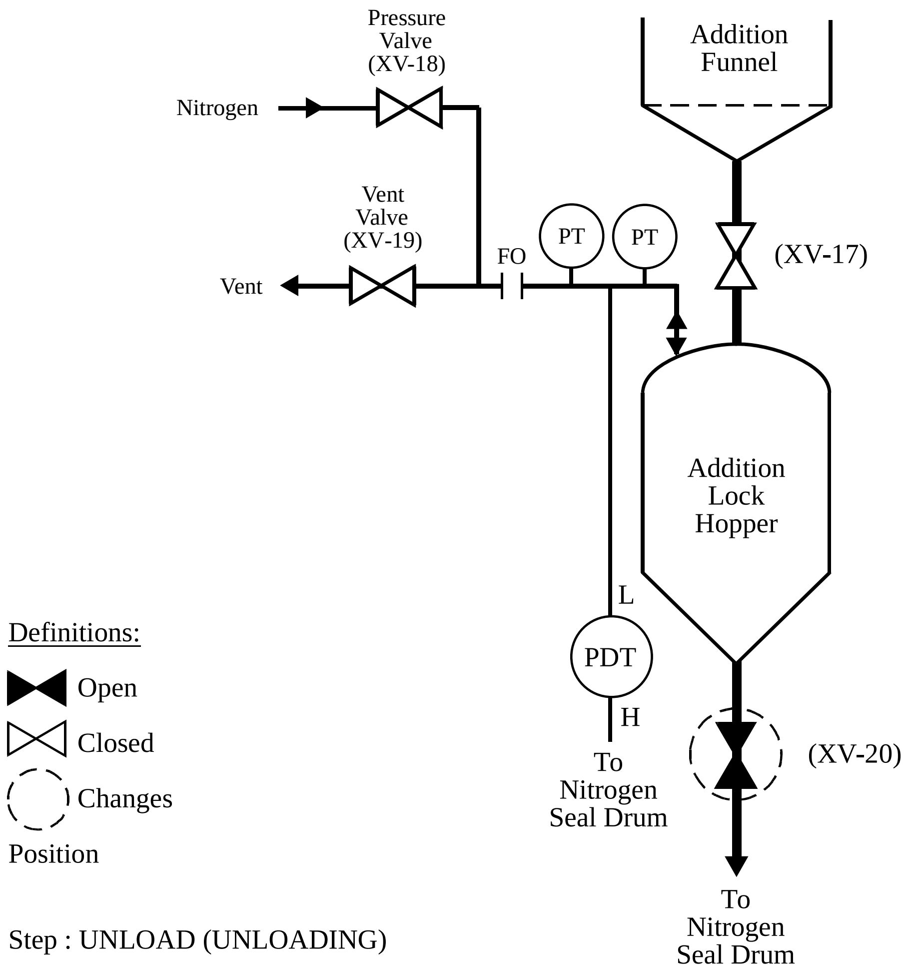
Conditions to Proceed :

1. Valve Positions Confirmed: XV-17 Closed, XV-18 Closed, XV-19 Closed, XV-20 Closed.
2. PT Indication Above High-High Setpoint, Pressure High.

CYM-R01-72

Figure XIII-9

Catalyst Addition Control
Changeout on-the-Fly



Step : UNLOAD (UNLOADING)

Conditions to Proceed :

1. Valve Positions Confirmed: XV-17 Closed, XV-18 Closed, XV-19 Closed, XV-20 Open.

2. The Lock Hopper Cycle Counter Has Reached Its Set Value.

Remarks :

1. The Unload Timer Begins Counting Loads when XV-20 Confirms Open.

2. When the Unload Timer Has Reached Its Set Value, the CATALYST ADDITION LOCK HOPPER NOT EMPTY Indicator Lamp Will Turn Off. Switch the Catalyst Addition Switch to "OFF."

3. If XV-17, XV-18 or XV-19 Is Not Confirmed Closed, then XV-20 Remains Closed.

CYM-R02-73

F. SPECIAL MAINTENANCE PRECAUTIONS FOR THE STAINLESS STEEL REGENERATION TOWER

The Regeneration Tower and associated piping are constructed out of 300 series stainless steel. The use of this material is compatible with all process conditions found in the vessel during normal operations and normal startup and shutdown. There is one concern with stainless steel in this service that warrants special consideration, that is stress corrosion cracking. Chloride-induced stress corrosion cracking is a trans-granular attack of the metal that can lead to vessel failure without having the typical outward signs of corrosion, i.e., metal loss at the affected site. The conditions required for this type of corrosion are as follows:

- The presence of water in the liquid state.
- The presence of HCl in the liquid water.
- The liquid water must be at a temperature above 60°C (140°F).

During normal operation (including startup and shutdown) of the unit the above conditions can not be present for a number of reasons. As a general statement the operating procedures precludes the presence of at least one of the above mentioned conditions at all times. Some pertinent examples are as follows:

- Normal operating temperatures in the tower are high enough to preclude the presence of liquid water in flowing lines.

- All low flow or dead legs are heat traced to prevent the presence of liquid water.

- Instrument taps are purged with dry nitrogen to preclude the presence of water and chloride.

- During any significant upset condition in the unit the Regeneration Tower will undergo a "Hot Shutdown" where regeneration of the catalyst ceases, but the tower remains at operating temperatures and gas flows remain in commission. A consequence of a Hot Shutdown is that the air is removed from the tower to stop combustion, thus removing the source of water from the system. When the air is removed it is replaced with a dry nitrogen flow to purge the tower of any oxygen and moisture remaining. When the nitrogen is introduced to the tower chloride addition is automatically stopped to preclude the presence of HCl.

- During any cooldown of the tower, i.e., low Regeneration Gas or Drying Zone gas temperature, the chloride injection to the tower is stopped to preclude the presence of HCl in the tower.

- Any cooling down of the tower will also cool down the catalyst, and the natural properties of the catalyst are such that, as it cools, it has a greater affinity and holding capacity for both chloride and water. Thus the catalyst acts as a desiccant to remove any free chloride and water left in the tower.

- During any heatup of the tower, chloride injection is prohibited by the logic system until the Regeneration Gas and Drying Zone Gas temperatures are near their design values. This precludes the presence of HCl in the tower before all liquid water is evaporated by the hot process gas.

- The design of the Regeneration Tower is such that all catalyst-free areas are free draining to catalyst full areas, actually the entire tower is free draining to the bottom of the tower. The catalyst will be able to absorb any free water in the system thus precluding its presence in the tower.

- While the tower is shutdown, either hot or cold, catalyst full or unloaded, procedures call for the tower to be kept under slight pressure with a nitrogen purge.

Given the above there are still two conditions which are out of the scope of the operating procedures, that is any time the Regeneration Tower is open to the atmosphere for screen cleaning or other maintenance, and when the Regeneration Blower fails for an extended period. During these situations it is important for the unit operating staff to be conscious of the conditions that lead to stress corrosion cracking. In order to facilitate this effort find the following recommendations:

1. Regeneration Tower Open.

- Keep any opening to the Regeneration Tower or associated piping covered to preclude the presence of any liquid water, i.e., rain or cooling tower mist.

- The free draining design of the tower should keep the accumulation of water to a minimum, but the metal may still become wetted.

- Keep an instrument air purge on the Regeneration Tower to preclude the presence of moist air in the tower.

2. Blower Failure.

- Depressure the Regeneration Tower via the normal tower vent line to near atmospheric pressure to affect a purge of the piping while it is still hot enough to prevent condensation.

CAUTION: The Regenerator must be depressured slowly. The Disengaging Hopper and spent catalyst lift system must be allowed to depressure with the Regenerator to prevent catalyst fluidization in the Regenerator. The Spent and Regenerated Catalyst Isolation Systems must be closed throughout this procedure.

- Close the tower vent valve to re-pressure the tower with nitrogen and depressure again after reaching design pressure. The Disengaging

Hopper should also be pressured up with the Regenerator by adding nitrogen to the lift as circuit.

- Repeat the pressuring and depressuring two more times to reduce the moisture and chloride concentration in the tower atmosphere to below that required for condensation.

G. ON-LINE LOCK HOPPER LOAD SIZE CALIBRATION

Lock Hopper load sizes are originally estimated by computing geometrically the volume of space between the elevations of the upper and lower Lock Hopper Zone switches plus an estimated slippage (typically 15~20%). However, during operation, more or less catalyst may be transferred during a Lock Hopper cycle because of variation in the amount of catalyst slippage during the unloading step. Catalyst slippage occurs when catalyst continues to drain from the Lock Hopper Zone to the Lock Hopper Surge Zone after the end of the unload step. A low level in the Lock Hopper Zone triggers the end of this step. However, during the short time before the Lock Hopper Zone is depressurized in the next step, extra catalyst can continue to drain into the Surge Zone of the Lock Hopper. The result is a load size larger than originally calculated.

The amount of slippage varies depending on the operating conditions of the Lock Hopper. Thus, an on-line calibration should be performed that will take catalyst slippage into account. The calibration should take place once the CCR Regeneration Section has been operating and the catalyst is being regenerated.

The following procedure outlines a general procedure for carrying out this operation.

a. Since the level in the Lock Hopper Surge Zone controls the cycling of the Lock Hopper Zone, this signal to the CRCS needs to be altered. A high-level signal must first be sent to the CRCS so that the Lock Hopper does not cycle while emptying the Surge Zone.

NOTE: If the Regenerator is in White Burn mode at this time, monitor the air demand carefully as the catalyst circulation stops. If the air demand decreases such that the Chlorination Zone flow decreases below the low flow alarm setting, the Regenerator should be put into Hot Shutdown.

b. The secondary lift gas flow controller is switched from cascade to automatic with a set point that is typical for the normal lifting rate so that lifting continues until the Lock Hopper Surge Zone is empty.

c. An empty Lock Hopper Surge Zone is indicated by zero lift line differential pressure. Although the Lock Hopper Surge Zone level on the DCS and the CRCS signifies a high level as a result of the altered value, the actual level reading will still be shown on the local display at the Lock Hopper.

d. Once all the catalyst has been emptied from the Lock Hopper Surge Zone, the manual V-port ball valve underneath the Lock Hopper is closed to refill the Lock Hopper Surge Zone.

e. Record the Lock Hopper cycle counts.

f. The Lock Hopper Surge Zone level signal to the CRCS is now altered to a low value that allows cycling of the Lock Hopper.

g. The Lock Hopper now cycles, unloading catalyst into the Surge Zone so that the level builds. As the Lock Hopper cycles, the unload and load times are recorded because these readings help determine the size of the last partial load.

