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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION

LAKE CHARLES, LOUISIANA

VINYL CHLORIDE MONOMER OPERATIONS MANUAL

MANUAL No. 20

ASSIGNED TO: Bob Lynch

February, 1967

CONFIDENTIAL

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NOTES ON PAGE NUMBERING

This manual is designed to permit revision or additions without disturbing the order of page numbers or the figure designations of illustrations and tables other than in the particular section affected by the changes. Pages are numbered using a combination of two numbers, the first being the section number while the second represents a page, illustration, or table in that section. Thus, page 4-6 represents page 6 in section IV; Figure 8.7 represents Figure 7 in section VIII.

I. COMPOUND ABBREVIATIONS

Abbreviation	Name	Formula	Atm. Boiling Point °F
N2	Nitrogen (Light)	N_2	-345.75
HCl	Hydrogen Chloride (Light)	HCl	-121.09
Cl_2	Chlorine (Light)	Cl_2	- 29.29
F-12	Dichlorodifluoromethane(Freon-12,Light)	CCl_2F_2	- 21.46
VC	Vinyl Chloride Monomer (Key)	C_2H_3Cl	7.93
VDC	Vinylidene Chloride (Heavy)	$C_2H_2Cl_2$	88.88
Trans-DCE	Trans-1,2-Dichloroethylene (Heavy)	$C_2H_2Cl_2$	119.12
1,1-EDC	1,1-Dichloroethane (Heavy)	$C_2H_4Cl_2$	135.10
CLP	Chloroprene (Heavy)	C_4H_5Cl	138.92
Cis-DCE	Cis-1,2-Dichloroethylene (Heavy)	$C_2H_2Cl_2$	140.36
$CHCl_3$	Chloroform (Heavy)	$CHCl_3$	143.11
1,2-EDC	1,2-Dichloroethane (Heavy)	$C_2H_4Cl_2$	182.25
TRI	Trichloroethylene (Heavy)	C_2HCl_3	188.74
1,1,2-TCE	1,1,2-Trichloroethane (Heavy)	$C_2H_3Cl_3$	236.79
PER	Perchloroethylene (Heavy)	C_2Cl_4	249.75
Tars or HvCl	Any heavy chlorinated compounds	--	--

NOTE: "Heavy" indicates compounds having higher boiling points than VC.

"Light" indicates compounds having lower boiling points than VC.

VINYL CHLORIDE MONOMER PROCESS

II. INTRODUCTION

This operations manual has been assembled to serve the following objectives:

A. As a training guide for the operators in learning the Vinyl Chloride (VC) plant operations.

B. To serve as a ready reference for the operating personnel.

C. To provide a standard approach for operating the plant so that continuity of operations is maintained.

D. To serve as a place where current data, information, procedures, etc., relating to the VC plant are compiled.

This manual is designed to provide a logical approach to the start-up and initial operation of the VC plant. As operational experience is gained, it is expected that some of the Standard Operating Procedures (SOP's) will have to be altered. The operators can help to keep this manual up to date by making recommendations to change SOP's that appear to be no longer in use.

The information contained in this manual is considered confidential. This manual is the property of PPG and may be recalled at any time.

III. GENERAL DESCRIPTION OF VC PROCESS

A. Uses of VC

The chief uses of vinyl chloride are in the production of polymers and copolymers. A wide range of properties have made their use possible in many applications. One example of a copolymer which utilizes vinyl chloride is the Saran(R) line of plastics; this is a copolymer of vinyl chloride and vinylidene chloride.

B. Chemistry

Vinyl chloride is produced by the following equation:

$$\underset{\text{EDC}}{\begin{array}{ccc} Cl & & Cl \\ HC & - & CH \\ H & & H \end{array}} \xrightarrow[600\text{-}975^{o}F]{} \underset{\text{VC}}{\begin{array}{ccc} Cl & & H \\ HC & = & CH \end{array}} + HCl$$

At high conversions and/or temperatures, side reactions involving acetylene and hydrogen formation become significant, according to these equations:

$$\underset{\text{VC}}{\begin{array}{ccc} Cl & & H \\ HC & = & CH \end{array}} \longrightarrow \underset{\text{Acetylene}}{HC \equiv CH} + HCl$$

$$\underset{\text{EDC}}{\begin{array}{ccc} Cl & & Cl \\ HC & - & CH \\ H & & H \end{array}} \longrightarrow H_2 + 2HCl + 2C$$

Other side reactions include the formation of chloroprene, phosgene, butadiene (1,3), cis- and trans-1,2-dichloroethylene, and vinylidene chloride. The extent of these side reactions is acceptable at around 50% conversion.

C. Process Description

1. EDC Drying and Vaporization: The EDC feed to the VC vaporizer is pumped from the heavies still reflux tank. It is first cooled and then passed through the EDC safety driers. It is important to guard against high water content in the EDC feed to minimize corrosion in the process equipment. The calcium chloride driers will keep the water content below 50 ppm as a maximum, and preferably below 20 ppm.

After being dried the EDC feed passes through a filter, which prevents any calcium chloride from being carried into the vaporizer. The EDC is next heated to 240^{o}F in the furnace feed economizer; the other stream in this economizer is a process stream which will be discussed later. Next a steam heater heats the EDC feed to around 375^{o}F.

The EDC then branches into two streams; each stream is flow controlled before entering the two-pass vaporizing furnace. EDC vapor leaves this furnace above 400°F. The furnace is gas fired with the natural gas automatically mass flow controlled.

The vaporizer has been provided with safety devices and instrumentation to make all foreseeable operations as safe as possible.

2. Cracking Furnace: The EDC vapor from the vaporizer is fed to the two cracking furnaces. One vaporizer pass feeds each cracker. The EDC vapor branches into four passes before entering a cracking furnace. Cracking of EDC to vinyl begins at about 600°F; the conversion is around 50% at 900-925°F.

It has been found that excessive temperatures and/or retention times in the tubes of the furnaces will cause coke deposits to form on the walls of the tubes. Over long periods of time coke will build up in the tub s. In order to minimize coke formation, steady feed rates to the furnaces and a constant outlet temperature must be maintained during operations. A flow controller for each furnace pass has been provided. Natural gas to the burners is mass flow controlled automatically.

Each of these furnaces is provided with safety devices and instrumentation commonplace to units of this type.

Coke can be cleaned out of the furnace tubes by using the steam-air decoking procedure discussed in detail later.

3. Quench Tower: The furnace exit gases must be quenched rapidly to lower the temperature in order to minimize undesirable side reactions such as coking, and in order the prevent the reverse reaction HCl plus vinyl chloride to give 1,1-dichloroethane. This quenching step is effected in a packed tower which services as a direct contact cooler. The gases enter the column through nozzles who outlets are submerged in a liquid level of EDC. This submerged quenching step is important for three reasons: (1) it provides an effective way for quenching the furnace exit vapors, (2) it prevents carbonaceous material from passing upwards into the column packing and forward into process equipment, and (3) if the entrance nozzles were not submerged, they would rapidly plug up, as demonstrated in pilot plant operations.

The quenched furnace gases are contacted countercurrently in the column with recycle quench liquor. This scrubbing action removes from the quench column overhead stream any residual carbonaceous matter. The downflowing quench liquor serves to replenish the liquid lost due to vaporization in the column. There is in addition enough excess quench liquor so that a purge of the carbonaceous and tarry materials collected in the bottom reservoir of the column can be made to the Dopp Kettles.

The vapor leaving the top of the quench tower is at its dewpoint, around 266°F.

4. Tar Removal: The removal of carbonaceous and tarry materials from the quench tower is accomplished by draining the bottoms to the two Dopp Kettles. The level in the quench tower controls two on-off automatic ball valves which regulates the bottoms purge rate.

Each Dopp Kettle is steam-jacketed and contains a scraper agitator. EDC serves as a carrier to bring the carbon and tar into a kettle and is recovered by being vaporized back to the bottom of the quench tower. These bottoms are periodically transferred to the tar trailer and then dumped.

5. Partial Condensers: Two partial condensers in parallel (primary quench condensers) are used to cool as far as practical the quench tower overhead vapor.

The condensate from the primary quench condensers drains to the quench liquor tank, and the gas is sent to the bottom of the vinyl absorber as a feed stream.

Liquor that is not used from the quench liquor tank for reflux quench liquor is fed forward to the HCl stripper. This stream is dried and filtered before being fed forward.

6. Vinyl Absorber: Vapor from the primary quench condensers and the HCl stripper are fed to the bottom of the vinyl absorber where they are contacted countercurrently with EDC. The bottoms stream contains the absorbed vinyl chloride and some HCl; this is the feed stream to the HCl stripper. The overhead vapor exit stream from the absorber consists mainly of HCl with small amounts of EDC and acetylene. The HCl vent is pressure controlled to maintain a pressure of about 80 psig at the top of the absorber. The absorber pressure control valve imposes a back-pressure on the complete furnace-quench system. A level control valve on the stripper feed stream controls the level in the absorber.

Both vinyl chloride and some HCl are absorbed into the EDC down-flowing stream in the absorber. As the VC and HCl are absorbed, an amount of heat is released that is essentially equivalent to the latent heat of vaporization of these compounds. This heat must be removed from the absorber to maintain the appropriate temperatures. This is accomplished in three ways: (1) by use of a refrigerated lean oil feed to the top of the absorber, (2) by use of two side draw intercoolers operating on trays 8 and 13 of the absorber, counted from the bottom, (3) by use of an overhead condenser operating on the vent HCl stream.

The lean oil to the absorber is obtained from the bottom of the vinyl product still. This recycle stream is cooled in four stages from 315°F to -28°F. These cooling steps are: (1) interchange with feed to EDC vaporizer in the economizer, (2) further cooling in a cooling water exchanger, (3) refrigeration in the 34° lean oil cooler and, (4) refrigeration in the -40° lean oil cooler.

The absorber intercoolers are designed so that liquid from the respective draw trays can be recirculated external to the column through refrigerated heat exchangers, dried, filtered, and then returned to the tray below automatically.

The absorber vent condenser cools the exit HCl vent gas to -18°F to recover the organics leaving the absorber in this stream. The condensate from this condenser flows to the upper intercooler surge tank.

A knock-out drum is located downstream of the absorber vent condenser and before the absorber pressure control valve. Condensate from this drum is sewered.

An HCl scrubber is used to neutralize HCl gas not normally consumed by other units. The solution formed is sewered.

A very important part of the vinyl absorber unit is the York refrigeration unit. Three levels of refrigeration (-40°F, -3°F, +34°F) using Freon-12 are provided. Two compressors, each driven with a 1250 HP electric motor, provide 1250 tons of refrigeration.

7. HCl Stripper: In theory the vinyl absorber and the HCl stripper could be one column. However, due to the number of theoretical plates required it was decided to make two separate columns instead. The purpose of the vinyl absorber is to remove the vinyl chloride from the HCl overhead stream, the purpose of the stripper is to remove HCl from the EDC and vinyl chloride bottom stream.

The HCl stripper receives feed from the bottom of the VC absorber and the quench liquor tank. The feed contains vinyl chloride absorbed in EDC, which will pass forward through the stripper to the vinyl purification column, and also some absorbed HCl, which must be removed from the forward stream by the separation operation known as stripping. A thermosiphon reboiler located at the bottom of the stripper provides the vapor to strip out the HCl from the forward stream. Steam to the stripper reboiler is flow controlled. Adjustment is made on the basis of the temperature profile of the absorber-stripper system.

Vapor from the stripper is returned to the bottom of the absorber. This stream, of course, imposes a load on the absorber heat removal system, just as does the vapor feed passing to the absorber from the primary quench condensers.

The level in the stripper is kept constant by a drain line to the product still feed tank.

8. Vinyl Product Still: Feed to the product still from the product still feed tank is flow controlled. This column separates VC from EDC and heavies. The still operates at about 80 psig top pressure, and top temperature of 105°F, so that cooling tower water rather than refrigeration can be used. This column, like the absorber-stripper columns, uses Glitsch Ballast trays. All compounds heavier than VC such as chloroprene, 1,1-EDC, and 1,2-EDC, are removed from the bottom of th column.

The bottoms stream from the product still reboilers contains mainly EDC, with some heavies. The major portion of this stream is recycled to the absorber while the remainder is sent to the heavies still for purification. The ratio is approximately 1.3 parts of lean oil to 1.0 part of recycle EDC to the heavies still.

These two streams split after passing through the economizer. The lean oil stream is cooled in four stages as mentioned earlier; the recycle EDC stream is cooled in two stages. These two stages are the economizer and the EDC recycle cooler where the EDC is cooled to 165°. A level control valve on the recycle EDC stream controls the column level. The flow of steam to the two reboilers is temperature controlled.

The recycle EDC stream contains impurities, notably chloroprene, which, if not removed would be detrimental to the subsequent cracking step. Therefore, a small amount of gaseous chlorine is added to the recycle stream after it has been cooled. The chlorine combines with the chloroprene to form heavy boiling compounds that can be easily separated from theEDC in the heavies still. This reaction is shown below:

```
 H    Cl  H   H                   H   Cl  H   H
 H C  = C - C = C H  +  2 Cl2 ---> HC - C - C - C H
                                  Cl  Cl  Cl  Cl

 Chloroprene        Chlorine      Pentachlorobutane
                                  and/or other heavies

 Cl     H                  Cl     H
 HC  =  CH  +  Cl2  --->   HC  -  CH
                           Cl     Cl

   VC        Chlorine      1,1,2-trichloroethane
```


It is this 1,1,2-trichloroethane which gives rise by cracking to the presence of small amounts of vinylidene chloride found in some of the process streams. These two compounds have no deleterious effects on the process.