The number of Lock Hopper loads required to fill the Surge Zone will not be integral; the Surge Zone will become full part of the way through a Lock Hopper cycle. When this happens, the catalyst can not physically flow from the Lock Hopper Zone to the Surge Zone. In this case, the Lock Hopper Zone high level indicator would indicate that the Lock Hopper has started to unload but the low level indicator would not indicate that it has finished unloading.

h. When the Lock Hopper Surge Zone is completely full part of the way through a Lock Hopper cycle, a Lock Hopper slow unload alarm sounds, and the Lock Hopper goes to the depressure and load steps.

i. Record the Lock Hopper cycle counts.

j. During the ensuing load step, a fast-load alarm occurs since the Lock Hopper Zone is already partially full. The load time for this the final loading of the Lock Hopper should be recorded.

k. These two alarms from consecutive Lock Hopper loads will cause a Hot Shutdown of the Regenerator.

l. Restore the Surge Zone level indicator communication with the CRCS.

m. Open the manual valves underneath the Lock Hopper to allow flow from the Surge Zone to the L-Valve assembly.

n. Use the Regenerated Catalyst Secondary Lift gas flow controller in local automatic to lift catalyst from the Surge Zone until a reasonable level is achieved.

o. Re-start the Regenerator as per the normal procedure.

p. The number of complete Lock Hopper loads transferred to fill the Surge Zone will be the difference in Lock Hopper cycle counts between step (e) and step (i) minus one. The fractional size for the final load of catalyst transferred from the Lock Hopper Zone can be determined by dividing the final (fast) load time by the average load time from the previous cycles.

q. The dry mass of the catalyst in the Surge Zone was determined during catalyst loading. If not, it will have to be determined by calculating the volume of the catalyst in the Surge Zone and multiplying it by the flowing catalyst density.

r. The Lock Hopper load size is determined by dividing the Surge Zone catalyst mass by the total number of Lock Hopper cycles required to fill the Surge Zone. If the load size is not within 5% of the design size, the lower-level switch of the Lock Hopper Zone should be adjusted.

CAUTION NOTES FOR THE CYCLEMAX CCR UNIT

CAUTION:
All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

CAUTION:
Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

CAUTION:
All upstream piping and equipment must be purged with inert gas before isolating the relief gas header from the line to the knockout drum and flare.

XIV. SAFETY

The information and recommendations contained in this section have been compiled from sources believed to be reliable and to represent the best opinion on the subject as of 1994. Refer to the references in Table XIV-1 for publications that can be used to supplement this information. However, no warranty, guarantee or representation, expressed or implied, is made by UOP as to the correctness or sufficiency of this information or to the results to be obtained from the use thereof. Each refiner should determine the suitability of the following material for his purposes before adopting them.

Since the use of UOP products by others is beyond UOP control, no guarantee, expressed or implied, is made and no responsibility assumed for the use of this material or the results obtained therefrom. Moreover, the recommendations contained in this manual are not to be construed as a license to operate under, or a requirement to infringe, any existing patents, nor should they be confused with state, municipal or insurance requirements, or with national safety codes.

A. OSHA HAZARD COMMUNICATION STANDARD

All references to environmental, occupational safety and material transport laws are based on U.S.A. federal, state and local laws that are applicable only within the U.S.A. and its territories. Non-U.S. refineries should follow comparable local guide-lines and regulations regarding safety in the unit. It cannot be assumed that all necessary warnings and precautionary measures are contained in this manual, or that any additional warning and or measures may not be required or desirable because of particular exceptional conditions or circumstances, or because of applicable federal, state or local law.

As of May 25, 1986, all U.S. employers covered under the Specific Industrial Classification (SIC) Codes 20-39 must be in compliance with the Occupational Safety and Health Standard, Subpart Z – Toxic and Hazardous Substances Hazard Communications, Section 1910.1200 of the Federal Regulations. This standard is commonly referred to as the “Right-to-Know Law.”

The OSHA standard is a U.S. Federal regulation requiring chemical manufacturers, importers and distributors to evaluate the hazards of their chemical products and convey hazard information through labels and material safety data sheets to its employees and customers which fall within SIC Codes 20-39. The customers in turn must pass the hazard information on to its employees and contractors that come on the premises. In this context, UOP employees who are working in or visiting a refinery are considered contractors to the refiner.

It is the responsibility of the U.S. refiners to inform all contractors of the hazardous chemicals the contractor’s employees may be exposed to while performing their work, and any suggestions for appropriate protection measures. It is then the responsibility of UOP to provide the information to its employees about the hazardous chemicals to which they could be exposed by means of 1) a written hazard communications program, 2) training and information, 3) labels and other forms of warning, and 4) material safety data sheets.

1. Written Hazard Communications Program

The OSHA standard requires that U.S. employers make available to its employees the company's written Hazard Communication Program. This document is intended to describe how the company will implement the OSHA standard. The program explains the company's labeling system, material safety data sheets (MSDS), and employee information and training. The latter includes a listing of hazardous chemicals known to be present in the work place, and methods the company will use to inform its employees and contractors of the hazardous chemicals.

2. Training and Information

All UOP employees receive classroom training in compliance with the OSHA standard. This includes an overview of the standard, an explanation on how to interpret and use the information on a MSDS, the location and availability of UOP's file of MSDS's, labeling requirements and their meaning, and an introduction to toxicology.

UOP employees working in or visiting U.S. refiners are considered contractor employees of that refinery. The OSHA standard states that contractors performing work in these facilities are required to train their people before they enter the refinery. However, it is the responsibility of U.S. refiners to inform UOP of the specific hazardous chemicals to which UOP's employees may be exposed. UOP complies with the OSHA standard by making available to its employees this list of hazardous chemicals and by appraising them of the hazards they will be exposed, relevant symptoms and appropriate emergency treatment and proper conditions and precautions of safe use or exposure.

3. Labels and Other Forms of Warning

The OSHA standard states that all portable containers of hazardous chemicals must have a large, readable label or tag which has on it:

a. The name and address of the manufacturer

b. The name of the chemical

c. A numerical hazard warning or other appropriate warnings supplied by the manufacturer

For the latter, the National Fire Protection Association (NFPA) Diamond is commonly used. An explanation of the NFPA Diamond may be found in Figure XIV-1 and Table XIV-2 located at the end of this chapter.

Labels can also be color coded according to the following:

Orange	Carcinogen Hazard (i.e.: Benzene)
Red	Chemical Burn Hazard (i.e.: Acids, Bases)
Yellow	Toxic Vapor Hazard (i.e.: H_2S)
White	All Others

An example of the information that can be found on a warning label may be found in Figure XIV-2 at the end of this chapter.

Contractor employees must label all containers of hazardous materials that they bring into the refinery. This applies to UOP employees who are visiting or working in refineries.

4. Material Safety Data Sheet (MSDS)

The MSDS requirement falls primarily on chemical manufacturers, importers and distributors. The OSHA standard requires them to develop and provide a MSDS for each hazardous chemical they produce or handle. These manufacturers, importers and distributors are required to provide the MSDS to the purchasers of the hazardous chemical.

Although the format of the MSDS can vary, they should all include the following information:

- Chemical and common name
- Ingredient information
- Physical and chemical characteristics
- Physical hazards - Potential for reactivity, fire and/or explosion
- Health hazards
- Symptoms of exposure
- Primary route of likely entry into the body upon exposure
- OSHA permissible exposure levels
- Precaution for use
- Waste disposal
- Protective measures and equipment, including during spills and maintenance
- Emergency and first-aid procedures
- Date of MSDS preparation and last revision
- Emergency contact of manufacturer or distributor

The OSHA standard requires that the manufacturer or distributor provide quick and easy access to all MSDS's applicable to their work place.

Contact UOP for the latest MSDS updates for the Platforming catalysts.

5. MSDS for UOP Platforming Processes

Following is a list of Material Safety Data Sheets (MSDS's) which should be considered the minimum for the CCR Platforming process. The most recent and up-to-date versions of these MSDS's that contain exact information relating to the materials used in or resulting from the operation of the unit should be obtained.

Naphtha
Reformate (can be identified as "Reformate Still Bottoms")
LPG, Sweetened
Hydrocarbons, C_{1-4}

Hydrogen
Hydrogen Sulfide
Benzene
Toluene
Xylene
Platforming Catalyst
Chloriding agent
Sulfiding Agent
Caustic
Oxygen Scavenger (for BFW)
Chloride Treating Material

At the end of this section, a ***sample*** MSDS for the most common CCR Platforming catalyst is included ***for illustrative purposes only***. This MSDS is current at time of publication of this manual. This MSDS may not apply to each individual unit. UOP assumes no responsibility for the use of any information contained in these MSDS's. ***Always*** check for the most recent (and applicable) version of the MSDS before using the information therein. MSDS's for UOP's various Platforming catalysts and other UOP-supplied products are available on request.

B. HYDROGEN SULFIDE POISONING

Hydrogen sulfide is both an irritant and an extremely poisonous gas. Breathing even low concentrations of hydrogen sulfide (H_2S) gas can cause poisoning. Many natural and refinery gases contain more than 0.10 mol-% H_2S. The current OSHA permissible exposure limits are 20 mol-ppm ceiling concentration and 50 mol-ppm peak concentration for a maximum 10 minute exposure.

The Platforming process recycle gas and debutanizer overhead gas can normally contain up to 20 mol ppm H_2S. During unit upsets, this value can increase to possibly greater than 1000 mol ppm. These gases must NEVER be inhaled. One full breath of high concentration hydrogen sulfide gas will cause unconsciousness and could cause death, particularly if the victim falls and remains in the presence of the H_2S.

The operation of any unit processing gases containing H_2S remains safe provided ordinary precautions are taken and the poisonous nature of H_2S is recognized and understood. No work should be undertaken on the unit where there is danger of breathing H_2S, and one should never enter or remain in an area containing it without wearing a suitable fresh air mask.

There are two general forms of H_2S poisoning – acute and subacute. A list of symptoms as they relate to the H_2S concentration level and exposure time may be found in Table XIV-3 at the end of this chapter.

1. Acute Hydrogen Sulfide Poisoning

Breathing air or gas containing more than 500 mol-ppm H_2S can cause acute poisoning and possibly be fatal.

a. Symptoms of Acute Poisoning

The symptoms of acute H_2S poisoning are muscular spasms, irregular breathing, lowered pulse, odor to the breath and nausea. Loss of consciousness and suspension of respiration quickly follow.

Even after the victims recovers, there is still the risk of edema (excess accumulation of fluid) of the lungs which may cause severe illness or death in 8 to 48 hours.

b. First Aid Treatment of Acute Poisoning

Move the victim at once to fresh air. If breathing has not stopped, keep the victim in fresh air and keep him quiet. If possible, put him to bed. Secure a physician and keep the patient quiet and under close observation for about 48 hours for possible edema of the lungs.

In cases where the victim has become unconscious and breathing has stopped, artificial respiration must be started at once. If a Pulmotor or other mechanical equipment is available, it may be used by a trained person; if not, artificial respiration by mouth-to-mouth resuscitation must be started as soon as possible. Speed in beginning the artificial respiration is essential. Do not give up. Men have been revived after more than four hours of artificial respiration.

If other persons are present, send one of them for a physician. Others should rub the patient's arms and legs and apply hot water bottles, blankets or other sources of warmth to keep him warm.

After the patient is revived, he should be kept quiet and warm, and remain under observation for 48 hours for the appearance of edema of the lungs.

2. Subacute Hydrogen Sulfide Poisoning

Breathing air or gas containing H_2S anywhere between 10 to 500 mol-ppm for an hour or more may cause subacute or chronic hydrogen sulfide poisoning.

a. Symptoms of Subacute Poisoning

The symptoms of subacute H_2S poisoning are headache, inflammation of the eyes and throat, dizziness, indigestion, excessive saliva, and weariness. These can be the result of continued exposure to H_2S in low concentrations. Edema of the lungs may also occur.

b. First Aid Treatment of Subacute Poisoning

Keep the patient in the dark to reduce eyestrain and have a physician treat the inflamed eyes and throat. Watch for possible edema.

Where subacute poisoning has been suspected, the atmosphere should be checked repeatedly for the presence of H_2S by such methods as testing by odor, with moist lead acetate paper, and by Tutweiler H_2S determination to make sure that the condition does not continue.

3. Prevention of Hydrogen Sulfide Poisoning

The best method for prevention of H_2S poisoning is to stay out of areas known or suspected to contain it. The sense of smell is not an infallible guide as to the presence of H_2S, for although the compound has a distinct and unpleasant rotten eggs odor, it will frequently paralyze the olfactory nerves to the extent that the victim does not realize that he is breathing it. This is particularly true of higher concentrations of the gas.

Fresh air masks or gas masks suitable for use with hydrogen sulfide must be used in all work where exposure is likely to occur. Such masks must be checked frequently to make sure that they are not exhausted. People who must work on or in equipment containing appreciable concentrations of H_2S, must wear fresh air masks and should work in pairs so that one may effect a rescue or call for help should the other be overcome.

As mentioned above, the atmosphere in which people work should be checked from time to time for the presence of H_2S.

REMEMBER – JUST BECAUSE YOUR NOSE SAYS IT'S NOT THERE, DOESN'T MEAN THAT IT IS NOT.

C. PRECAUTIONS FOR ENTERING A CONTAMINATED OR INERT ATMOSPHERE

Nitrogen is non-toxic. Seventy-nine mol-% of the air we breathe is nitrogen, 21 mol-% is oxygen. However, in vessels or areas where there is a high concentration of nitrogen, there is also a deficiency of oxygen for breathing. Breathing an atmosphere deficient in oxygen (i.e.: an inert atmosphere) will rapidly result in dizziness, unconsciousness, or death depending on the length of exposure. Do not enter or even place your head into a vessel that has a high concentration of nitrogen. Do not stand close to a valve where nitrogen is being vented from equipment at a high rate that might temporarily cause a deficiency in oxygen close to the valve.

UOP policy is not to allow any UOP technical advisors to perform work in a vessel that is <u>known</u> to be contaminated or under an inert atmosphere. UOP does not permit its technical advisors to perform "inert entry" work inside any vessel.

Refinery personnel who do have to enter a contaminated or inert atmosphere should follow all prescribed standard safety precautions and regulations that apply for the refinery. OSHA regulations concerning the use of respirators (29 CFR Subpart 1, Section 1910.134) should be read and thoroughly understood.

It is also important to emphasize that if a person has entered a vessel and becomes unconscious, no individual should go in to help him without first putting on a fresh air mask, confirming that the air supply is safe, donning a safety harness, and enlisting the aid of a minimum of two other people to remain immediately outside of the vessel to assist him. This may seem to be an obvious warning, but people do forget this in the trauma of an emergency situation. Often the first thought is to save the person in distress and people enter the vessel without proper protection only to succumb to the same hazard without anyone else being present to save them.

D. SAFETY FOR VESSEL ENTRY

Whenever any personnel must enter a vessel, a meeting should be arranged between the refinery personnel who will be involved. The meeting should include review of the vessel entry procedures, the refiner's safety requirements and facilities, preparation of a vessel entry schedule, assignment of responsibility for the preparation of a blind list, and assignment of responsibility for the vessel entry permits.

The most common tasks that could involve a potentially hazardous vessel entry are:

Unit Checkout Prior to Startup
Turnaround Inspections
Regeneration Section Loading
Regeneration Section Unloading

There are many precautions common to each situation. In the remaining part of this section, these general precautions will be summarized, followed by a discussion of the particular hazards associated with these common tasks. The precautions apply equally to entry into all forms of vessels, including those enclosed areas that might not normally be considered vessels:

Reactors
Regenerators
Separators
Columns
Drums
Receivers
Fired Heaters
Storage Tanks
Sumps

The API publication "Guide for Inspection of Refinery Equipment" or the NIOSH publication No. 87-113; "A Guide to Safety in Confined Spaces" can be referred to for additional information on safety procedures for vessel entry and accident prevention measures.

1. General Precautions

a. The vessel must be positively isolated.

b. Safe access to the vessel must be assured.

c. Ladders, or safe internal access, must be provided.

d. Personnel entering the vessel must be provided with safety harnesses.

e. Two standby personnel must be available outside of the vessel to assist the personnel inside.

f. The safety of the atmosphere inside of the vessel must be confirmed by checks for toxic gases (e.g.: H_2S), oxygen content and for explosive gases before entry.

g. A dedicated supply of fresh air must be available for the standby people who will assist personnel in the vessel in the event that they encounter difficulty.

h. A vessel entry permit must be obtained and registered with the responsible persons.

2. Positive Isolation

Every line connecting to a nozzle on the vessel to be entered must be blinded. This includes drains connecting to a closed sewer, utility connections and all process lines. The location of each blind should be marked on a master piping and instrumentation diagram (P&ID), each blind should be tagged with a number and a list of all blinds and their locations should be maintained. One person should be given responsibility for the all blinds in the unit to avoid errors.

The area around the vessel manways should also be surveyed for possible sources of dangerous gases that might enter the vessel while personnel are inside. Examples include acetylene cylinders for welding and process vent or drain connections in the same or adjoining units. Any hazards found in the survey should be isolated or removed.

3. Vessel Access

Proper access must be provided both to the exterior and interior of the vessel to be entered. The exterior access should be a solid, permanent ladder and platform, or scaffolding strong enough to support the people, equipment, and safety gear that will be involved in the work to be performed.

Access to the interior should also be strong and solid. Scaffolding is preferred when the vessel is large enough to permit it to be used. The scaffolding base should rest firmly on the bottom of the vessel and be solidly anchored. If the scaffolding is tall, the scaffolding should be supported in several places to prevent sway. The platform boards should be sturdy and capable of supporting several people and equipment at the same time. Rungs should be provided on the scaffolding spaced at a comfortable distance for climbing on the structure.

If scaffolding will not fit in the vessel a ladder can be used. A rigid ladder is always preferred over a rope ladder and is essential to avoid fatigue during lengthy periods of work inside a vessel. The bottom and top of the ladder should be solidly anchored. If additional support is available, then the ladder should also be anchored at intermediate locations. When possible, a solid support should pass through the ladder under a rung, thereby providing support for the entire weight should the bottom support fail. Only one person at a time should be allowed on the ladder.

When a rope ladder is used, the ropes should be thoroughly inspected prior to each new job. All rungs should be tested for strength, whether they be made of metal or wood. Each rope must be individually secured to an immovable support. If possible, a solid support should pass through the ladder so that a rung can help support the weight and the bottom of the ladder should be fastened to a support to prevent the ladder from swinging. As with the rigid ladder, only one person should climb the ladder at a time.

4. Safety Harness

Any person entering a vessel should wear a safety harness with an attached safety line. The harness is not complete without the safety line. The harness should be strong and fastened in such a manner that it can prevent a fall in the event the man slips and so that it can be used to extricate the man from the vessel in the event he encounters difficulty. A full-body type harness is required by OSHA since it distributes the shock load during a fall and it prevents some falls which simple belts do not. Another advantage of the parachute type harness over a belt type is that it allows an unconscious person to be lifted from the shoulders, making it easier to remove him from a tight place such as an internal manway.

A minimum of one harness for each person entering the vessel and at least one spare harness for the people watching the manway should be provided at the vessel entry.

5. Manway Watch

Before a person enters a vessel, there should be a minimum of two people available outside of the vessel, one of who should be specifically assigned responsibility to observe the activity of the people inside of the vessel. The other person must remain available in close proximity to the person watching the manway so that he can assist or go for help if necessary. He must also be alert for events outside of the vessel, such as a nearby leak or fire, which might require the people inside to come out. Standby people should not leave their post until the people inside of the vessel have safely gotten out.

A communication system should be provided for the manway watch so that they can quickly call for help in the event that the personnel inside of the vessel encounter difficulty. A radio, telephone, or loud speaker can be used for this purpose.

6. Fresh Air

The vessel must be purged completely free of any noxious or poisonous gases and inventoried with fresh air before permitting anyone to enter. The responsible department, usually the safety department, must test the atmosphere within the vessel for toxic gases, oxygen level and explosive gases before entry. This must be repeated every 4 hours while there are people inside the vessel. Each point of entry and any dead areas inside of the vessel, such as receiver boots or areas behind internal baffles, where there is little air circulation should be checked. Fresh air can be circulated through the vessel using an air mover, a fan, or, for the cases where moisture is a concern, the vessel can be purged using dry certified instrument air from a hose or hard piped connection. When an air mover is used, make certain that the gas driver uses plant air, not nitrogen, and direct the exhaust of the driver out of the vessel to guarantee that the exit gas does not reenter the vessel. When instrument air is used, responsible personnel must check the supply header to ensure that it is properly lined up and that there are no connections where nitrogen or a contaminated backup source can enter the system. The fresh air purge should be continued throughout the time that people are inside the vessel.

A minimum of one fresh air mask for each person entering the vessel and at least one spare mask for the standby should be provided at the vessel entry. These masks should completely cover the face, including the eyes, and have a secure seal around the mouth and nose. When use of the mask is required, it must first be donned outside of the vessel where it is easy to render assistance in order to confirm that the air supply is safe. Each mask must have a backup air supply that is completely independent of the main supply. It must also be independent of electrical power. This supply is typically a small, certified air cylinder fastened to the safety harness and connected to the main supply line via a special regulator that activates when the air pressure to the mask drops below normal. The auxiliary supply should have an alarm that alerts the user that he is on backup supply and it should be sufficiently large to give the user 5 minutes to escape from danger.

7. Vessel Entry Permit

Before entering the vessel a vessel entry permit must be obtained. A vessel entry permit ensures that all responsible parties know that work is being conducted inside of a vessel and establishes a safe preparation procedure to follow in order to prevent mistakes which could result in an accident. The permit is typically issued by the safety engineer or by the shift supervisor. The permit should be based on a safety checklist to be completed before it is issued. The permit should also require the signatures of the safety engineer, the shift supervisor, and the person that performed the oxygen, toxic and explosive gas checks on the vessel atmosphere. Copies of the approved permit should be provided to the safety engineer, the shift supervisor, the control room, and one copy should be posted prominently near the manway through which the personnel will enter the vessel. The permit should be renewed before each shift and all copies of the permit should be returned to the safety engineer when the work is complete. Additional requirements or procedures may be imposed by the refiner, but the foregoing is considered the minimum acceptable for good safety practice.