It is doubtful whether much reaction occurs between the dichloroethylenes and the gaseous chlorine under the chlorination conditions employed.

<u>The chlorination of the recycle EDC is a very definite and essential part of this process because there is no other way to remove the chloroprene which is so detrimental to the pyrolysis step</u>.

9. <u>Product Neutralization and Storage</u>: Vinyl chloride with a small amount of HCl is taken overhead in the vinyl product still, condensed, and collected in the reflux tank. Reflux for the still is withdrawn from this tank and returned to the top of the still. The reflux ratio for this still is approximately 1.3:1. Excess production in the reflux tank is pumped to the flake caustic product neutralizers where the HCl is neutralized. It was found in the pilot plant that VC directly off the vinyl still would not meet the rigid specifications for HCl, even though the stripper was under control. This is to be expected since the ppm of HCl in the stripper bottoms is concentrated by a factor of about 8 in the vinyl still overhead product.

The feed to the neutralizer is first cooled from 105°F to 95°F. It then flows through a phase separator where it comes in contact with water. The purpose of this phase separator is to insure a wet product flowing into the flake caustic neutralizer and, therefore, better neutralization. Another phase separator and a filter follow the neutralizer so that caustic which is carried from the neutralizer can be removed from the vinyl chloride product. The vinyl chloride then goes to one of eight day tanks, from which it can be transferred to one of three spheres after laboratory approval.

10. Heavies Still: The recycle EDC stream goes to the heavies still feed tank after being chlorinated. Liquid from the heavies still feed tank is pumped to the feed tray of the heavies still; a flow controller regulates this stream. The heavies still separates EDC from heavies. The liquid feed flows downward through the column countercurrent to the EDC vapors. The heavy chlorinated organics with higher boiling points flow down the column to the reboiler. An overflow line controls the level in the heavies still. This line empties into the waste recovery tank. Bottoms are circulated back to the heavies still until a predetermined level is reached in the waste recovery tank. Then they are transferred to the bottoms plant.

Liquid in the bottom of the still is vaporized in the thermosiphon reboiler. This produces the upward flow of EDC vapors which become increasingly purer toward the top of the still. These vapors are condensed in the still condenser and the liquid drains to the still reflux tank through a vertical standleg. Any non-condensables are vented out through the stack seal to the vent pipe. The stack seal pressure drop determines the operating pressure (slightly positive at top) on the still over and above the slight nitrogen pad pressure imposed on the condenser. Steam to the reboiler is temperature controlled. The reflux ratio of this column is approximately 0.9:1. The furnace feed pumps also draw from the still reflux tank; this stream is also flow-controlled. Pure EDC make-up from EDC or OHC is pumped to this tank. The stream is flow controlled.

11. HCl Distribution: The HCl which passes through the knockout drum can be handled in several ways. Some of it goes to the oxyhydrochlorination (OHC) plant. First this stream passes through a spiral plate heat exchanger to heat the HCl from -20°F to ambient temperature to prevent condensation on the outside of the line. The HCl line pressure to OHC is sufficient so compression is not required.

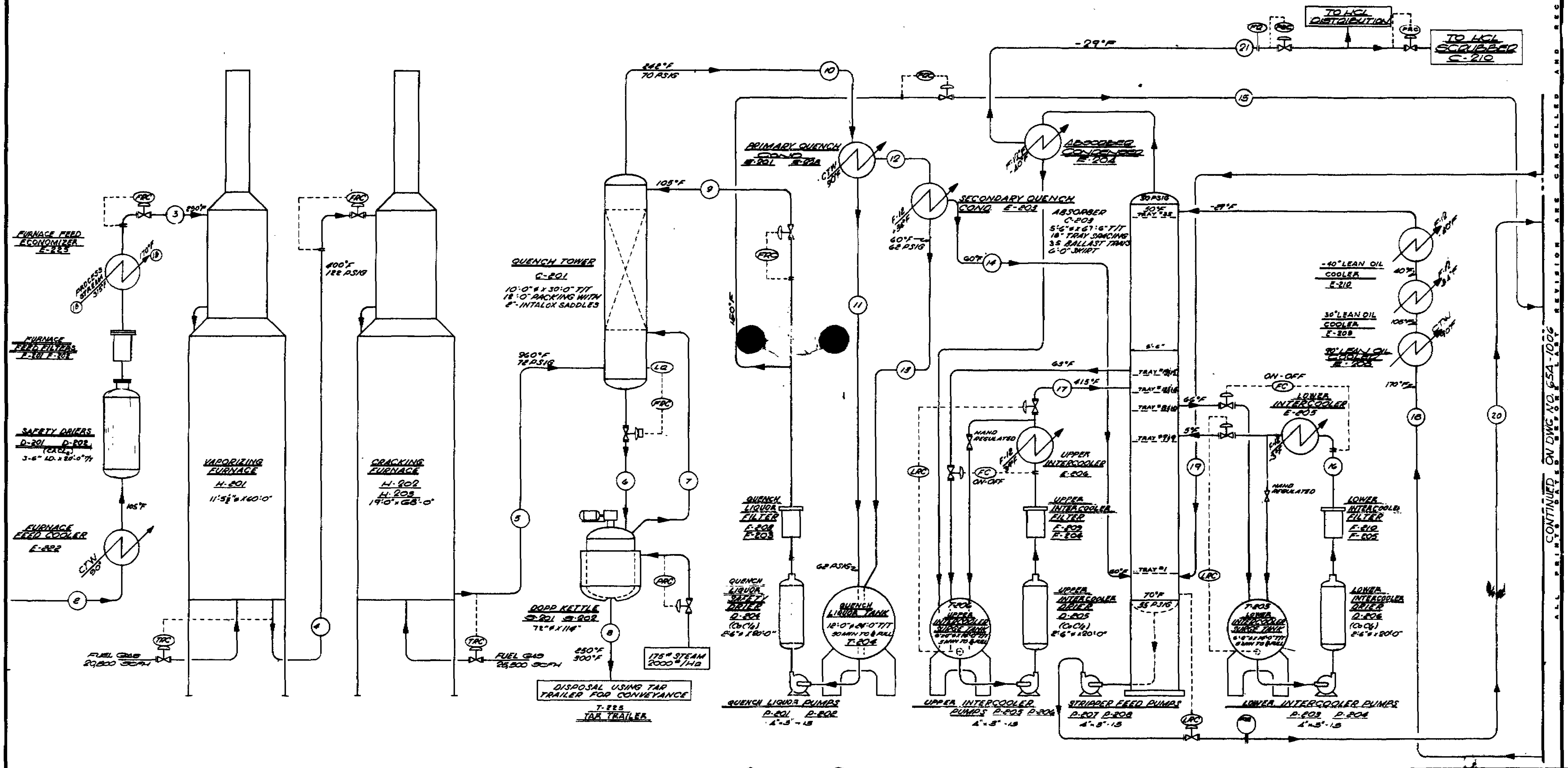
The remaining HCl passes through the absorber pressure control valve. Some of it passes through two activated carbon filter to remove any EDC from the HCl gas. The HCl stream then passes through a pressure control valve and on to the absorbers in the HCl plant.

Some of the HCl passes through a manual loading station (MLS) and on to the suction of No. 1, 2, 3 compressors. The HCl is compressed and sent to the EC plant.

Any temporary excess HCl is scrubbed. A back pressure control valve regulates the flow of HCl to the scrubber. Water and cell liquor are used for scrubbing the HCl.

	① WT %	① LB/HR	② WT %	② LB/HR	③ WT %	③ LB/HR	④ MOL %	④ LB/HR	⑤ MOL %	⑤ LB/HR	⑥ WT %	⑥ LB/HR	⑦ MOL %	⑦ LB/HR	⑧ WT %	⑧ LB/HR
HCL									32.54	22 615						
VC			0.18	106	0.08	106	0.13	106	32.99	39 300						
TRANS									0.13	229						
LI EDC			0.51	301	0.24	301	0.23	301	0.12	216						
CLP									0.10	165						
C/S									0.02	38						
EDC	100.00	68 167	99.31	126 860	99.68	126 860	99.64	126 860	33.83	63 812	90.00	4 467	100.00	4 279	27.58	188
TRI									0.15	395						
SYM TERTA																
H_2Cl									0.12	496	10.00	496			72.42	496
Cl_2																
TOTAL		68 167		127 267		127 267		127 267		127 266		4 963		4 279		684
FLOW	110 GPM		216 GPM		236 GPM		1445 CFM		5572 CFM		10 GPM		74 CFM		1 GPM	

	⑨ WT %	⑨ LB/HR	⑩ MOL %	⑩ LB/HR	⑪ WT %	⑪ LB/HR	⑫ MOL %	⑫ LB/HR	⑬ WT %	⑬ LB/HR	⑭ MOL %	⑭ LB/HR	⑮ WT %	⑮ LB/HR	⑯ WT %	⑯ LB/HR	⑰ WT %	⑰ LB/HR
HCL	1.29	1 802	19.46	24 417	0.96	1 948	48.64	22 469	6.86	802	54.45	21 667	1.29	948	7.88	15 102	8.55	15 580
VC	11.51	16 113	25.77	55 413	8.52	17 200	48.27	39 213	63.32	7400	45.19	30 813	11.51	8488	8.75	16 775	3.75	6 844
TRANS	0.31	446	0.20	475	0.33	675							0.31	229				
LI EDC	[illegible]	416	0.19	632	0.31	632							0.30	216				
CLP	[illegible]	310	0.16	475	0.24	475							0.22	165				
C/S	[illegible]	78	0.03	116	0.06	116							0.05	38				
EDC	85.78	120 061	53.94	183 684	89.01	179 817	3.09	3 868	29.82	3485	0.36	383	85.78	63 241	83.37	159 798	87.70	159 817
TRI	0.54	761	0.25	1155	0.57	1155							0.54	395				
SYM TERTA																		
H_2Cl																		
Cl_2																		
TOTAL		139 987		264 567		202 018		64 569		11 687		52 863		73 720		191 675		182 241
FLOW	237 GPM		5479 CFM		340 GPM		1725 CFM		23 GPM		1356 CFM		125 GPM		317 GPM		299 GPM	



NOTES:

1. MATERIAL BALANCE FIGURES ARE FOR 456 TPD (NOMINAL CAPACITY OF 300 MM LBS/YR)
2. STREAM FACTOR IS 90%.
3. MATERIAL BALANCE FLOWS ARE GIVEN AT PROCESS CONDITIONS.

EXCHANGER	AREA SQ.FT.	SHELL [illegible]	NO. TUB[illegible]	[illegible]TY-MM BTU/HR	TUBE SIDE	SHELL SIDE
H-201	2800	11'-5½"x68'0"	2 Pass	19.0	PROCESS	COMBUSTION GASES
H-203	4100	19'-6"x68'0"	4 Pass	20.65	do	do do
E-201	5900	37" x 16'-0"	1842	18.0	C.T.W.	PROCESS
E-203	2480	29" x 16'-0"	790	2.25	PROCESS	FREON-12
E-204	1828	27" x 19'-0"	360	0.53		
E-205	1960	25" x 16'-0"	434	3.43		
E-206	840	21.25" x 16'-0"	306	1.17	do	do
E-208	1240	27" x 10'-0"	632	11.8	CTW	PROCESS
E-209	1140	23.25"x16'-0"	364	3.15	PROCESS	FREON-12
E-210	960	21.25"x16'-0"	306	3.08	do	do do
E-222	730	17.25"x16'-0"	232	3.63	CTW	PROCESS
E-225	3500	2'x20' (15 UNITS)	1 UNIT	4.33	PROCESS	PROCESS

REVISIONS

ISSUED 10-3-65
FOR [illegible]
BULLETIN NO. A-H

⚠1 GENERAL REVISION CHARGE P-741 11-17-65 G. SMITH

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Fig. 3.1

SL 009775

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CONTINUED ON DWG NO. 65A-1006

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No. 91-1145

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

V.C. PLANT
PROCESS FLOW SHEET 1 OF 3
DESIGN CAPACITY OF 333 MM LBS/YR (456 TPD)
NOMINAL CAPACITY OF 300 MM LBS/YR (411 TPD)

DRAWN BY K Harrell DATE 9-9-65 SCALE —
CHECKED BY ______ DATE ______ CHARGE P-741
APPROVED BY ______ DATE ______ SUB ______
BILL OF MATERIAL ______ DWG. NO. 65A-1005.1