8. Checkout Prior to Startup

The risk of exposure to hydrocarbon, toxic or poisonous gases, and catalyst dust is low during a new unit checkout; the primary danger is nitrogen. There will be pressure testing, line flushing, hydrotesting, and possibly chemical cleaning being conducted in the unit and nitrogen may be used during any of these activities. Some of the equipment may have been inventoried with nitrogen to protect the internals from corrosion. An additional hazard is posed by operations in connected plants that may be beyond the control of the people entering the vessel. Actions taken at a remote location could admit nitrogen, fuel gas, steam, or other dangerous material through a connecting process line into the vessel that is being entered. For these reasons vessel entry procedures must still be rigorously followed during the checkout of a new unit.

Each vessel should be blinded using blinds at each vessel nozzle. However, in the event that many vessels are to be entered in a new unit that is isolated from other plants, the entire unit can be isolated by installing blinds at the battery limits rather than by individually isolating every vessel nozzle.

The oxygen content of the atmosphere inside a vessel should be rechecked before every entry.

9. Turnaround Inspections

In turnaround inspections, the possibility that vessels will contain dangerous gases is much higher. Equipment that has been in service must be thoroughly drained and purged before entry. The vessel should have been steamed out, unless steam presents a hazard to the internals, and then fresh air circulated through it until all traces of hydrocarbons are gone. If liquid hydrocarbon remains or if odors persist afterwards, repeat the purging procedure until the vessel is clean. The service history of the vessel must also be investigated before entry so that appropriate precautions may be taken. The service may require a neutralization step or a special cleaning step to make the vessel safe. Internal scale can trap poisonous gases such as hydrogen sulfide that may be released when the scale is disturbed. If this sort of danger is present, fresh air masks and protective clothing may be required to be worn while working inside of the equipment.

In a turnaround inspection, every vessel nozzle must be blinded with absolutely no exceptions. There will always be residual process material at the low and high points in the lines connecting to the vessel because it is not possible to purge them completely clean. The blinds must all be in place at the vessel nozzles before the vessel is purged.

Another factor to be cautious of, especially if entering a vessel immediately after the unit has been shut down, is heat. The internals of the vessels can still be very hot from the steam-out procedure or from operations prior to the shutdown. If that is the case, the period of time spent working inside of the hot vessel should be limited and frequent breaks should be taken outside of the vessel.

10. Regeneration Section Loading

Catalyst loading has perhaps the highest risk for asphyxiation or injury because some of the safety practices could be overlooked in the rush to complete the loading and get the unit on stream. If the Regeneration Section being loaded is new, the main concerns are catalyst dust and nitrogen. If the loading is a reload, any of the dangerous conditions described for turnaround inspections may also be present.

During Regeneration Section loading, dust will always be present. The effect of dust on the lungs is cumulative and even small concentrations with short exposure times should not be tolerated. Spent catalyst dust is especially hazardous because it can contain hydrocarbon that may be flammable or other absorbed material that may be toxic, such as arsenic. Whenever possible, fresh air should be supplied from above the catalyst bed and exhausted from below the bed so that the downward flow of air will hold the dust down and prevent hazardous material from being carried into the working space inside of the Regeneration Section. This might not be possible when spent catalyst is present because of residual hydrocarbon and carbon on the spent catalyst. In either case, the fresh air should never be supplied from below the catalyst bed because the air may carry hazardous gases into the working space of the men inside of the Regeneration Section.

People who are exposed to the catalyst either outside or inside the Regeneration Section should wear OSHA/NIOSH approved dust masks or fresh air respirators. Goggles are also recommended. Exposure to catalyst dust can be minimized greatly by staying outside of the vessel during catalyst loading and by allowing the dust to settle before entering the vessel for inspection after loading.

Platforming units can have another danger from iron sulfide. Iron sulfide is pyrophoric, which means that under favorable conditions it can ignite on exposure to air. The iron sulfide can be present on the vessel and piping walls, as loose scale, or in the catalyst bed. When this danger could be present, special precautions have to be taken to either keep the iron sulfide moist or to prevent the iron sulfide from being exposed to air.

11. Regeneration Section Unloading

Regeneration Section unloading can present extraordinary health risks, especially to personnel working in the Regeneration Section. During the unloading, large quantities of catalyst dust may be generated. Additional hazards may include a contaminated or inert atmosphere in the Regeneration Section, residual hydrocarbons or toxic forms of catalyst chemical reactants.

UOP believes that the OSHA exposure limits to catalyst chemicals will not be exceeded if proper handling procedures are followed, and the proper protective clothing and safety devices are used. UOP recommends that the following minimum safety procedures be established and adhered to:

a. Personnel working in Regeneration Sections being unloaded should wear a fresh air respirator with a hood or helmet operated in a pressure demand or other positive pressure mode, or in a continuous flow mode (NIOSH Respirator Code SAFE: PD, PP, CF). This respirator should have a primary, secondary, and emergency supply of air.

b. Personnel in the Regeneration Section should be equipped with safety harnesses and safety lines for rescue and a means for visual, voice or signal line communication with standby personnel, who should be strategically located with suitable rescue equipment.

c. The OSHA regulations concerning use of respirators (29 CFR, Subpart 1, Section 1910.134) should be read and thoroughly understood before undertaking to place personnel in Regeneration Section during catalyst loading and unloading operations.

d. Protective clothing and all safety devices should be thoroughly decontaminated after each use. Worn-out, broken or defective safety equipment and clothing should be removed from service and repaired or replaced. Good personal hygiene after handling a catalyst or being exposed to catalyst dust is an essential part of a responsible catalyst safety program. Do not eat, drink, or smoke in areas where the catalyst is being handled or where exposure to catalyst dust is likely.

E. GENERAL UNIT SAFETY NOTES

1. CCR Platforming Unit

a. All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

b. This unit and all streams leaving can contain hydrogen sulfide. Care must be exercised when opening lines and equipment.

c. Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

F. AROMATIC HYDROCARBONS

1. Benzene

Benzene will be present in the Platforming process. Benzene is extremely toxic. A summary of health effects which can occur from exposure to benzene appear in “Documentation of the Threshold Limit Values (Benzene), 4th edition, 1980, ACGIH” included at the end of this chapter.

Special Instruction: If clothing (including gloves, shoes) becomes contaminated with benzene, the clothing should be removed immediately. Wash any skin area exposed to benzene with soap and water. Take a complete bath if the body is wetted with benzene. Do not wear clothing that has been wet with benzene until the garment has been decontaminated by washing or dry cleaning. Wearing clothing that has been wet with benzene almost assures that the person will inhale benzene vapors over a long period of time, resulting in potential health hazards.

Avoid draining benzene to the concrete or into the sewers where it can vaporize and create a health hazard. If benzene is accidentally spilled, flush it from the concrete and sewer catch basin with large quantities of cold water. Do not use hot water or steam which increases the vaporization of benzene. If you must enter an area of high benzene vapor concentration, wear appropriate respiratory protection, such as self-contained breathing apparatus or an air mask with an external air supply.

Though not specifically a health hazard, an environmental problem can result from benzene entering the sewer since benzene is much more soluble in water than any other hydrocarbon. This places an extra load on the effluent treating system.

2. Toluene, Xylenes and Heavier Aromatics

These aromatic compounds are also present in the Platforming process. These compounds are moderately toxic and are believed to not have the destructive effect on the blood-forming organs as does benzene. If clothing (including gloves, shoes, etc.) becomes wet with such aromatics, remove the clothing, bathe and put on fresh clothing. Avoid breathing aromatic vapors. The NIOSH Occupational Health Guidelines for ethyl benzene, toluene and xylene are included at the end of this chapter.

3. Toxicity Information

Toxicity and safe handling information on most of the materials used in the unit can be found in the following references:

a. Dangerous Properties of Industrial Materials
N. Irving Sax
Van Nostrand Reinhold

b. Patty's Industrial Hygiene Toxicology
Craley and Craley, eds., 1979

c. ASTM D-270, "Standard Method of Sampling Petroleum and Petroleum Products."

d. Data Sheet D-204 "Xylene and Toluene." Published by the National Safety Council.

e. Data Sheet D-308 "Benzene." Published by the National Safety Council.

4. Minimizing Exposure to Aromatics

Operating and laboratory personnel involved in obtaining samples should wear chemical-type safety goggles or shield, protective apron or laboratory coat, solvent-resistant gloves, and approved respiratory protective equipment where ambient concentrations exceed allowable limits. This protective equipment is not, however, a substitute for safe working conditions, proper ventilation, safe sampling practices, and proper maintenance of both operating and safety equipment. In all cases, skin contact (especially eyes) and inhalation must be minimized.

Sampling liquid hydrocarbons always requires some care to limit personal exposure and release to the atmosphere. Even greater care is needed when the liquid to be sampled contains aromatic hydrocarbons, especially benzene. UOP's current design calls for flow-through sampling points that utilize closed sample containers whenever aromatics are present.

In order to minimize vaporization, hot hydrocarbon streams must be routed through a cooler before drawing a sample. In all sampling situations, the personnel involved should be instructed to remain at arm's length from the sample container and to situate themselves upwind of the container if at all possible. These simple precautions will greatly minimize exposure to the hydrocarbon vapors.

5. Medical Attention

The US NIOSH/OSHA guidelines attached for ethyl benzene, toluene and xylene set forth recommendations for medical monitoring of personnel working in environments where exposure to these materials can occur. UOP recommends that the NIOSH/OSHA guidelines for medical monitoring be considered in development and implementation of an occupational health-monitoring program for employees who may be exposed to toluene, xylene and/or ethylbenzene.

OSHA has recommended the following medical monitoring for employees who may be exposed to benzene:

> Preplacement and quarterly examinations, including a history which includes past work exposures to benzene or any other hematologic toxins, a family history of hematological neoplasms, a history of blood dyscrasias, bleeding abnormalities, abnormal function of formed blood elements, a history of renal or liver dysfunction, a history of drugs routinely taken, alcoholic intake and systemic infections; complete blood count including a differential white blood cell count; and additional tests, where, in the opinion of the examining physician, alterations in the components of the blood are related to benzene exposure. (42 Federal Register 22516, 1977.)

UOP recommends that these guidelines be considered in development and implementation of an occupational health-monitoring program for employees who may be exposed to benzene.

All new or current employees should be alerted to the early signs and symptoms resulting from exposure to aromatics, and any workers experiencing such symptoms should seek professional medical attention. In addition to the above, all employees should be advised of the hazards involved and precautions to be taken when working with aromatics.

OSHA has established stringent maximum exposure levels for various chemicals, some of which may be found in UOP catalysts. These exposure limits can be found in the **Code of Federal Regulations**, Title 29, Chapter 17, Subpart Z, Section 1910.1000. This information is also contained in **NIOSH/OSHA Pocket Guide to Chemical Hazards**, DHEW (NIOSH) Publication No. 78-210.

G. SAFETY INFORMATION FOR UOP PLATFORMING CATALYSTS

It is during periods of opening and cleaning equipment or in sampling that bodily exposure to UOP Platforming Catalyst can occur and caution must be exercised. **Material Safety Data Sheets should be obtained from UOP at the time of catalyst supply and should be available to the operating personnel.**

The major constituent of the UOP Platforming catalyst is alumina, which is not currently listed by OSHA as a hazardous substance. These catalysts do contain other constituents, in lesser amounts, which might present hazards to human health and/or the environment if handled or disposed of improperly. It is the purpose of this safety section to provide information and recommendations that will allow safe handling and proper disposal of these catalysts.

Only the following fresh catalysts (R-11, R-12, R-14, R-16, R-18, R-19, R-50, R-51, R-55, R-60, R-62) contain hydrogen sulfide.

Spent Platforming catalysts may also contain additional hazardous chemicals, such as: arsenic, carbon, hydrocarbons, iron pyrites, iron sulfide, lead, and vanadium. The toxic properties and exposure limit of the most hazardous of these chemicals follow:

1. Hydrogen Sulfide

Hydrogen sulfide is both an irritant and an asphyxiant. The current OSHA permissible exposure limits are 20 ppm ceiling concentration and 50 ppm peak concentration for a maximum 10-minute exposure.

2. Arsenic

Arsenic is a recognized carcinogen and can cause acute and chronic toxicity. Symptoms of acute toxicity are somewhat dependent upon the route of contact and can include (for ingestion or inhalation): irritation of the stomach and intestines, with nausea, vomiting and diarrhea; liver damage; kidney damage; blood disturbances; and allergic reactions. The OSHA 8-hour time weighted average exposure limit to inorganic arsenic compounds is 10 micrograms per cubic meter of air.

The greatest potential for human exposure to catalyst materials comes from catalyst dust during Regeneration Section loading, and from dust, fumes, and vapors during catalyst unloading operations. For the unprotected worker, hazardous dust, fumes, and vapors may be inhaled, ingested, or contaminate the eyes and skin.

OSHA has established stringent maximum exposure levels for various chemicals, some of which may be found in UOP catalysts. These exposure limits can be found in the Code of Federal **Regulations,** Title 29, Chapter 17, Subpart Z, Section 1910.1000. This information is also contained i**n NIOSH/OSHA Pocket Guide to Chemical Hazards, D**HEW (NIOSH) Publication No. 78-210.

3. Handling Catalyst Spills and Deposited Catalyst Dust

Always wear a NlOSH-approved self-contained breathing apparatus or the combination of toxic dust respirator-rubber frame eye goggles, protective clothing, and gloves. Avoid cleaning methods that raise dust. Dispose of all catalyst wastes properly in containers, which should then be labeled as to the contents and hazards.

Do not dispose of catalyst wastes in a public water system or in the normal solid waste. Return material to supplier for metal recovery.

4. Handling UOP Catalysts Safely

UOP believes that the OSHA exposure limits to catalyst chemicals will not be exceeded if proper handling procedures and worker protective clothing/safety devices are used. UOP recommends that the following minimum safety procedures be established and adhered to:

- Handle catalysts only in a well-ventilated area.

- In areas where natural ventilation is insufficient, use local mechanical exhaust ventilation.

- Wear a NIOSH-approved toxic dust respirator with full face-piece, protective clothing, and gloves for normal catalyst handling operations.

- Regeneration Section loading and unloading operations present extraordinary health risks, especially to personnel working in the Regeneration Section. During loading operations, large quantities of catalyst dust may be generated. During unloading, the hazards may include insert (nitrogen) atmosphere, toxic feedstock, product, or purge materials present with the catalyst, or toxic forms of catalyst chemicals. Personnel working in Regeneration Section should wear a supplied air respirator with a hood or helmet, operated in a pressure-demand or other positive-pressure mode, or in a continuous flow mode (NIOSH Respirator Code SAFE: PD, PP, CF). This respirator should have a primary, secondary, and emergency supply of air. In addition, personnel in the Regeneration Section should be equipped with safety harnesses and safety lines for rescue and a means for visual, voice or signal line communication with standby personnel, who should be strategically located with suitable rescue equipment. The OSHA regulations concerning use of respirators (29 CFR, Subpart 1, Section 1910.134) should be read and thoroughly understood before undertaking to place personnel in Regeneration Section during catalyst loading and unloading operations.

Protective clothing and all safety devices should be thoroughly decontaminated after each use. Worn-out, broken or defective safety equipment and clothing should be removed from service and repaired or replaced. Good personal hygiene after handling a catalyst or being exposed to catalyst dust is an essential part of a responsible catalyst safety program. Do not eat, drink, or smoke in areas where the catalyst is being handled or where exposure to catalyst dust is likely.

TABLE XIV-1
Safety Topic References

OSHA, Specific Industrial Classification Codes 20-39; Subpart Z; Toxic and Hazardous Substances Communication Act, Section 1910.1200.; 1983.

OSHA, 29 CFR Subpart 1, Section 1910.134.

Guide for Inspection of Refinery Equipment; API.

A Guide to Safety in Confined Spaces; DHHS (NIOSH) Publication No. 87-113; July 1987.

Documentation of the Threshold Limit Values; ACGIH; 4th edition; 1980.

Occupational Health Guidelines for Chemical Hazards; NIOSH/OSHA; Sept. 1978.

42 Federal Register 22516; 1977.

Sax, N. Irving; Dangerous Properties of Industrial Materials; Van Nostrand Reinhold; 6th ed.

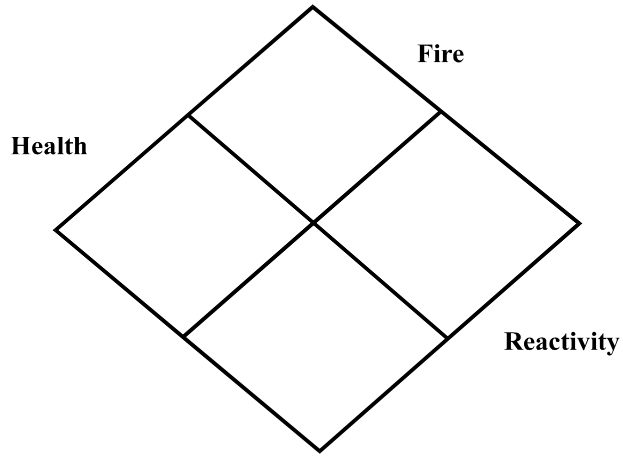
ASTM D-270, Standard Method of Sampling Petroleum and Petroleum Products.

Chemical Data Sheets; National Safety Council; 1984.

Code of Federal Regulations, Title 29; Chapter 17, Subpart Z; Section 1910.1000.

Figure XIV-1

NFPA 704 Diamond



CAUTION: CONTAINS HAZARDOUS CHEMICAL
Transportation Emergencies . . . . Call
Health Emergencies . . . .

HAZARD RANKING
0 = Least
1 = Slight
2 = Moderate
3 = High
4 = Extreme

PLT-R00-99

TABLE XIV-2

National Fire Protection Association
Identification of Color Coding

<u>Color Blue:</u>	**<u>Type of Possible Injury</u>**
Signal 4:	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment was given.
Signal 3:	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment was given.
Signal 2:	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.
Signal 1:	Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given.
Signal 0:	Materials which on exposure under fire conditions would offer no hazard beyond those of ordinary combustible materials.

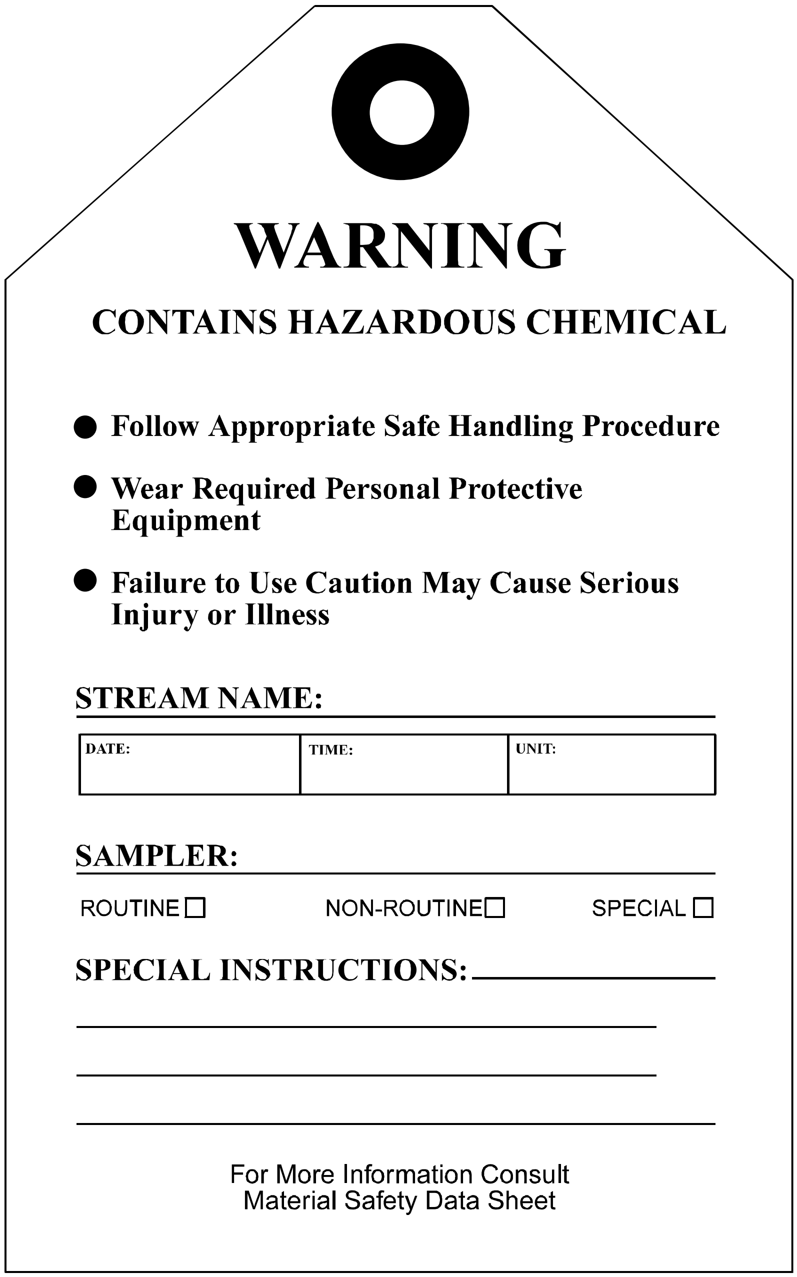
<u>Color Red:</u>	**<u>Susceptibility of Materials Burning</u>**
Signal 4:	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.
Signal 3:	Liquid and solids that can be ignited under almost all ambient temperature conditions.
Signal 2:	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.
Signal 1:	Materials that must be preheated before ignition can occur.
Signal 0:	Materials that will not burn.

TABLE XIV-2 (cont'd)

National Fire Protection Association
Identification of Color Coding

Color Yellow:	**Susceptibility of Release of Energy**
Signal 4:	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperature and pressure.
Signal 3:	Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
Signal 2:	Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form potentially explosive mixtures with water.
Signal 1:	Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.
Signal 0:	Materials which in themselves are normally stable, even under fire exposure conditions and which are not reactive with water.