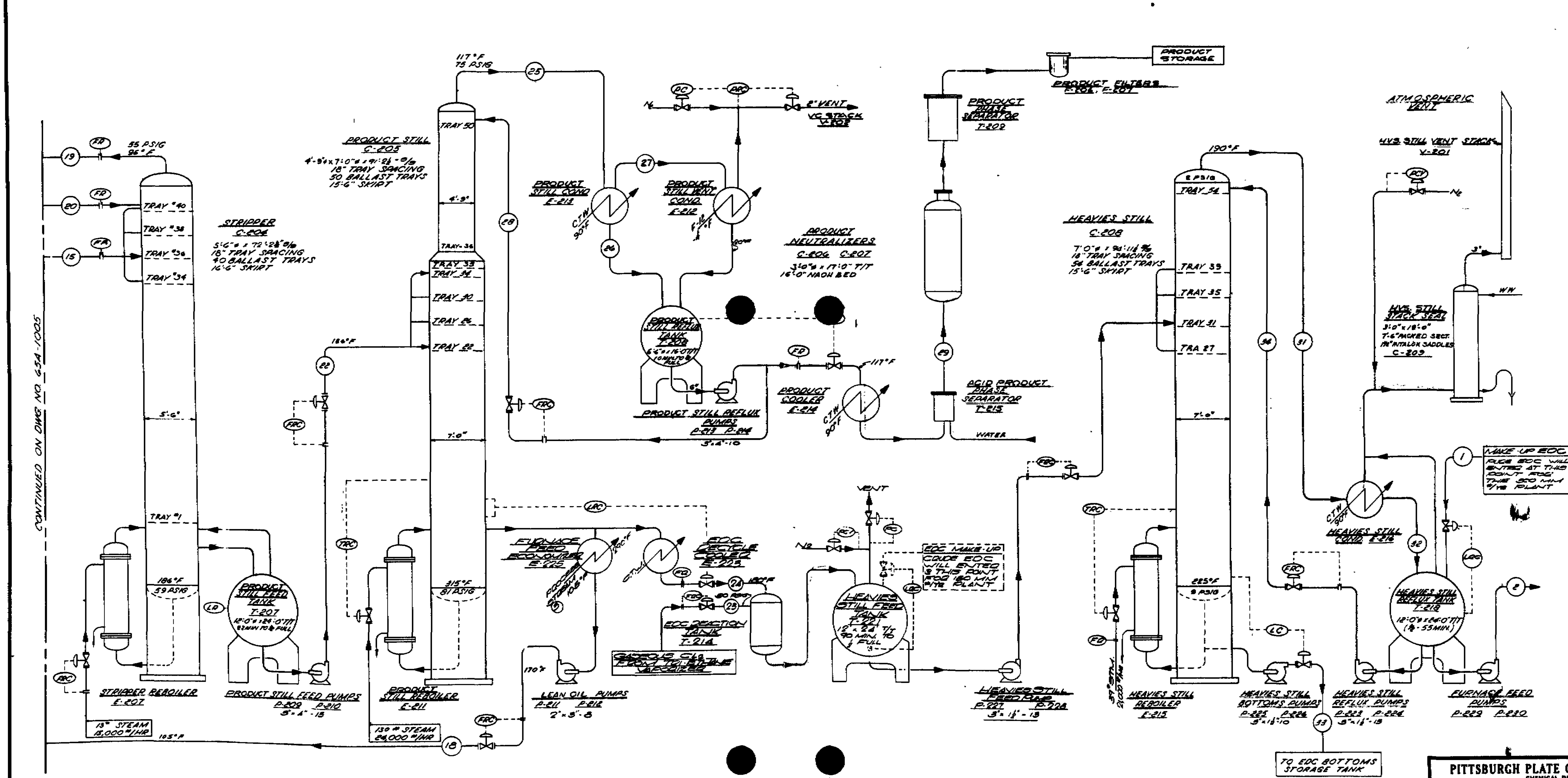
REVISIONS

ISSUED 10-6-65 FOR — BULLETIN NO. 3-6

1 GENERAL REVISIONS 11-18-65 G. SMITH

	18 WT %	18 LB/HR	19 MOL %	19 LB/HR	20 WT %	20 LB/HR	21 MOL %	21 LB/HR	22 WT %	22 LB/HR	23 MOL %	23 LB/HR	24 WT %	24 LB/HR	25 MOL %	25 LB/HR
HCl			53.90	13 392	5.61	12 440	99.90	22 615	.0001						0.001	1
V.C.	0.32	510	43.49	18 519	22.22	49 306	0.03	13	15.17	39 857			0.318	206	99.996	91 581
TRANS	0.35	557							0.33	861			0.353	229		
1,1 EDC	0.33	523							0.31	814			0.334	216		
CLP	0.25	398							0.24	622			0.255	165		
C/S	0.06	95							0.05	144			0.059	38		
EDC	98.08	156 010	2.61	1 762	72.17	160 104	0.07	40	83.37	219 098			98.072	63 580	0.003	5
TRI	0.61	970							0.53	1403			0.609	395		
SYM TETRA																
H₄Cl																
Cl_2											100.00	674				
TOTAL		159 063		33 673		221 850		22 668		262 799		674		64 929		91 587
FLOW	271 GPM		965 CFM		386 GPM		750 CFM		478 GPM		16 CFM		112 GPM		1766 CFM	

	26 WT %	26 LB/HR	27 MOL %	27 LB/HR	28 WT %	28 LB/HR	29 WT %	29 LB/HR	30 WT %	30 LB/HR	31 MOL %	31 LB/HR	32 WT %	32 LB/HR	33 WT %	33 LB/HR	34 WT %	34 LB/HR
HCl	TR			1			0.0001											
V.C.	99.9996	91 388	100.00	194	99.994	52500	99.994	39 140	0.162	106	0.29	213	0.18	213			0.18	106
TRANS																		
1,1 EDC									0.330	216	0.50	601	0.51	601			0.51	301
CLP																		
C/S																		
EDC	0.0004	5			0.006	3	0.006	2	97.063	63 580	99.21	117 385	99.31	117 385	75.00	4803	99.31	58 693
TRI									1.567	1 027					16.03	1 027		
SYM TETRA									0.662	433					6.76	433		
H₄Cl									0.216	142					2.21	142		
Cl_2																		
TOTAL		91 393		195		52503		39 142		65 503		118 199		118 199	-	6405		59 100
FLOW	212 GPM		4 CFM		122 GPM		90 GPM		113 GPM		7800 CFM		204 GPM		11 GPM		102 GPM	



EXCHANGER	AREA SQ.FT.	SHELL SIZE	NO. TUBES	DUTY-MM BTU/HR	TUBE SIDE	SHELL SIDE
E-207	1500	35" x 10'-0"	576	14.5	PROCESS	STEAM
E-211	3240	48" x 10'-0"	1240	20.3	PROCESS	STEAM
E-212	110	8" x 16'-0"	26	0.21	PROCESS	FREON-12
E-213	3500	37" x 16'-0"	1242	10.9	CTW	PROCESS
E-214	70	8" x 14'-0"	26	0.18	CTW	PROCESS
E-215	2100	39" x 10'-0"	804	15.2	PROCESS	STEAM
E-216	1750	25" x 16'-0"	538	18.3	CTW	PROCESS
E-223	190	10" x 12'-0"	82	3.2	CTW	PROCESS
E-225	3800	4" x 20' (15 UNIT)	77/UNIT	8.33	PROCESS (3)	PROCESS (4)

SL 009776

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

V.C. PLANT
PROCESS FLOW SHEET 2 OF 3

DRAWN BY K. Harrell DATE 9-9-65 SCALE —
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APPROVED BY ______ DATE ______ SUB ______
BILL OF MATERIAL ______ DWG. NO. 65A-1006

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REVISIONS

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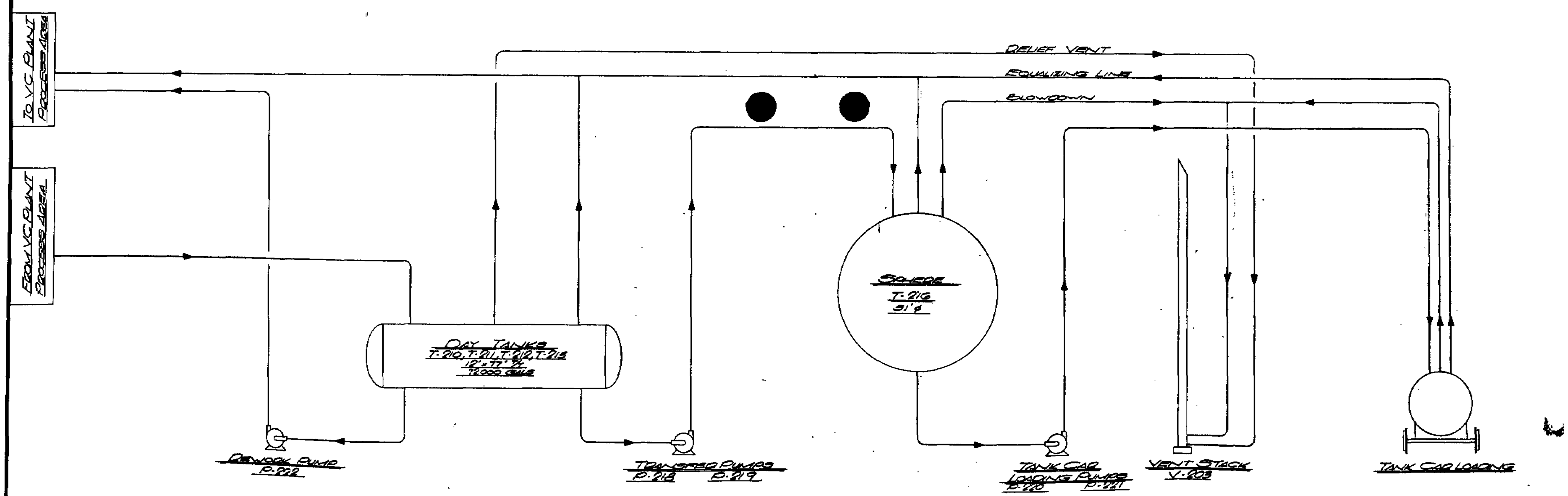
Fig. 3.3



PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VC PLANT
PROCESS FLOWSHEET

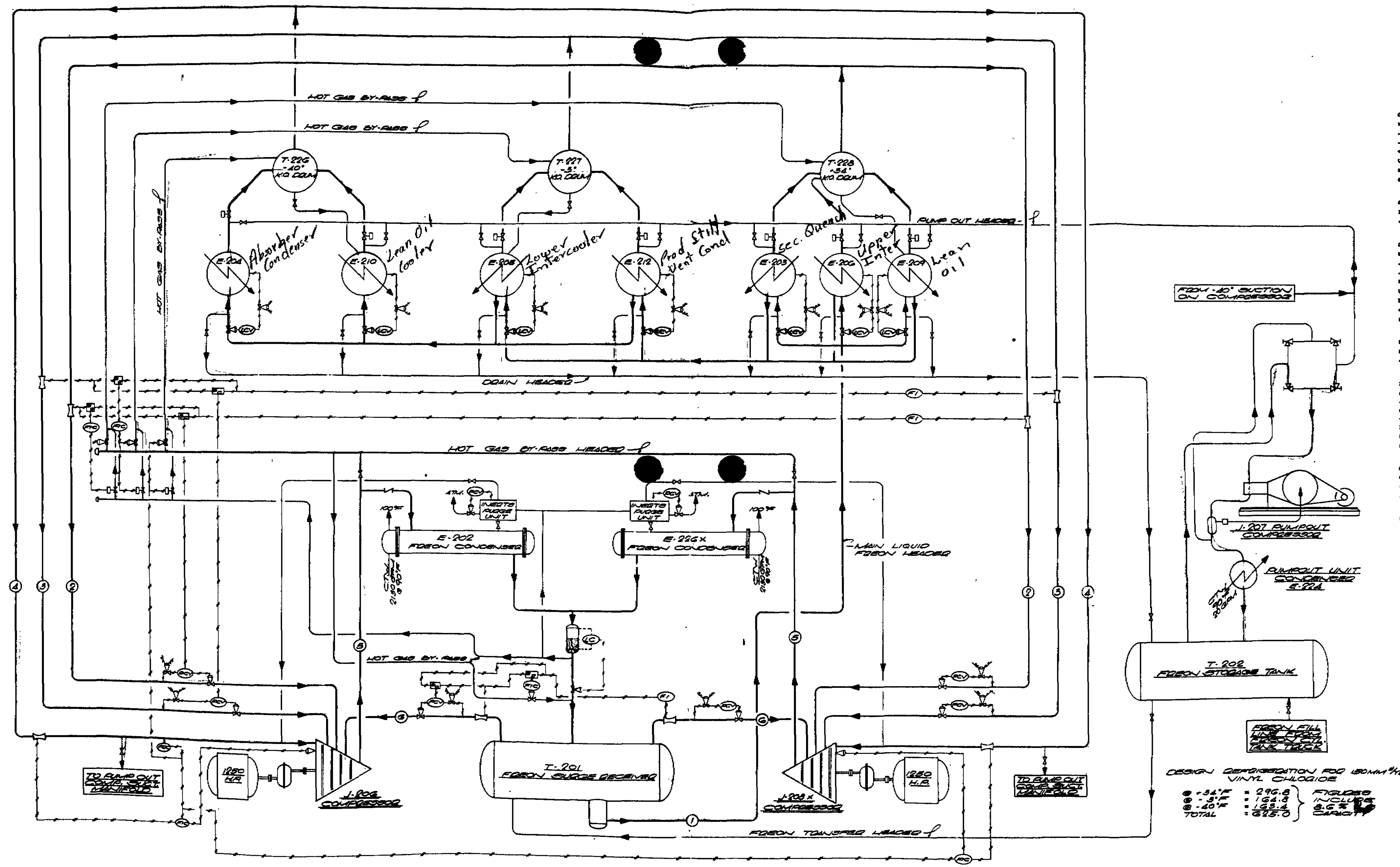
SHEET 3 OF 6

DRAWN BY MALLETT DATE 8-8-66 SCALE NONE
CHECKED BY ______ DATE ______ CHARGE P741
APPROVED BY ______ DATE ______ SUB ______
BILL OF MATERIAL
DWG NO 654-1007

SL 009777

REVISIONS

Page 3-10
Fig. 3.4



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NOTE:
REFRIGERATION COMPRESSORS HAVE CAPACITY OF 625 TONS EACH UNDER DESIGN CONDITIONS. ONE COMPRESSOR IS REQUIRED FOR 150 MM#/YR V.C. CAPACITY.