Figure XIV-2



WARNING

CONTAINS HAZARDOUS CHEMICAL

- Follow Appropriate Safe Handling Procedure
- Wear Required Personal Protective Equipment
- Failure to Use Caution May Cause Serious Injury or Illness

STREAM NAME:

DATE:	TIME:	UNIT:

SAMPLER:

ROUTINE ☐ NON-ROUTINE ☐ SPECIAL ☐

SPECIAL INSTRUCTIONS:

For More Information Consult
Material Safety Data Sheet

Figure XIV-3
H_2S Poisoning
Toxicity of Hydrogen Sulfide to Humans

H_2S PPM	0-2 Minutes	2-15 Minutes	15-30 Minutes	30 Min-1 Hour	1-4 Hours	4-8 Hours	8-48 Hours
50 100				Mild conjunctivitis, respiratory tract irritation.			
100 150		Coughing, irritation of eyes, loss of sense of smell.	Disturbed respiration, pain in eyes, sleepiness.	Throat Irritation.	Salivation and mucous discharge, sharp pain in eyes, coughing.	Increased Symptoms.*	Hemmorhage and death.*
150 200		Loss of sense of smell.	Throat and eye irritation.	Throat and eye irritation.	Difficult breathing, blurred vision, light shy.	Serious irritating effects.	Hemmorhage and death.*
H_2S PPM	0-2 Minutes	2-15 Minutes	15-30 Minutes	30 Min-1 Hour	1-4 Hours	4-8 Hours	8-48 Hours
250 350		Irritation of eyes, loss of sense of smell.	Irritation of eyes.	Painful secretion of tears, weariness.	Light shy, nasal catarrh, pain in eyes, difficult breathing: conjunctivitis.	Hemorrhage and death.*	
350 450		Irritation of eyes, loss of sense of smell.	Difficult respiration, coughing, irritation of eyes.	Increased irritation of eyes and nasal tract, dull pain in head, light shy.	Dizziness, weakness, increased irritation, death.	Death.*	
500 600	Coughing, collapse and unconsciousness.*	Respiratory disturbances, irritation of eyes, collapse.*	Serious eye irritation, light shy, palpitation of heart, a few cases of death.*	Severe pain in eyes and head, dizziness, trembling of extremities, great weakness and death.*			
600 700 800	Collapse,* unconsciousness,* Death.	Collapse,* unconsciousness,* Death.					

Effects of Hydrogen Sulfide Gas

	Hydrogen Sulfide (H_2S)		
	Concentration (PPM)	Time	Effect
Subacute	0.13	Sniff	Odor detectable
	10.0	8 Hours	Threshold limit
	50-100	1 Hour	Mucous membrane irritation
	200-300	1 Hour	Mucous membrane irritation (Severe)
Acute	500-700	1/2 Hour	Coma
	900	Minutes	May be fatal
	1000	Minutes	Fatal

CAUTION NOTES FOR THE CYCLEMAX CCR UNIT

CAUTION:
All equipment containing hydrogen shall be evacuated and purged with nitrogen before opening and admitting air and after closing before admitting hydrogen.

CAUTION:
Care must be exercised when venting and draining equipment to prevent personnel exposure to toxic aromatics.

CAUTION:
All upstream piping and equipment must be purged with inert gas before isolating the relief gas header from the line to the knockout drum and flare.

uop

Material Safety Data Sheet

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: R-134 Catalyst

UOP
25 E. Algonquin Road
Des Plaines, IL 60017-5017
Telephone: 708-391-3189
FAX: 708-391-2953
Telex: 211442

Emergency Assistance
24 Hour Emergency Telephone Numbers:

USA:	UOP	708/391-2123
	Chemtrec	800/424-9300
Canada:	Canutec	613/996-6666
Outside USA:	Chemtrec	202/483-7616

2. COMPOSITION

MATERIAL	CAS No.	~WT%	1993-94 ACGIH TLV-TWA (1993 OSHA PEL-TWA)
Aluminum oxide (non-fibrous)	1344-28-1	98	10 mg/m^3, as Al (15 mg/m^3, total dust) (5 mg/m^3, respirable dust)
Platinum	7440-06-4	--	1 mg/m^3, metal (1 mg/m^3, metal)
Chloride, complexed with alumina	----------	--	None established (None established)

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
TLV - Threshold Limit Value
TWA - Time Weighted Average
PEL - Permissible Exposure Limit

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

These grey spheres may present a nuisance dust hazard. Repeated or prolonged exposure may irritate eyes, skin and upper respiratory tract.

POTENTIAL HEALTH EFFECTS:

Primary Routes of Exposure:	Contact with skin. Product dust inhalation and ingestion may also occur if product dust is generated during handling and or/processing.
Skin Contact:	May cause irritation with repeated or prolonged exposure.
Eye Contact:	Product dust may cause irritation or reddening of the eye mainly due to physical abrasion.
Inhalation:	Repeated or prolonged inhalation of product dust may irritate upper respiratory tract.
Ingestion:	Product has a low order of toxicity.

4. FIRST AID MEASURES

Skin: Wash affected area with soap and water. If irritation persists obtain medical attention.

Eyes: Flush with water for at least 15 minutes. If irritation persists, obtain medical attention.

Inhalation: Remove affected person to fresh air. If breathing is difficult oxygen may be needed. Obtain medical attention.

Ingestion: Do not induce vomiting. Obtain medical attention.

5. FIRE FIGHTING MEASURES

Flash Point: Unused catalyst does not burn.

Extinguishing Media: Unused catalyst will not burn. Use media appropriate for surrounding fire (carbon dioxide, water spray, dry chemical or foam).

Fire and Explosion Hazard: Spent catalysts, in their reduced state, can react with air and generate enough heat to spontaneously ignite residual organic material on the catalyst.

6. ACCIDENTAL RELEASE MEASURES

Isolate the affected areas, confine entry to the contaminated area to those who are wearing proper personal protective equipment. Special attention should be given to respiratory and eye protection, because recovery of material can be expected to generate dust. Vacuum or shovel up spilled material, placing it into appropriate recovery drums or containers.

Do not load recovered product from a spill into a reactor until proper evaluation of the catalyst's quality has been made. If assistance is required for this evaluation, contact the UOP Catalyst Marketing Department or the Technical Service Department.

7. HANDLING AND STORAGE

Store in tightly closed, properly labeled containers. Avoid repeated or prolonged contact with skin. Avoid contact with eyes and inhalation of dust.

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Respiratory: Where natural ventilation is inadequate, use mechanical ventilation, other engineering controls or, a toxic dust respirator (in USA - NIOSH/MSHA approved) to prevent inhalation of catalyst dust.

Skin: Gloves and work uniform as necessary to prevent repeated or prolonged skin contact.

Eye: Chemical goggles or face shield as necessary to prevent eye contact.

9. PHYSICAL AND CHEMICAL PROPERTIES

These data do not represent technical or sales specifications.

Physical State:	Solid	Appearance:	Grey spheres 1/16" diameter
Boiling Point:	Not applicable	Solubility in Water:	Insoluble, will sink in water
Apparent Bulk Density:	35 lbs/ft^3	% Volatile:	Not available
Vapor Pressure:	Not available	Vapor Density:	Not applicable
Pour Point:	Not applicable	Odor:	None
Freezing Point:	Not applicable	pH:	Not applicable

10. STABILITY AND REACTIVITY

Stability:	Stable
Conditions to Avoid:	None
Hazardous Decomposition Products:	None
Hazardous Polymerization:	Will not occur
Incompatible Materials:	None

11. TOXICOLOGICAL INFORMATION

Product not specifically tested. Data presented is for a product with very similar composition.

Acute Oral:	LD_{50} >5 g/kg (rat)
Acute Inhalation:	LC_{50} >16.65 mg/l (rat). Value limited by physical properties. Non-lethal at dosage indicated.
Acute Dermal:	LD_{50} >2 g/kg (rabbit).
Primary Eye Irritation:	*Draize score = 11.1/110 maximum. Effects reversed within 7 days (rabbit).*
Primary Dermal Irritation:	Primary Irritation Index = 0.8 (rabbit). Not a primary irritant

12. ECOLOGIC INFORMATION

No data currently available.

13. DISPOSAL CONSIDERATIONS

Dispose of catalyst in accordance with all applicable waste management regulations. Catalyst may be returned to supplier for metals recovery.

14. TRANSPORTATION INFORMATION

DOT Hazard Classification:	Not regulated
ID Number:	Not applicable
IMO Hazard Classification:	Not regulated
ID Number:	Not applicable

15. REGULATORY INFORMATION

U.S. TOXIC SUBSTANCES CONTROL ACT (TSCA): All the ingredients of this mixture are registered in accordance with TSCA.

U.S. SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) TITLE III, SECTION 313: The following component(s) in this product is subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act, 40 CFR 372: —none—

EUROPEAN INVENTORY OF EXISTING COMMERCIAL CHEMICAL SUBSTANCES (EINECS): The components of this preparation are included on the EINECS under the following registry numbers:

Aluminum oxide	2156916
Platinum	2311161

CANADIAN HAZARDOUS PRODUCTS ACT: This product is not classified as a controlled product under regulations pursuant to the Federal Hazardous Products Act (e.g., WHMIS).

16. OTHER INFORMATION

For additional information concerning this product contact the following:

For health, safety & environmental information, please contact:

Product Stewardship Manager
Health, Safety and Environment Department
UOP
25 E. Algonquin Road
Des Plaines, IL 60017-5017 USA
Telephone: (708) 391-3189
Fax: (708) 391-2953

For technical or purchasing information, please contact:

Refining Catalysts Marketing Department
UOP
25 E. Algonquin Road
Des Plaines, IL 60017-5017 USA
Telephone: (708) 391-2239
Fax: (708) 391-3690

PRODUCT EMERGENCIES

If you have a product-related emergency, resulting in an incident such as a spill or release of product, human exposure, etc., and need assistance from UOP, please call us at the following number:

UOP 24-Hour EMERGENCY Telephone Number: (708) 391-2123

UOP 2260 Date: August 1994

Revision: 1- Sections 2, 4, and 8 Supersedes: September 1993

XV. EQUIPMENT EVALUATION

While the majority of UOP unit performance tests are conducted in order to satisfy contractual agreements between UOP and the customer, the potential significance of a mechanical evaluation is much greater. From the information generated and collected during an evaluation test, the refiner has the means to assess the potential of the unit, to plan for future debottlenecking and to optimize refinery operations.

A. GENERAL EQUIPMENT

The following description includes data necessary for contractual tests plus information required for evaluating hydraulic systems, heaters, exchangers, pumps, compressors, etc. A large amount of the information would be gathered in any case (flows, temperatures, pressures, samples, etc.), and much of the rest can be obtained on a one-time basis.

However, the test information may not be of much value unless the following criteria are met:

1. The unit ***must*** weight balance. The weight balance must be consistently between 98 and 102 wt.%, and preferably between 99 and 101 wt.%.

2. All operations must be steady, including quality of charge stock, reactor severity (hence coke-make), exchanger outlet temperatures, etc.

3. Sufficient sample containers and laboratory analytical time must be available, including containers for sample shipment to UOP (optional).