FREON MATERIAL BALANCE

		①	②	③	④	⑤	⑥
FREON 12 FLOW	LBS/MIN	4566	1245	571	490	2700	594
TEMPERATURE	°F	+68.4°	+34°	-3°	-40°	108°	68.4°
PRESSURE	PSIG	62.2	31.7	7.7		132.1	64.2
	"Hg VAC.	~	~	~	10.9	~	~
	PSIA	78.9	46.4	22.4	9.3	146.8	78.9
PHYSICAL STATE		LIQUID	VAPOR	VAPOR	VAPOR	VAPOR	VAPOR

SL 009778

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE
REFRIGERATION
PROCESS FLOWSHEET
SHEET 4 OF 5

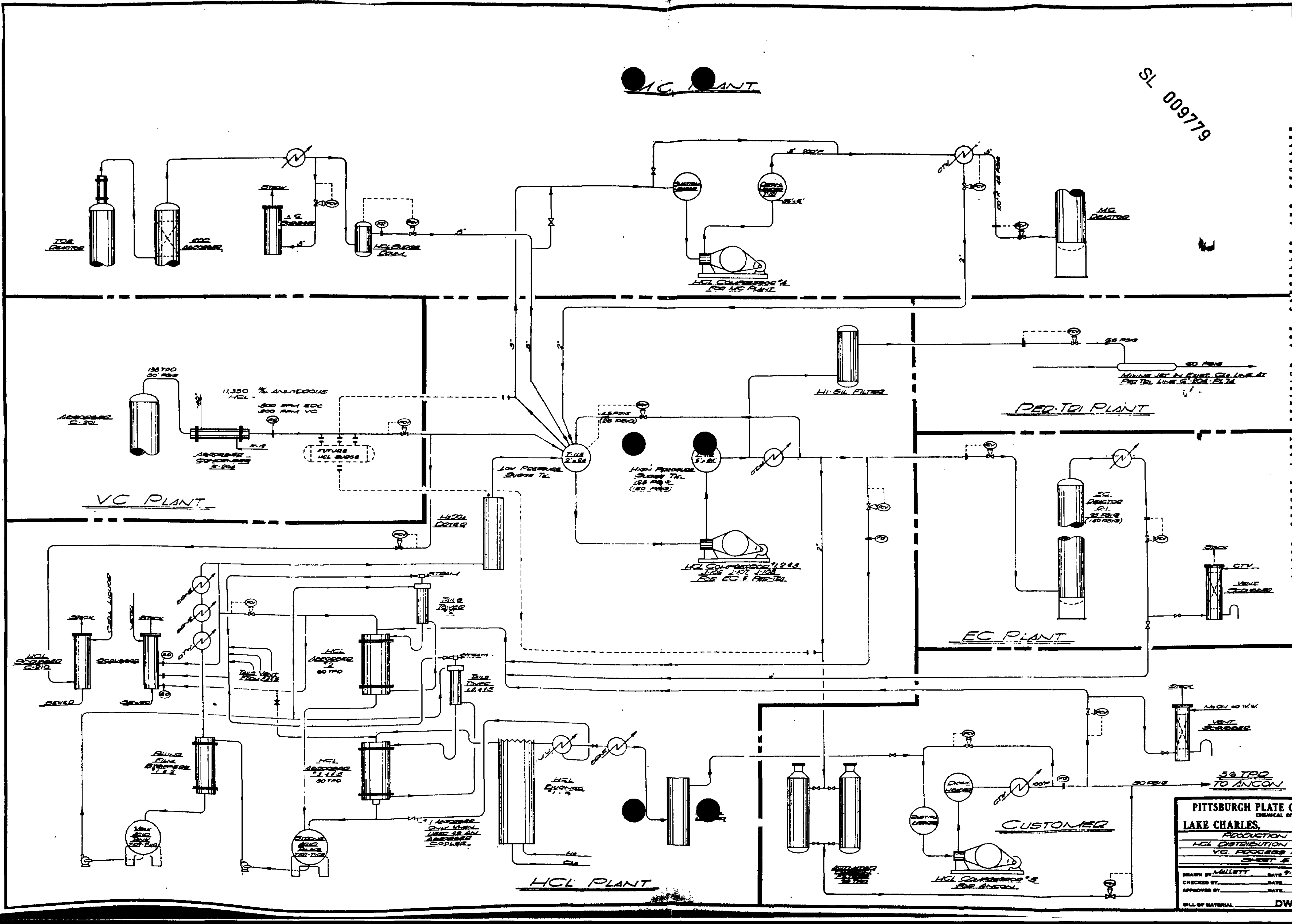
DRAWN BY Mallett DATE 8-12-66 SCALE none
CHECKED BY DATE CHARGE P-741
APPROVED BY DATE SUB.
BILL OF MATERIAL DWG. NO. G54-1008

REVISIONS

LAST CHANGE 8-11-66

Page 3-11
Fig. 3.5

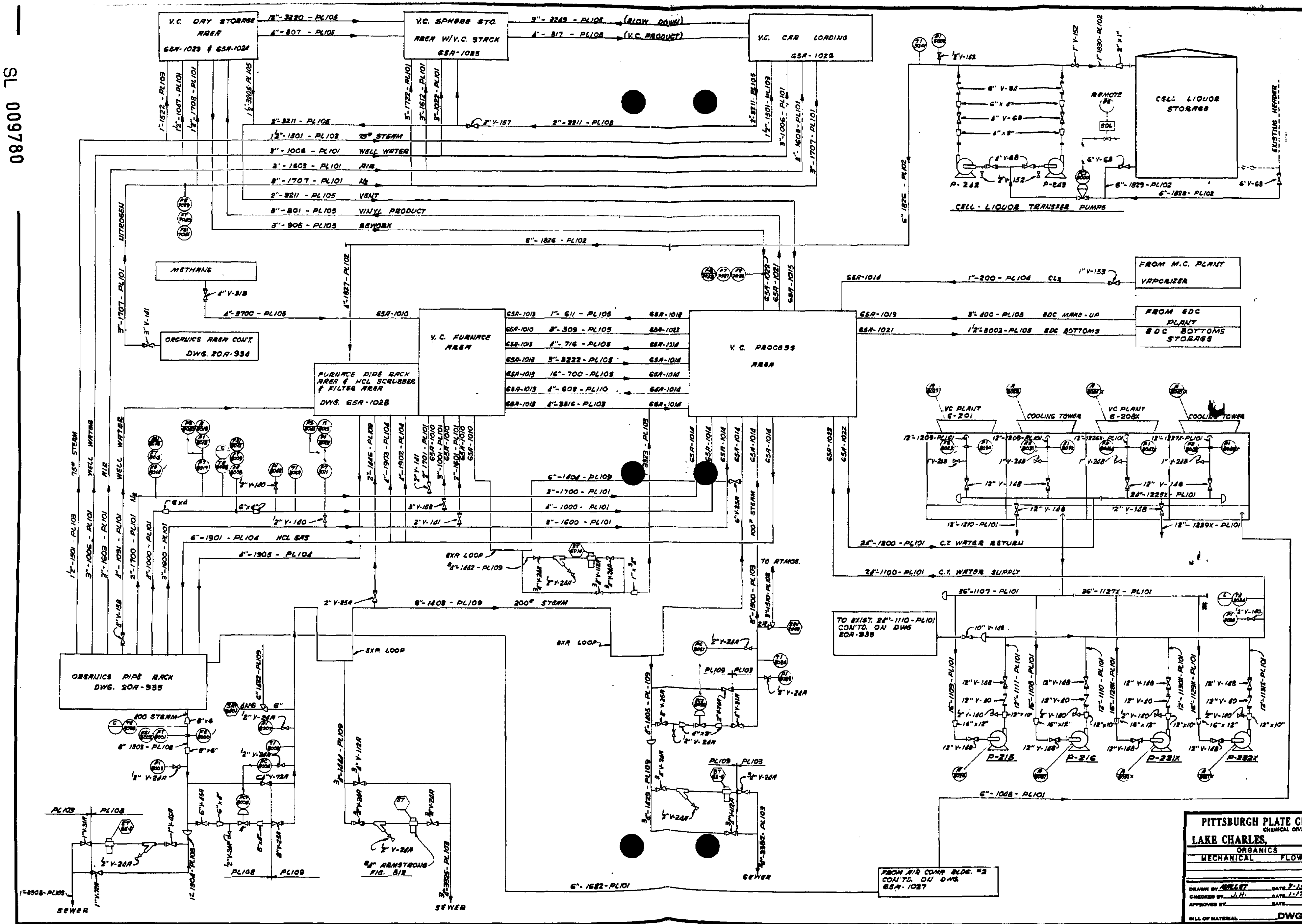
SL 009779



PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
PRODUCTION AREA "B"
HCL DISTRIBUTION FLOW SHEET
V.C. PROCESS FLOW SHEET
SHEET 5 OF 5

DRAWN BY MALLETT DATE 9-21-66 SCALE NONE
CHECKED BY DATE CHARGE
APPROVED BY DATE SUB.
BILL OF MATERIAL DWG. NO. G64-1009

SL 009780



REVISIONS

△ REDRAWN W.Z.F. 1-10-67

Page 3-12
Fig. 3.6

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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
ORGANICS AREA
MECHANICAL FLOW SHEET

DRAWN BY [illegible]	DATE 7-15-65	SCALE NONE	
CHECKED BY J.H.	DATE 1-17-66	CHARGE P-761	
APPROVED BY	DATE	SUB.	
BILL OF MATERIAL	DWG. NO. 20A-1063.II		

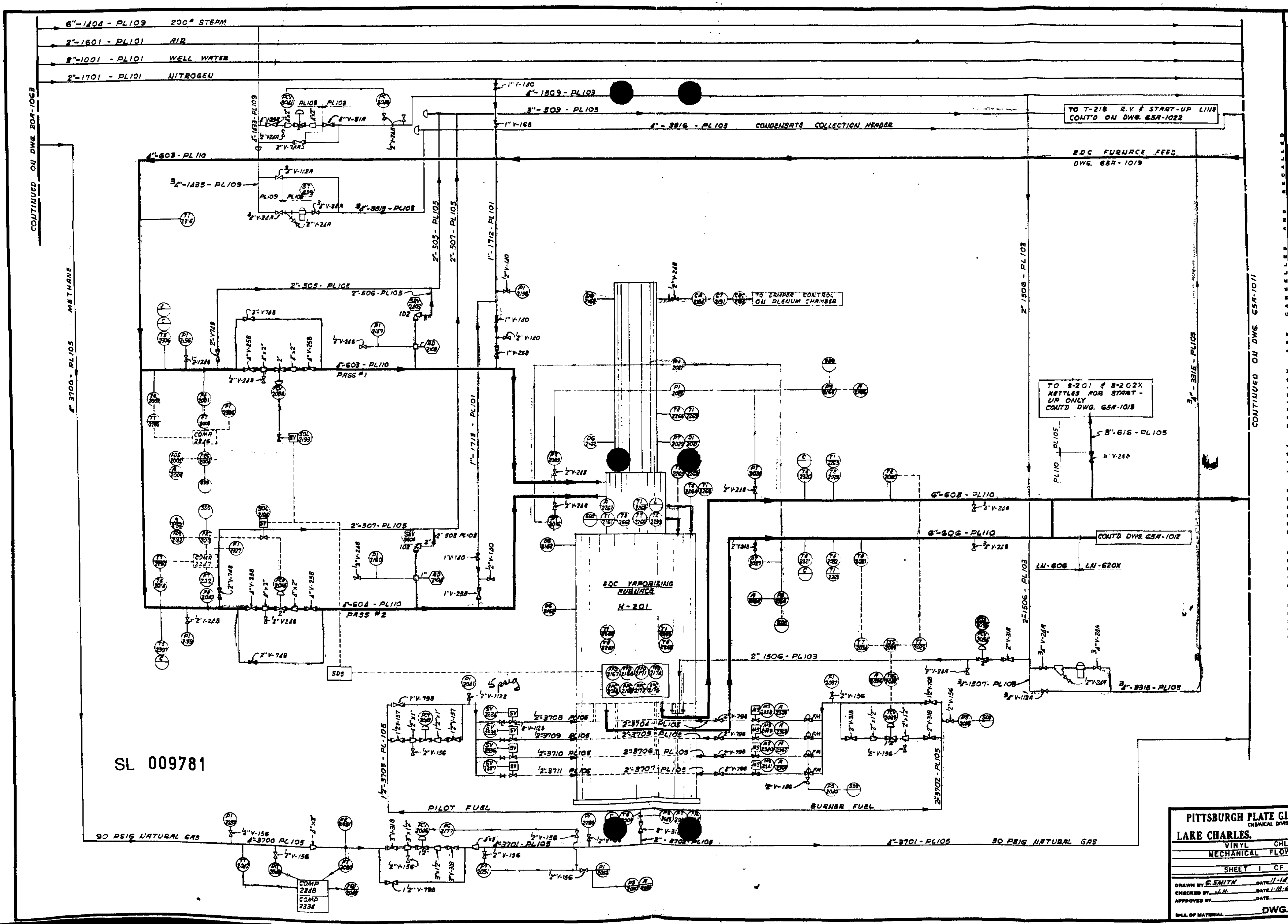

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Fig. 3.7

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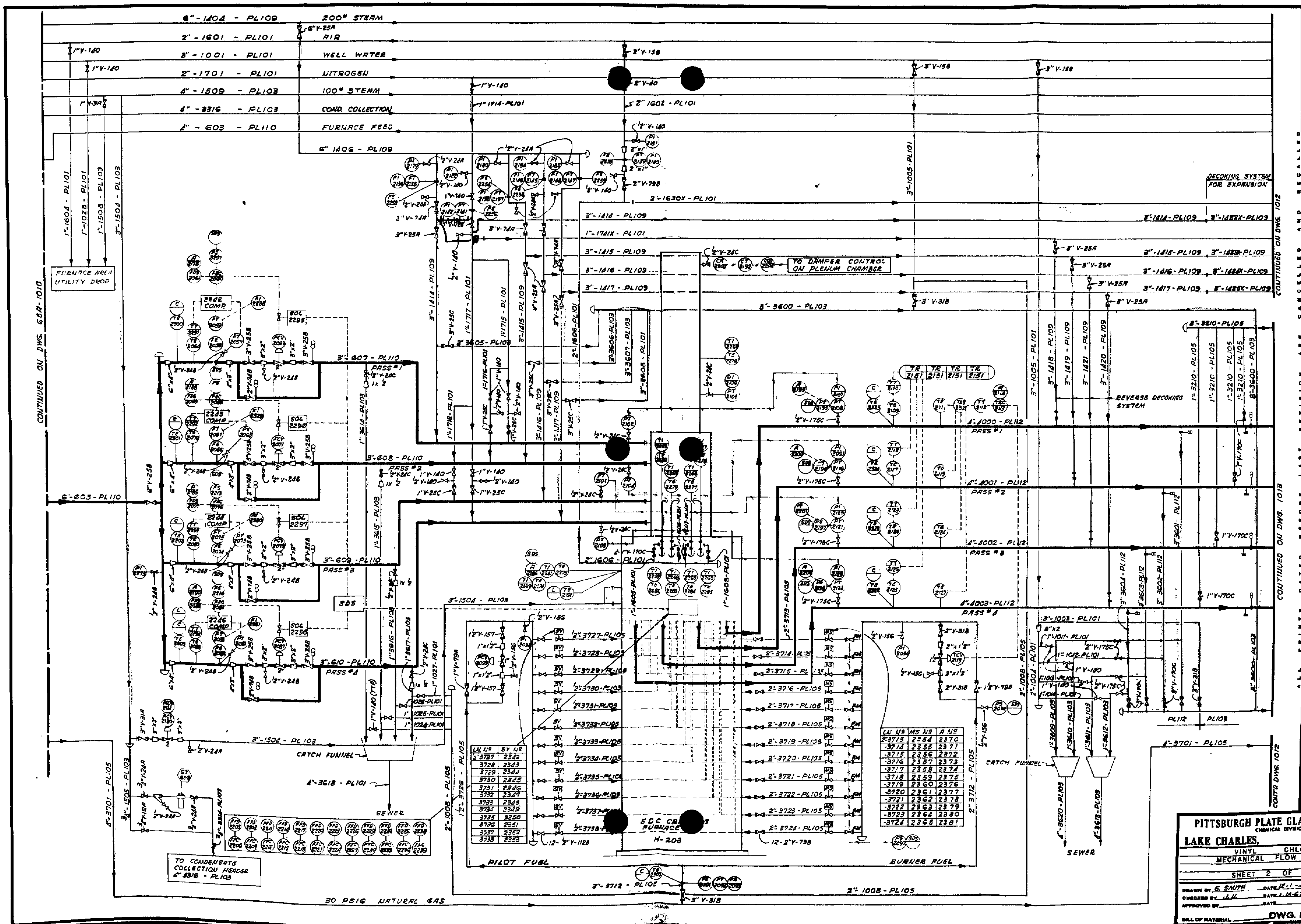
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE
MECHANICAL FLOW SHEET
SHEET 1 OF 19

DRAWN BY G. SMITH DATE 11-14-66 SCALE NONE
CHECKED BY J.H. DATE 1-18-67 CHARGE P-741
APPROVED BY DATE SUB.
BILL OF MATERIAL DWG. NO. 65A-1010.13



LN Nº	SY Nº
½" 3727	2342
3728	2343
3729	2344
3730	2345
3731	2346
3732	2347
3733	2348
3734	2349
3735	2350
3736	2351
3737	2352
3738	2353

LN Nº	MS Nº	A Nº
2"-3713	2354	2370
-3714	2355	2371
-3715	2356	2372
-3716	2357	2373
-3717	2358	2374
-3718	2359	2375
-3719	2360	2376
-3720	2361	2377
-3721	2362	2378
-3722	2363	2379
-3723	2364	2380
-3724	2365	2381

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE
MECHANICAL FLOW SHEET

SHEET 2 OF 19

DRAWN BY G. SMITH DATE 12-1-65 SCALE NONE
CHECKED BY J.H. DATE 1-11-67 CHARGE P-741
APPROVED BY DATE SUB.
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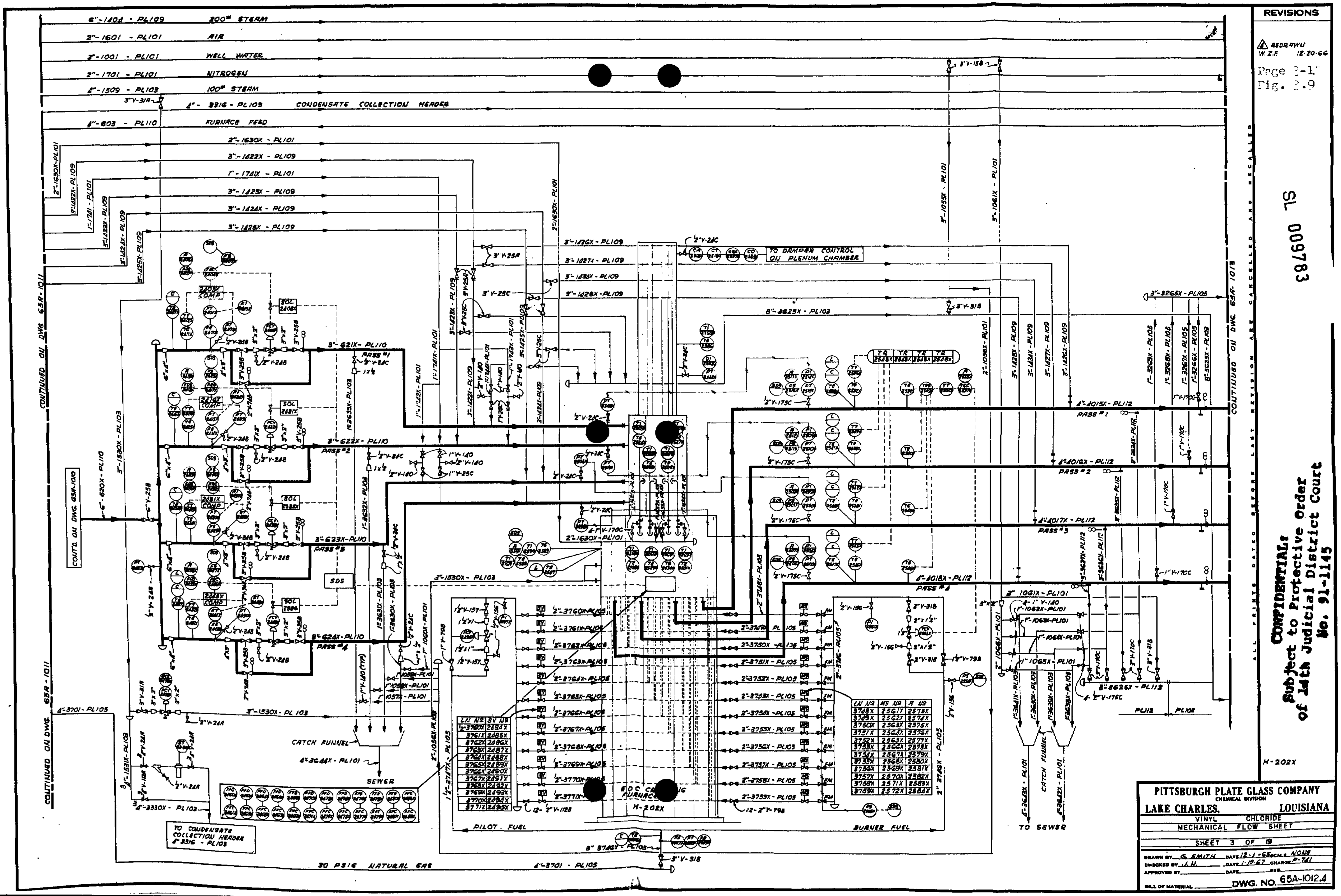
REVISIONS
REDRAWN W.Z.F. 12-20-66
Page 3-17
Fig. 3.9
6"-1404 - PL109 200# STEAM
2"-1601 - PL101 AIR
3"-1001 - PL101 WELL WATER
2"-1701 - PL101 NITROGEN
4"-1509 - PL103 100# STEAM
4"- 3316 - PL103 CONDENSATE COLLECTION HEADER
4"-603 - PL110 FURNACE FEED
CONTINUED ON DWG. 65R-1011
CONTINUED ON DWG. 65R-1013
CONT'D ON DWG 65R-1010
TO DAMPER CONTROL ON PLENUM CHAMBER
PASS #1
PASS #2
PASS #3
PASS #4
CATCH FUNNEL
SEWER
TO SEWER
PILOT FUEL
BURNER FUEL
H-202X
30 PSIG NATURAL GAS
4"-3701 - PL105
TO CONDENSATE COLLECTION HEADER 4"-3316 - PL103
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
VINYL CHLORIDE
MECHANICAL FLOW SHEET
SHEET 3 OF 19
DRAWN BY G. SMITH DATE 12-1-65 SCALE NONE
CHECKED BY J.H. DATE 1-19-67 CHARGE P-741
APPROVED BY DATE SUB.
BILL OF MATERIAL DWG. NO. 65A-1012 A
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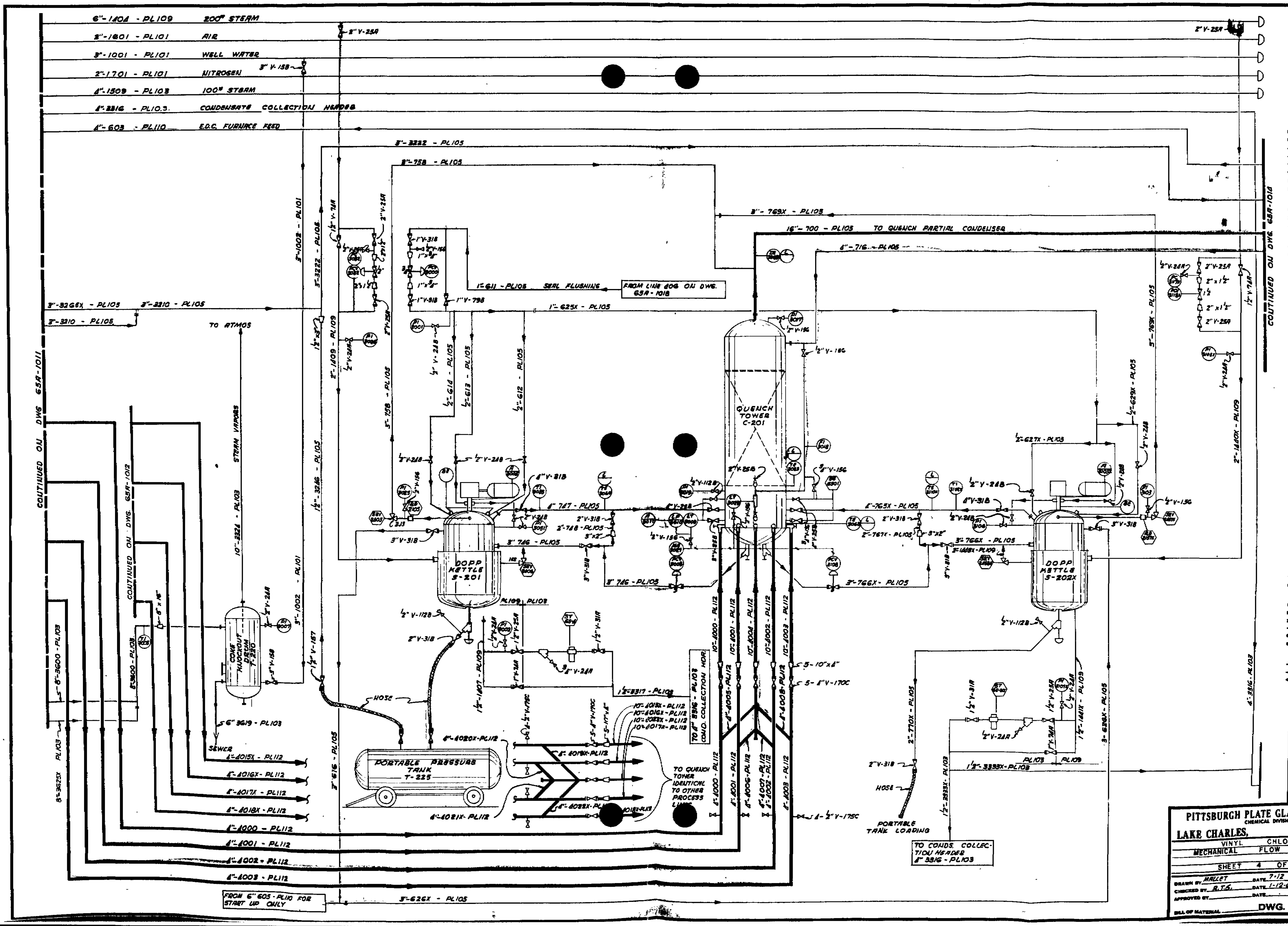