4. Sufficient technical manpower must be available to gather data and take samples, in addition to those normally available for operating the unit.

5. The instrument technicians will be required before and during the performance test in order to calibrate the instrumentation daily during the test.

The following list indicates the amount and type of information required:

1. Flows: All process flows into and out of the unit, and also intermediate streams such as Regeneration, lift and elutriation gas, utility flows such as steam, BFW, instrument and plant air, cooling water, fuel oil and gas, power consumption.

2. Temperatures: All process temperatures, including those not usually measured, but provided for by thermowells, such as exchanger temperatures.

3. Pressures: All process pressures, including single gauge hydraulic surveys on the Regeneration Tower, pump and compressor suction and discharge pressures.

4. Levels: Chemical consumption (chloride, caustic, etc.), catalyst levels in the surge vessels, compressor seal oil and/or cylinder oil losses, etc.

5. Samples: Samples of spent and regenerated catalyst, fines, combustion air, booster gas, etc.

Why is all this data required? There are many reasons, but those used most frequently are to establish a unit base line performance, to predict the unit's maximum capacity, and to identify where the unit bottlenecks are. Another reason is for UOP's Engineering Department to evaluate actual unit and equipment performance compared to design. It is suggested that the data be accumulated at one time (during the performance run for contract demonstration), and that evaluation of the equipment be made later. It is important, however, to have ***all*** the necessary information available. To this end, the following lists and data sheets are given to use as guides in collecting data.

GENERAL

Ambient air conditions: temperature
relative humidity
barometric pressure
wind velocity and direction
(shown on rough plot plan)

General description of unit – includes process flow diagram.

Unit system used (e.g. USA, Imperial, Metric) and definition of any uncommon units (e.g. kPa) and Standard Conditions (0°C, 760 mm; 60°F, 14.7 psia, etc.)

Guarantee

Data as required for Guarantee Agreement.

Complete weight balance, including meter correction factors.

Exchangers

Flow through exchangers on both sides (gas and liquid), composition and mass flow.

Temperature in and out on both sides, also between shells, bundles.

Pressures in and out on both sides, if possible.

If air coolers; air temperature out, air velocity out, blower motor amps, etc.

In preparing data, submit overall heat transfer coefficient, specifics on exchangers.

Heaters

Process flows (volume and mass, avg. mol wt., composition, etc.)

Process pressures in and out

Process temperatures in and out

Electrical power usage

Element electrical resistance to ground.

Need sufficient data to calculate heat flux from process side, heat flux from heater side, calculate total heat release, calculate heater efficiency.

Chemical Consumption

PERC or TCE (organic chloride)

Caustic

Water

Other

Hydraulic Survey and Process Separations

Single gauge pressure survey of every point available on reactor circuit

All control valve positions (including utilities etc.)

Pump, blower and compressor motor amps

Pump suction, discharge pressure, flow rates, composition, temperatures, with manufacturer's curve data for comparison

Compressor and blower suction, discharge pressures, flow rates, composition, temperatures, with manufacturer's curve data for comparison

Single gauge pressure survey of the vent gas Wash Tower..

Utility consumption/production data:

Steam (all pressures)
Air (Plant and Inst.)
N_2
Cooling water
Utility water

Samples (typical)

Catalyst – spent on-stream catalyst sample(s) if possible
Catalyst – regenerated on-stream catalyst sample(s) if possible
Catalyst – reduced on-stream catalyst sample(s) if possible

Comments:

It is not necessary to obtain all the data at one time. It is acceptable to run various segments of the survey at different times, and one possible period would be during the line-out period prior to the guarantee test period. Data collections for heater and air-fin exchangers, in particular, are lengthy processes, and may be done at any time when the unit is stable, provided all the required process data is available.

If the data are collected, it obviously is necessary to have a good weight balance (100 ± 2%) for the information to be meaningful. For most pieces of information, if the unit is lined out, spot data will be sufficient, rather than long-term averaged data. It might be possible to obtain the spot data in sections spread out during the guarantee test (one exception is column performance).

In presenting the data, some order should be kept. UOP suggests keeping sections by type of information, i.e., one section on the guarantee test results, one on heaters, one on exchangers, one on hydraulics, etc. Attached are some typical summary sheets for this purpose.

CONTROL VALVE SUMMARY

page ______________________________

date ______________________________

Item No.: ______________________________ by ______________________________

Service: ____

Description of Valve: ______________________ Design CV: ______________________

Mfgr. and Catalog No.: ____

Positioner? ____

		Actual	Design
Percent open (valve position)		____________	
Flow rate:	______________________	____________	__________
Upstream pressure:	______________________	____________	__________
Downstream pressure:	______________________	____________	__________
Flowing temperature:	______________________	____________	__________

Deviations from UOP Specification: ____

____

____

____

AIR COOLER SURVEY

page ______________________________
date ______________________________
Item No.: ___________________________ by ______________________________
Service: ____
Manufacturer: ____
Type, Model: ____
No. of Bundles: ______________________ No. of Passes: ____________________
No. of Tubes per Pass: ________________ Fans/bundle: _____________________
Tube Size ______________ ID x ______________ Gauge x ______________ Length
Piping Geometry: _____________________ Type*: ___________________________
Overall Heat Transfer Coefficient: _____________________________________

		Pressure	Temperature
Inlet		________	________
Outlet		________	________
Air	In	________	________
	Out	________	________

Butterfly valve position ________________

	Air	Process
Mass flow	________	________
Q (calc.)	________	________
Composition, ____ %		
O_2		________
N_2		________
H_2S		________
H_2O		________
HCl		________
Avg. Mol. Wt.		________
Relative Humidity	________	

Deviations from UOP Specification: ____
____
____

*Include sketch of piping geometry if different from UOP standard practice types.

FLOW METER SUMMARY

page ______________________________

date ______________________________

Item No.: _________________________________ by ______________________________

Service:____

Type of Fluid: _____________________________ Normal Units of Flow:_________________

____

Type of Meter:____

Meter Reading: ____

Pressure ___________________

Temperature ___________________

Sp. Gr.** ___________________

Meter Factor ___________________

Corrected Flow Rate ___________________

Mass Flow Rate ___________________

Avg. mol. wt. ___________________

Molar Flow Rate ___________________

**Sketch piping layout, showing distances in nominal pipe IDs.

HEAT EXCHANGER SURVEY

page________________________
date________________________
Item No.: ______________________ by________________________
Service: ____
Manufacturer:____
Type, Model: ____
No. of Bundles: _____________________________________
No. of Passes/Bundle: ______________ Tubes per Pass:______________
Tube Size____________ ID x____________ Gauge x __________ Length
Heat Exchange Surface Area/Bundle:___________________________
Piping Geometry (sketch if necessary): ________________________
Length of Service: ___________________________________
Design Heat Transfer Coefficient: _____________________________

		Stream	Pressure	Temperature
Shell Side	Inlet	A	________	________
	Outlet		________	________
Tube Side	Inlet	B	________	________
	Outlet		________	________

Q (calc.) Shell side ________
Q (calc.) Tube side ________

Composition, _____ %	A	B
H_2	________	________
N_2	________	________
H_2S	________	________
H_2O	________	________
C_1	________	________
C_2	________	________
C_3	________	________
iC_4	________	________
nC_4	________	________
iC5	________	________
nC_5	________	________
C_6+	________	________
Mass Flow	________	________
Avg. Mol. Wt.	________	________

Deviations from UOP Specification: ______________________________
____
____

CENTRIFUGAL PUMP SURVEY

page ______________________
date ______________________
Item No.: ______________________ by ______________________
Service: ______________________
Manufacturer: ______________________
Type, Model: ______________________
No., Size and Style (Mfgrs. Designation) ______________________
____

	Pressure	Temperature
Suction	________	________
Discharge	________	

Other Information

Rated Flow (STP) ________ Seal Type? Single, Tandem, Double, Bellow
Sp. Gr. ________ Spillback? Yes/No
Viscosity ________ NPSHR? ________
Static Suction Head ________ Suction Specific Speed: ________
Speed ________
Differential Head (flowing condition) ______________________

Driver Type: ______________________
Manufacturer: ______________________
No., Size, Rating and Style (Mfgrs. designation): ______________________
Rating: ________ Insulation Class: ________
Service Factor: ________ Voltage/Phase/Cycle: ________

Motor:

Power consumption ________
Speed ________

Turbine:

Steam consumption ________

	Pressure	Temperature
Steam supply	________	________
Steam exhaust	________	________

Speed ________

Supply copy of Mfgrs. pump curve and plot operating point.

Deviations from UOP Specification: ______________________
____
____
____

B. REGENERATOR TOWER SURVEY

Hydraulic surveys are to be completed, after screen cleaning, at design process conditions for the following cases:

1. Regenerator with no catalyst and 100% nitrogen circulation.

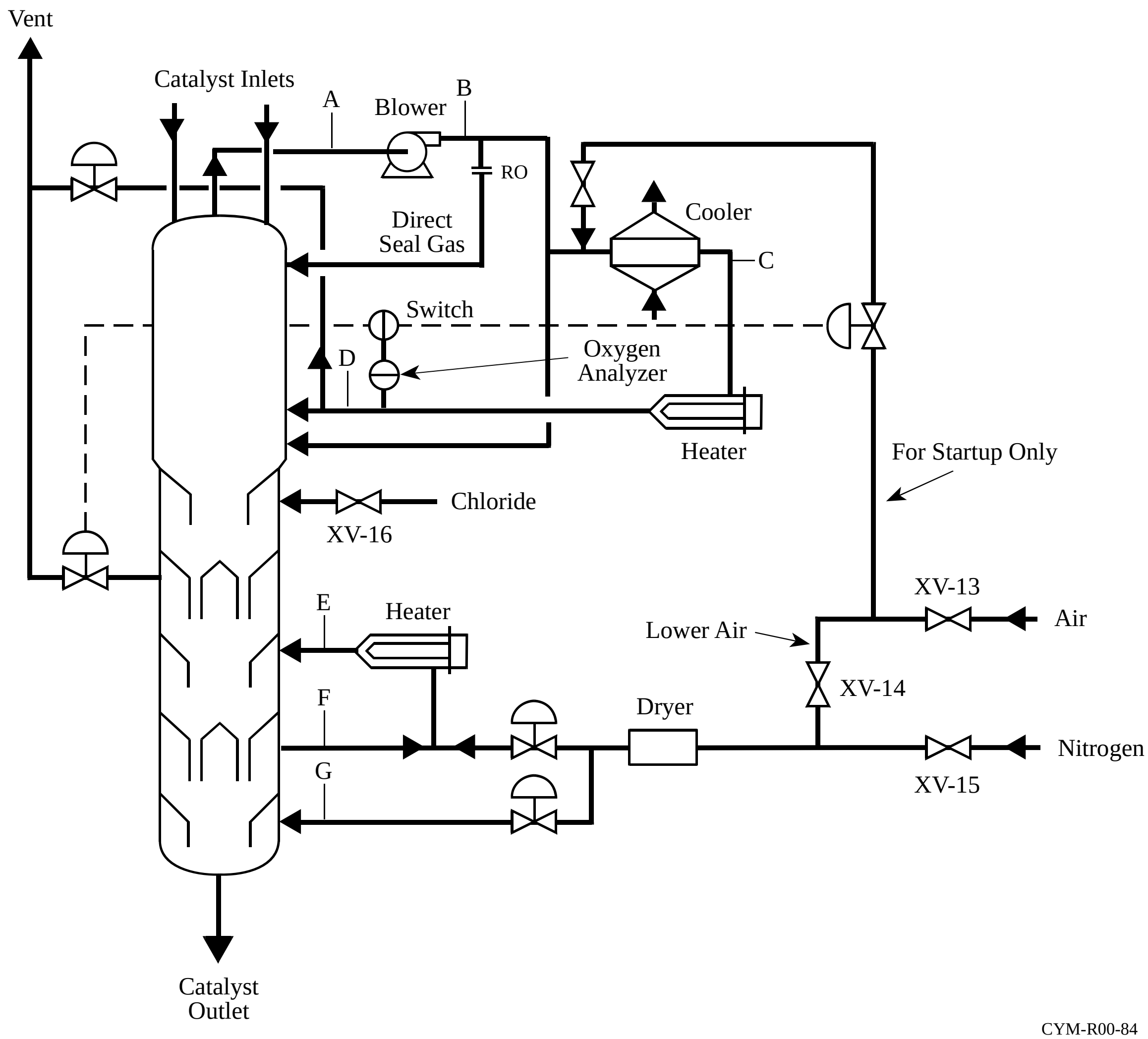
2. Regenerator with catalyst, no catalyst circulation, and 100% nitrogen circulation.