REVISIONS

REDRAWN W.Z.R. 12-20-66

Page 3-16
Fig. 3.10

SL 009784

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C-201
S-201
S-202X
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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

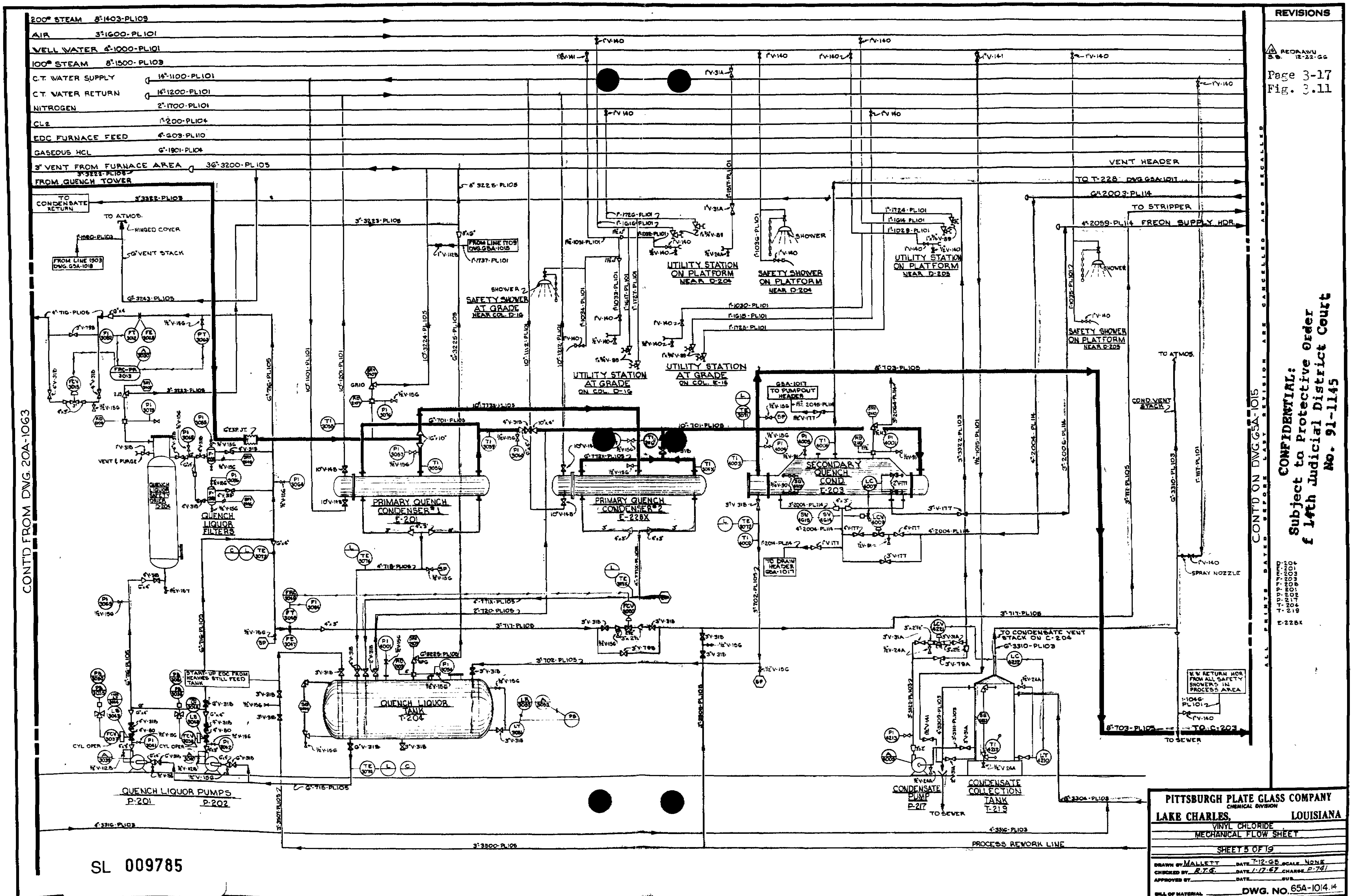
VINYL CHLORIDE
MECHANICAL FLOW SHEET

SHEET 4 OF 19

DRAWN BY MALLET DATE 7-12-65 SCALE NONE
CHECKED BY R.T.G. DATE 1-12-67 CHARGE P-721
APPROVED BY DATE SUB.
BILL OF MATERIAL

DWG. NO. 65A-1013.13

Page 3-17
Fig. 3.11



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No. 91-1145

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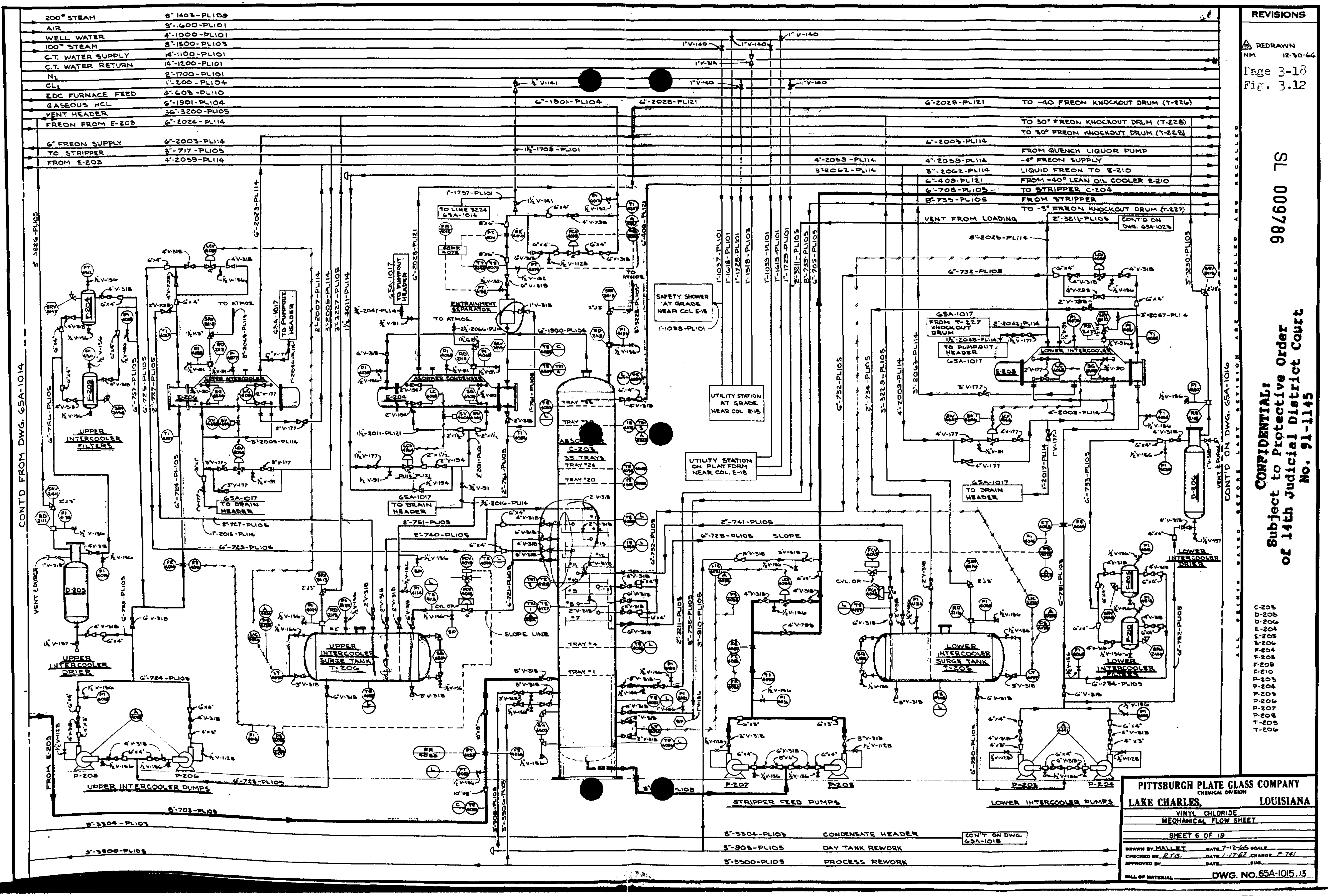
Page 3-18
Fig. 3.12



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Page 3-19
Fig. 3.13

SL 009787

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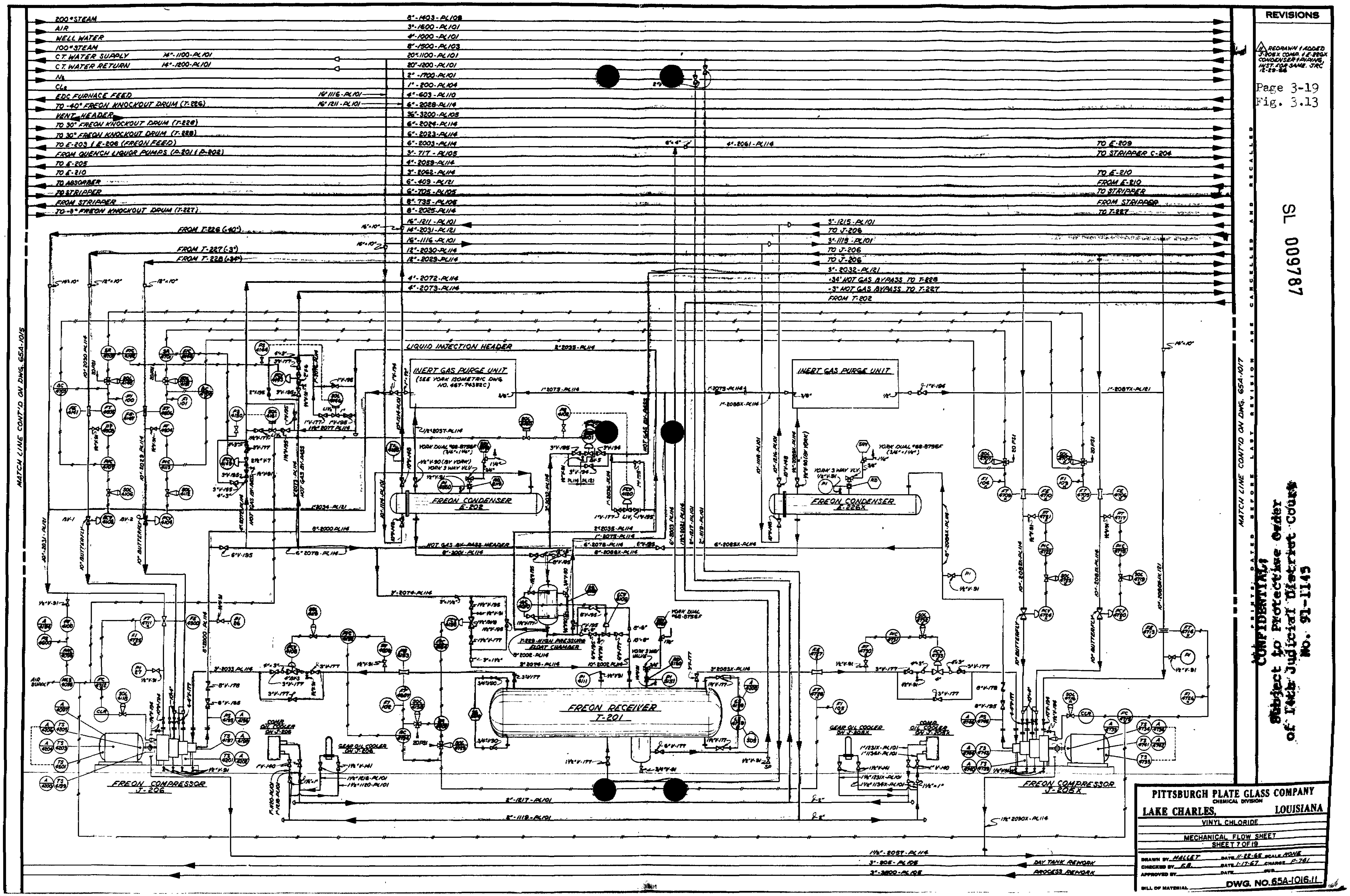
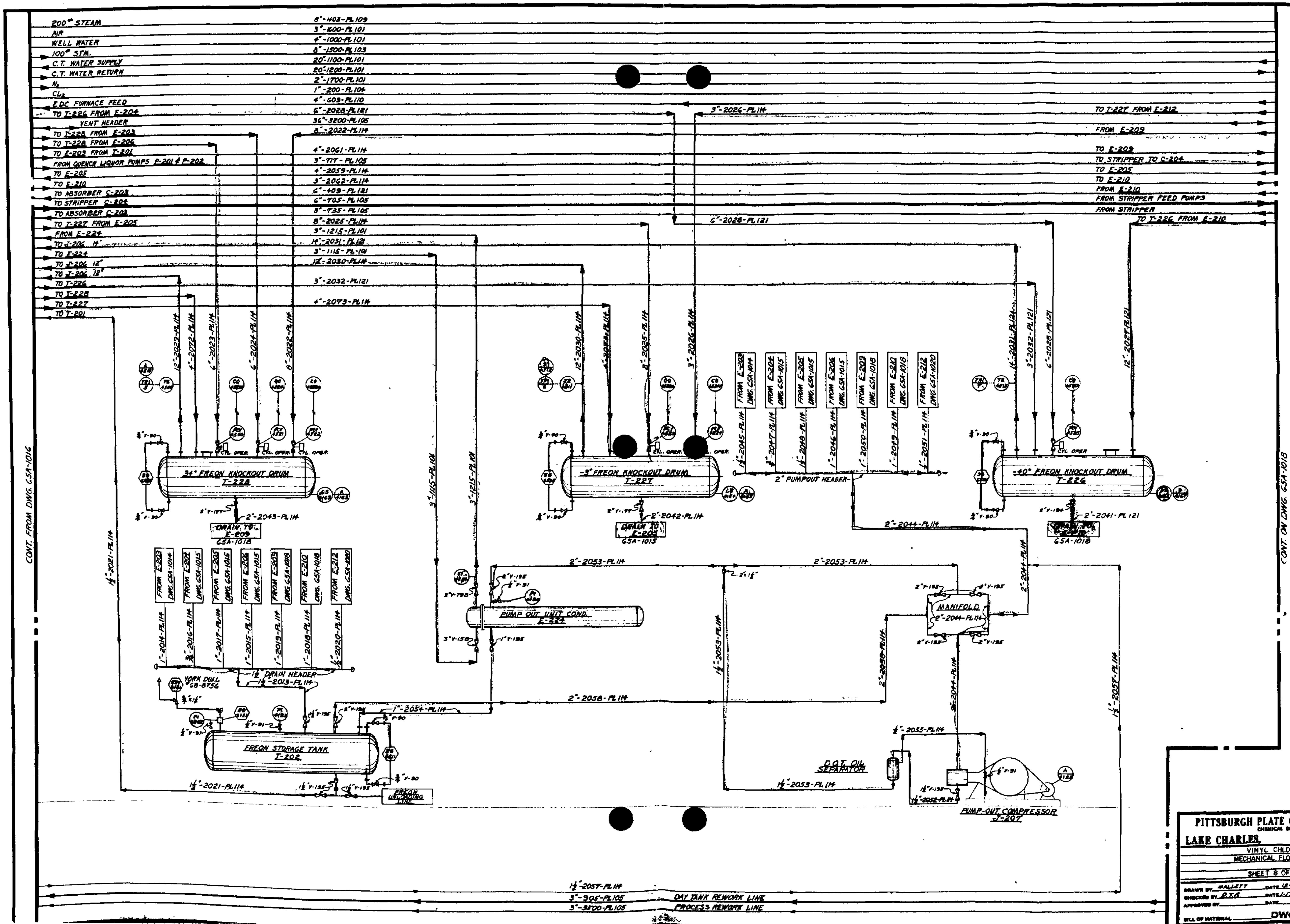
No. 91-1145



Page 3-20
Fig. 3.14



REVISIONS

REDRAWN H.B. 12-22-66

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of 14th Judicial District Court
No. 91-1145

E-224
J-207
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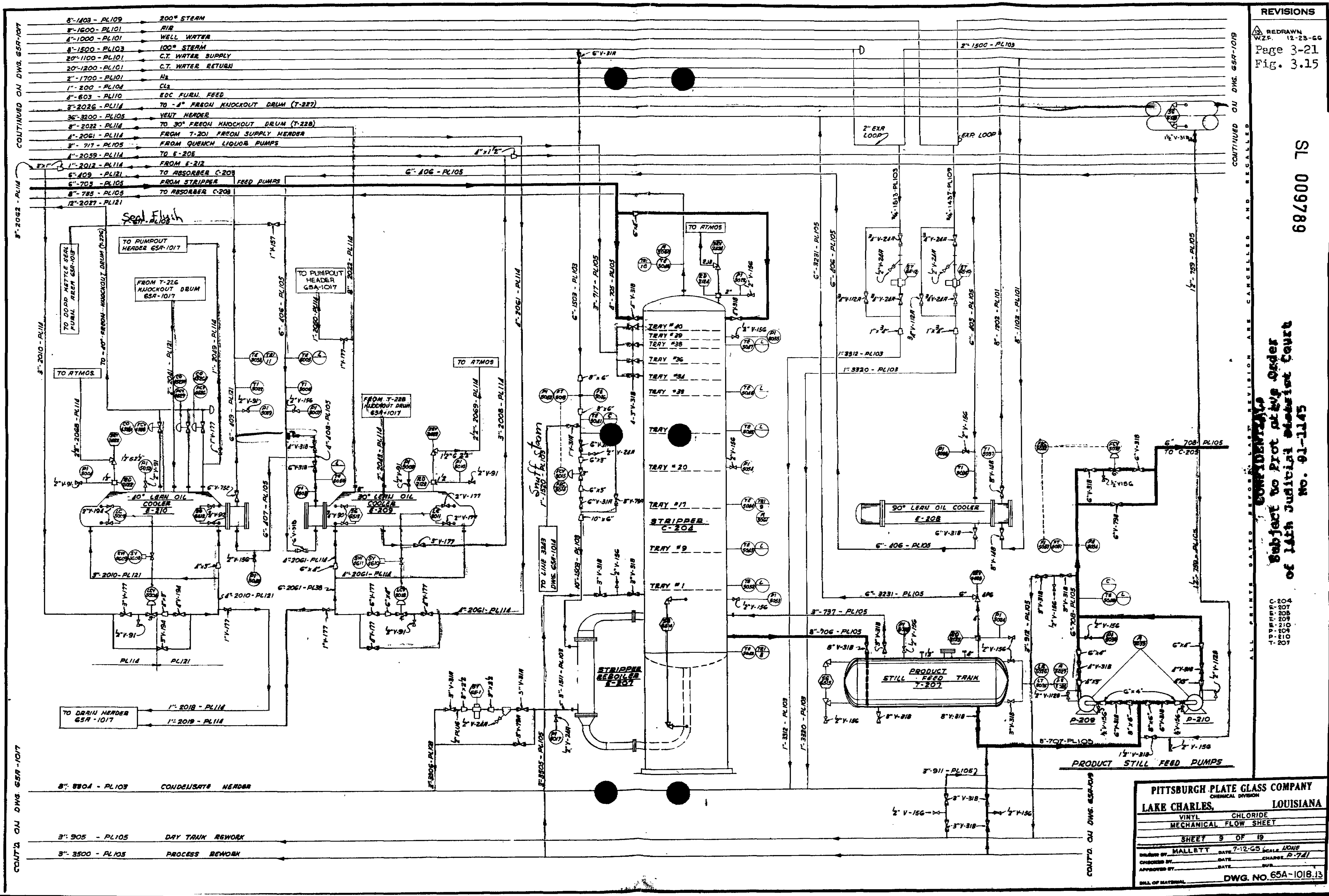
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
VINYL CHLORIDE
MECHANICAL FLOW SHEET
SHEET 8 OF 19

DRAWN BY MALLETT DATE 12-23-65 SCALE NONE
CHECKED BY P.T.G. DATE 1-17-67 CHARGE P-741
APPROVED BY DATE SUB.
BILL OF MATERIAL
DWG. NO. 65A-1017.12

Page 3-21
Fig. 3.15

SL 009789



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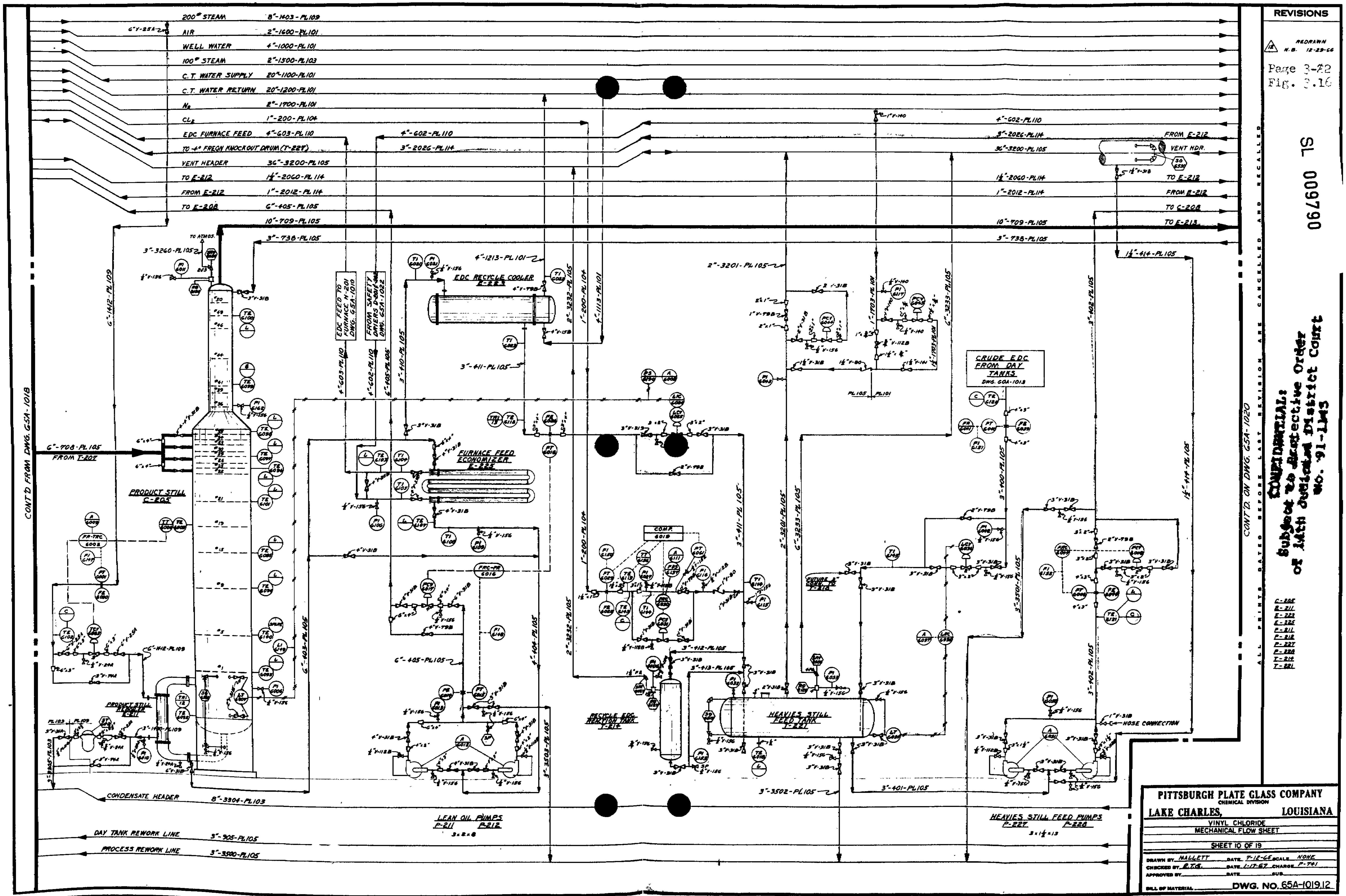
No. 91-1145

Page 3-72
Fig. 3.16



Page 3-23
Fig. 3.17

REVISIONS

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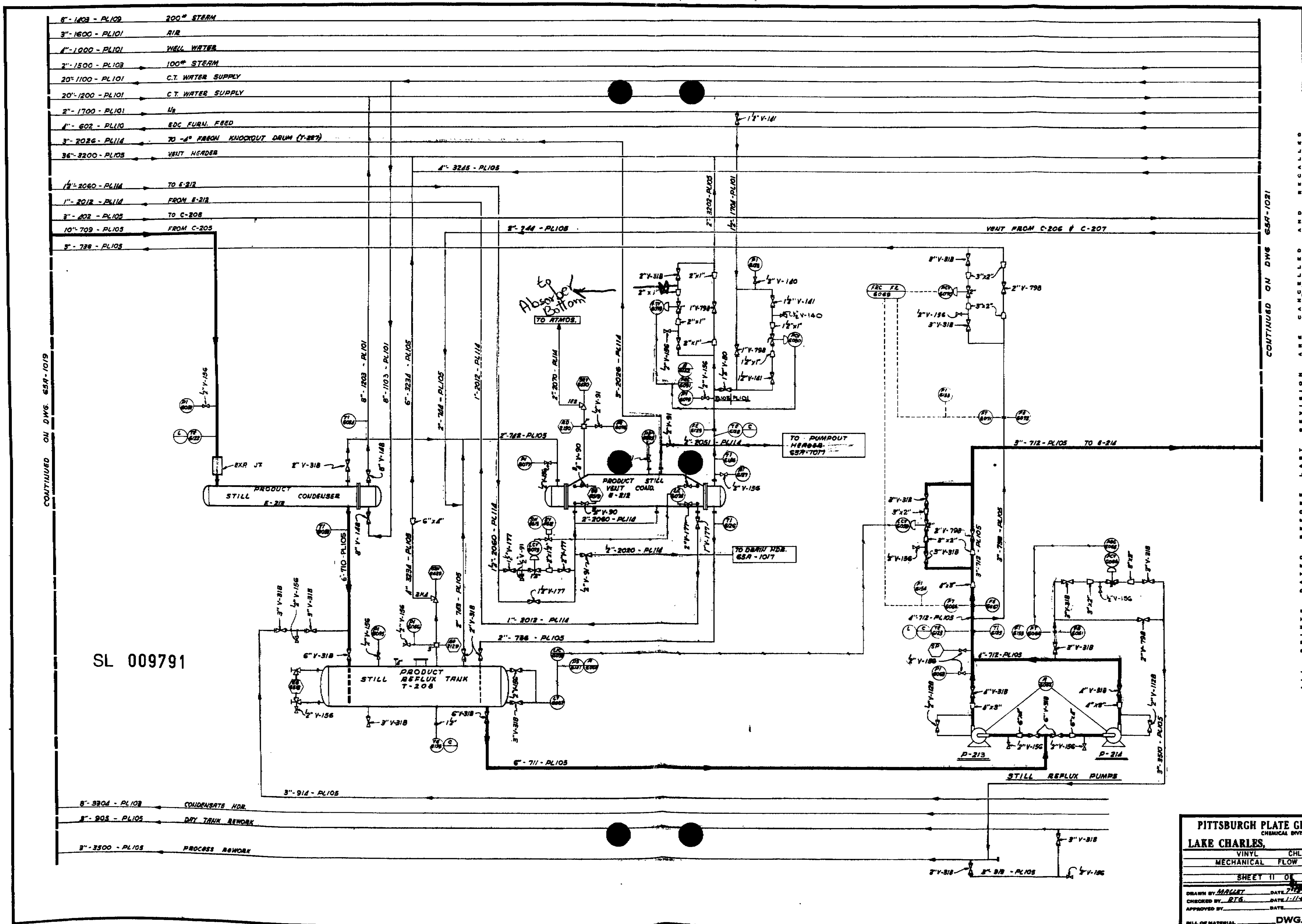