3. Regenerator in white burn conditions.

Use Figure XV-1 as a template for the type and locations of the required information.

Figure XV-1

CycleMax Regeneration Tower



Pressure and Temperatures (supply from available locations).

Location	**Temperature**	**Pressure**
A	________	________
B	________	________
C	________	________
D	________	________
E	________	________
F	________	________
G	________	________

Nitrogen Bubbles

Spent Catalyst Bubble	Top	________
Regenerated Catalyst Bubble	Top	________
	Bottom	________

Regeneration Zone Bed

1	________	6*	________
2	________	7*	________
3	________	8*	________
4	________	9*	________
5	________	10*	________

*if indicator is provided

Regeneration Gas Flow Rate	________
Drying Air Flow Rate	________
Cooling Air Flow Rate	________
Drying Zone Vent Gas (Excess Air) Rate	________
Reheat Gas Flow Rate	________
Upper Air Flow Rate	________
CCR Rate at this Time	________
% O_2 in Regeneration Gas Inlet	________
% O_2 in Regeneration Gas Outlet	________
% C on Spent Catalyst	________
Total White Burn Nitrogen Consumption	________

ELECTRIC HEATER SURVEY

Page ______________________________

Date ______________________________

Item No.: ______________________________ By ______________________________

Service: ______________________________

Manufacturer: ______________________________

Type: ______________________________

Number & Passes: ______________________ Tubes per Pass: ______________________

Tube Length: ______________________ Tube Skin Temperature: ______________________

Resistance of Each Phase: 1 ____________ 2____________ 3____________

Current at Peak Firing: ______________________ Voltage: ______________________

Deviations from UOP Specification: ______________________________

____

____

____

Item No.: ______________________________

Service: ______________________________

Manufacturer: ______________________________

Type: ______________________________

Number & Passes: ______________________ Tubes per Pass: ______________________

Tube Length: ______________________ Tube Skin Temperature: ______________________

Resistance of Each Phase: 1 ____________ 2____________ 3____________

Current at Peak Firing: ______________________ Voltage: ______________________

Deviations from UOP Specification: ______________________________

____

____

____

BLOWER PERFORMANCE SURVEY

CCR HOT FAN DATA

Page ______________________
Date ______________________
By ______________________

GENERAL
Service: ______________________
Item No.: ______________ Spare Plug Item No. ______________
Manufacturer: ______________________
Fan Model: ______________________
Type of CCR: ______________________
Fan Location: ______________________

OPERATING CONDITIONS/PERFORMANCE
Flow Rate: ______________ η @ Rated Point: ______________
Temperature: ______________ Power: ______________
Suction Pressure: ______________
Discharge Pressure: ______________

N_2 Buffer Seal Gas Rate: ______________ SCFH
Operating Vibration Levels:
Radial
Horizontal (inboard/outboard): ______________ in/s
Vertical (inboard/outboard): ______________ in/s
Axial (inboard/outboard): ______________ in/s

Type of Bearing Lubrication: ______________
Supply Pressure: ______________
Supply/Return Temperature: ______________
Flow Rate: ______________

DRIVER
Motor Manufacturer: ______________________
Rating: ______________ Service Factor: ______________
Insulation Class: ______________ Voltage/Phase/Cycle: ______________

Supply copy of fan manufacturer performance curve with operating point indicated.

CATALYST CIRCULATION SURVEY

Page: ______________________________
____
____
______________________________ Page

Date ______________________________
By ______________________________

Calibration:

Lock Hopper Load Size: ______________________

Maximum Catalyst Circulation Rate: ______________________

List any operating or lock hopper settings that were adjusted to reach this maximum catalyst circulation rate: ____
____
____
____

Lock Hopper Cycle Times:

Lock Hopper

Pressure-1: ______________________
Pressure-2: ______________________
Unload: ______________________
Depressure-1: ______________________
Depressure-2: ______________________
Load: ______________________

Total Cycle Time: ______________________

Note: 1. Total Cycle Time is measured from the time a cycle moves from the "Ready" step until it returns to the "Ready" step.

Lifting Characteristics:

Spent Catalyst L-Valve Assembly

Total Lift Gas Rate: ______________________
Secondary Lift Gas Rate: ______________________
Total Lift Gas Velocity: ______________________
Lift Line Nominal Size: ______________________
Lift Line Pipe Schedule: ______________________

Regenerated Catalyst L-Valve Assembly

Total Lift Gas Rate: ________________________

Secondary Lift Gas Rate: ________________________

Total Lift Gas Velocity: ________________________

Lift Line Nominal Size: ________________________

Lift Line Pipe Schedule: ________________________

Elutriator

Elutriation Gas Rate: ________________________

Elutriation Gas Velocity: ________________________

Elutriator Nominal Line Size: ________________________

Elutriator Pipe Schedule: ________________________

Approximate Catalyst Flux: ________________________

Dust Collector

Daily Average Dust Make: ________________________ *

*The daily average dust make is the total material collected, including whole pills, per day.

CATALYST LOADING

Catalyst Type ____________

Vessel Name	Vessel #	Catalyst Lot #s	wt_____	vol_____
Reactor #1	____________	____________________	______	_______
Reactor #2	____________	____________________	______	_______
Reactor #3	____________	____________________	______	_______
Reactor #4	____________	____________________	______	_______
___________________	____________	____________________	______	_______
Disengaging Hopper	____________	____________________	______	_______
Regenerator	____________	____________________	______	_______
Lock Hopper	____________	____________________	______	_______

LABORATORY

1. Spent Catalyst:
   a. Carbon
   b. Loss on ignition
   c. Particle size distribution
   d. Chloride on catalyst.

2. Regenerated Catalyst:
   a. Carbon
   b. Particle size distribution
   c. Chloride on catalyst.

3. Regeneration and Chlorination Gases:
   a. Density
   b. HCl
   c. Cl_2

4. Fines
   a. Loss on ignition
   b. Particle size distribution

C. TECHNICAL DOCUMENTATION AND DRAWINGS

Provide two sets of the following information (where applicable):

1. Drawings:
   a. Catalyst Collector
   b. Disengaging Hopper
   c. Regenerator
   d. Lock Hopper
   e. Regeneration Heater
   f. Air Heater
   g. Reduction Heaters
   h. Regeneration Cooler
   i. Regeneration Blower
   j. Cooler Blower
   k. Regeneration Loop Piping Isometrics
   l. Lock Hopper Equalization Line Piping Isometrics
   m. CCR Section P&IDs
   n. Reheat Gas Heater (if applicable)

2. Technical Data Sheets and Performance Curves:
   a. Regeneration Heater
   b. Air Heater
   c. Reduction Heaters
   d. Regeneration Blower
   e. Cooler Blower
   f. CCR Flow Meter Information
   g. Reheat Gas Heater (if applicable)

D. GENERAL COMMENTS

Comment about potential problems/bottlenecks in the unit such as lock hopper capacity, lift times, elutriation flux, heat loss around the regenerator, etc. This will provide insights which may not be apparent from the results of the various tests and surveys.

E. COKE BURN TEST

Every CCR Regenerator should have a coke burn test conducted while the tower screens are clean. This will define the maximum coke burn capacity of the Regeneration tower. See Chapter XIII for the procedure for conducting a Coke Burn Test.

F. UNIT PERFORMANCE EVALUATION

For unit performance evaluation, UOP recommends the CDOTS system.

The CDOTS system is a complete data handling system that encompasses the automatic collection of selected raw process and laboratory data from the unit, manipulation of the data into acceptable formats and reports for local interpretation, and transmission of this data to UOP where analysis by sophisticated tools and process specialists can be efficiently performed for more timely feedback. At the heart of the system is a software package for data handling on-site that provides the plant engineer with a tool to manage and present data in a consistent format. It can be integrated with existing information systems for the collection of data or used independently for manual data entry. The communication module included with the software package provides total control of data transmission to the refiner. The features of the CDOTS system are summarized on the following page. Data from the CycleMax and the Platforming Units are collected and processed simultaneously with CDOTS.

For more information on the CDOTS system, please contact the CDOTS co-ordinator in Des Plaines at (847)391-2220 or your Technical Service contact.

1. Features for the CCR Platforming Process Software

a. The system can be configured for:

- All Platforming units
- Up to four reactors in series
- Any of four separator types, Recovery Plus and a reformate splitter
- Up to three fresh feed streams and two recycle gas streams with analyses
- Reactor effluent measurement
- Up to four net gas streams with analyses
- One gas and one liquid configurable streams for non-standard streams
- Analog, digital or corrected flow calculations
- CCR section

b. There are calculations for:

- Raw flow correction for temperature, pressure and specific gravity
- GC analysis conversion and normalization
- Material balance based upon configured streams
- As-produced and reactor effluent yields
- Actual C_5+ and hydrogen yield comparisons against UOP predicted values
- Weighted average inlet & bed temperatures
- Catalyst activity comparisons against UOP predicted values
- Light ends ratios
- Liquid hourly space velocity
- Hydrogen to hydrocarbon ratio
- Water and chloride injection
- Catalyst life and days on stream
- Heater duties
- CCR calculations including liftgas velocities

c. Output includes:

- Variety of single day reports including the popular one page summary report
- Multi-day reports with optional minimum, maximum, average and standard deviation calculations
- Single page configurable plots with up to four variable and optional regression and confidence interval curves
- Stacked configurable plots with up to four plots per page, each plot having up to four variables
- Control charts
- Comma separated ASCII data files for transmission to UOP