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No. 91-1145

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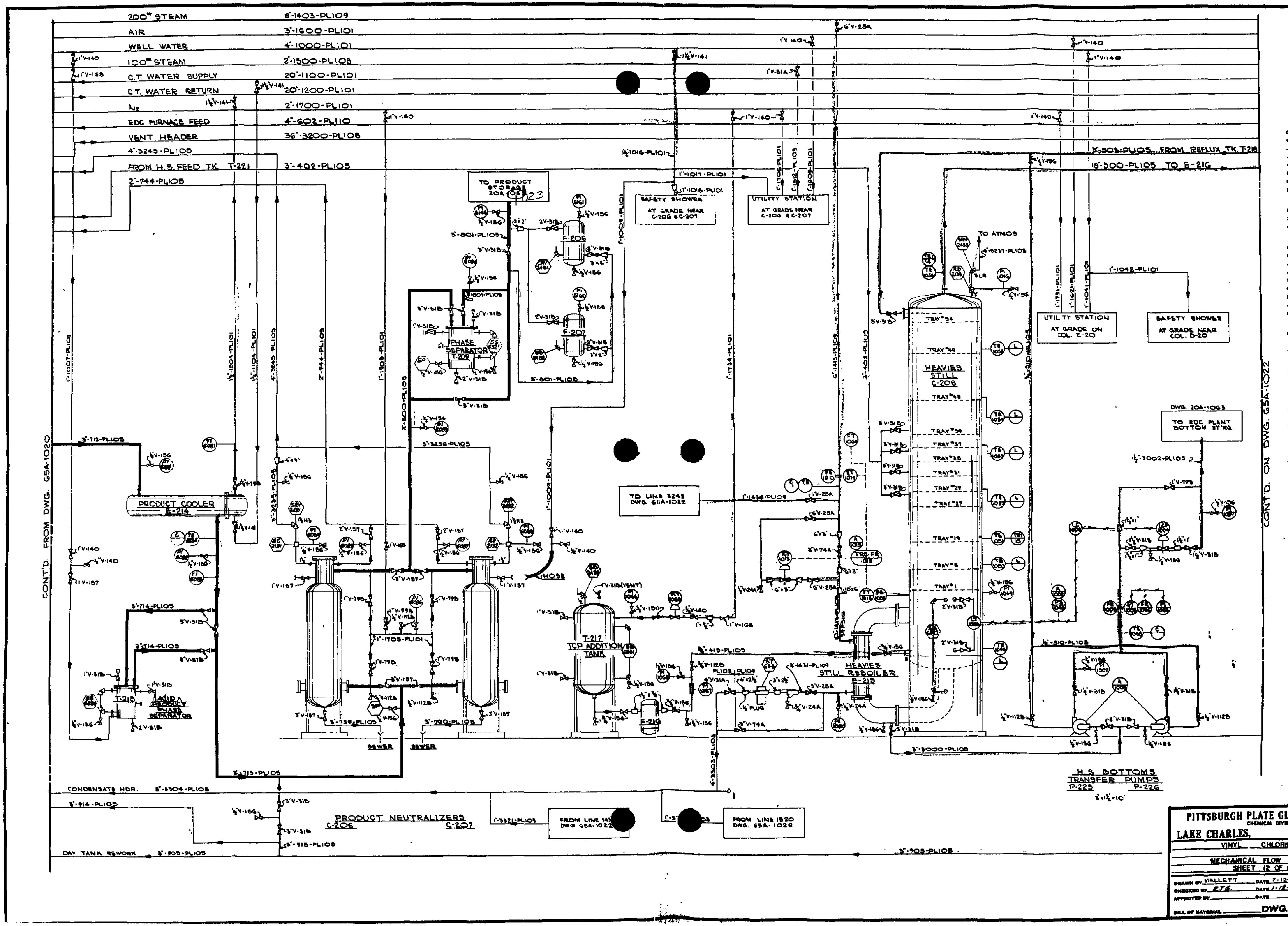
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
VINYL CHLORIDE
MECHANICAL FLOW SHEET
SHEET 11 OF 19
DRAWN BY MALLET DATE 7-12-65 SCALE NONE
CHECKED BY RTG DATE 1-11-67 CHARGE P-741
APPROVED BY DATE SUB
BILL OF MATERIAL DWG. NO. 65A-1020.13



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REDRAWN 1-4-67

Page 3-24
Fig. 3.1f

SL 009792

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C-206
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C-208
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E-215
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F-207
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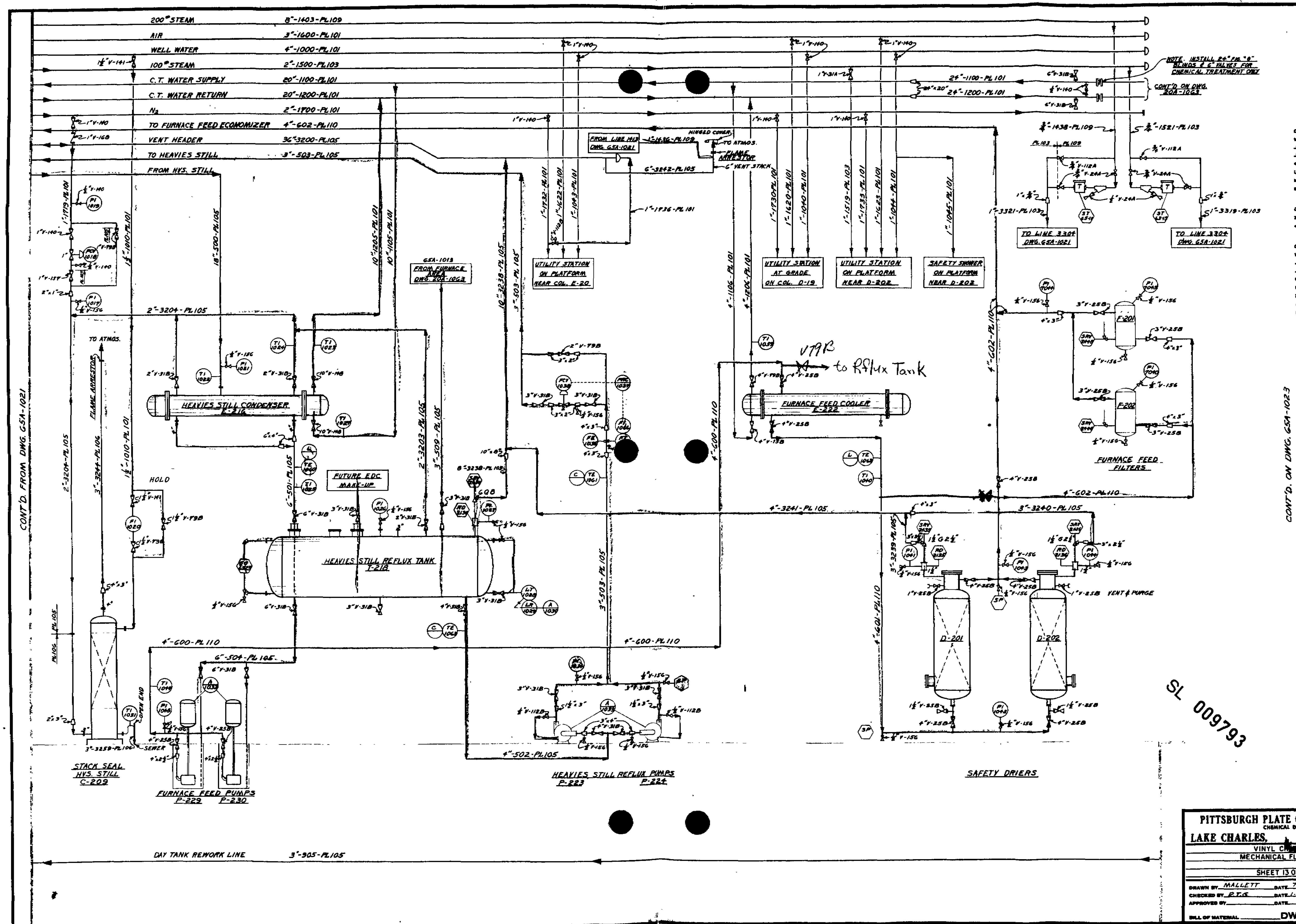
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE

MECHANICAL FLOW SHEET
SHEET 12 OF 19

DRAWN BY MALLETT DATE 7-12-65
CHECKED BY RTG DATE 1-18-67 CHARGE P-741
APPROVED BY
BILL OF MATERIAL

DWG. NO. 65A-1021.12



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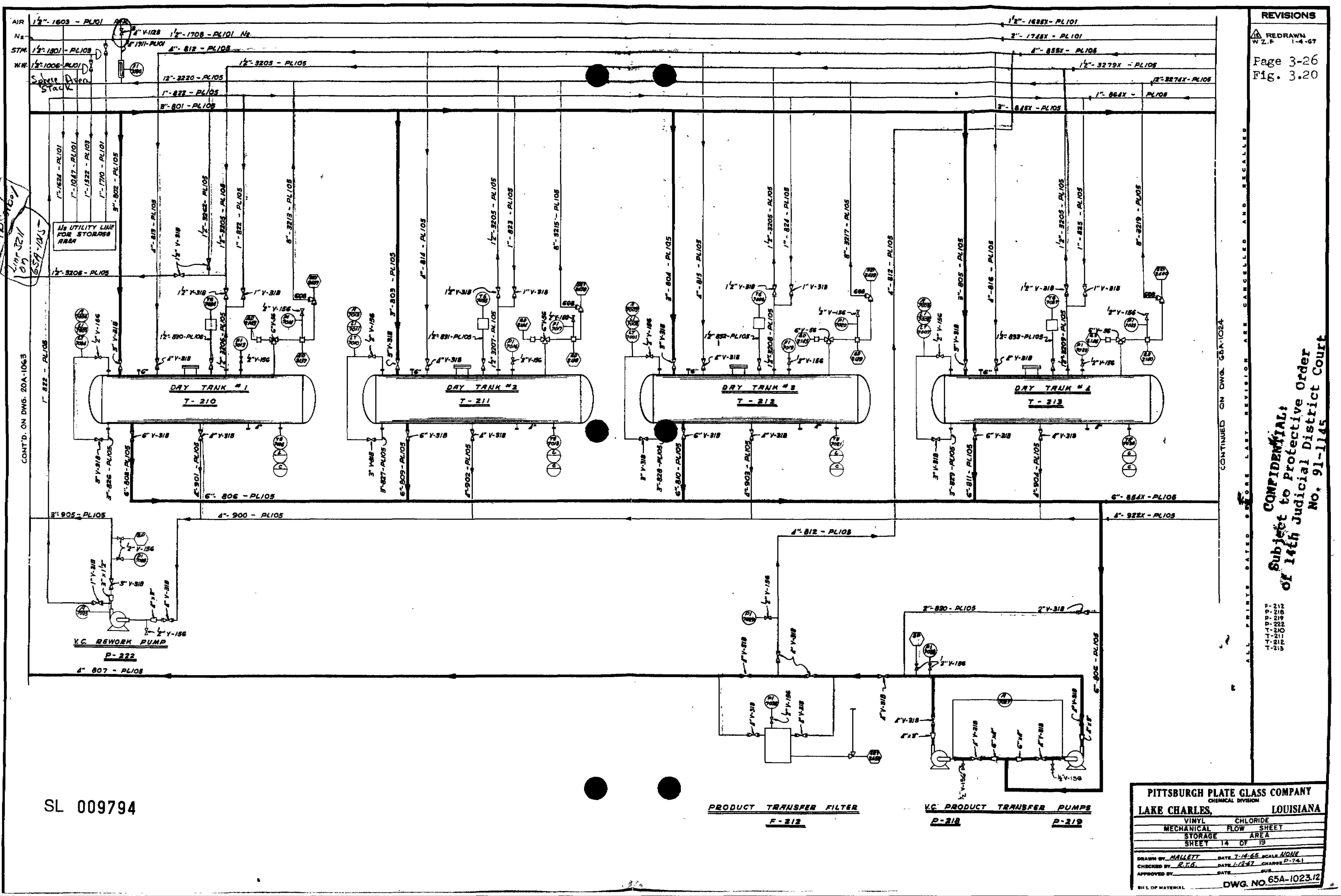
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE
MECHANICAL FLOW SHEET

SHEET 13 OF 19

DRAWN BY MALLETT	DATE 7-13-65	SCALE NONE
CHECKED BY P.T.S.	DATE 1-17-67	CHARGE P-741
APPROVED BY	DATE	SUB
BILL OF MATERIAL		DWG. NO. 65A-1022.11

Page 3-26
Fig. 3.20



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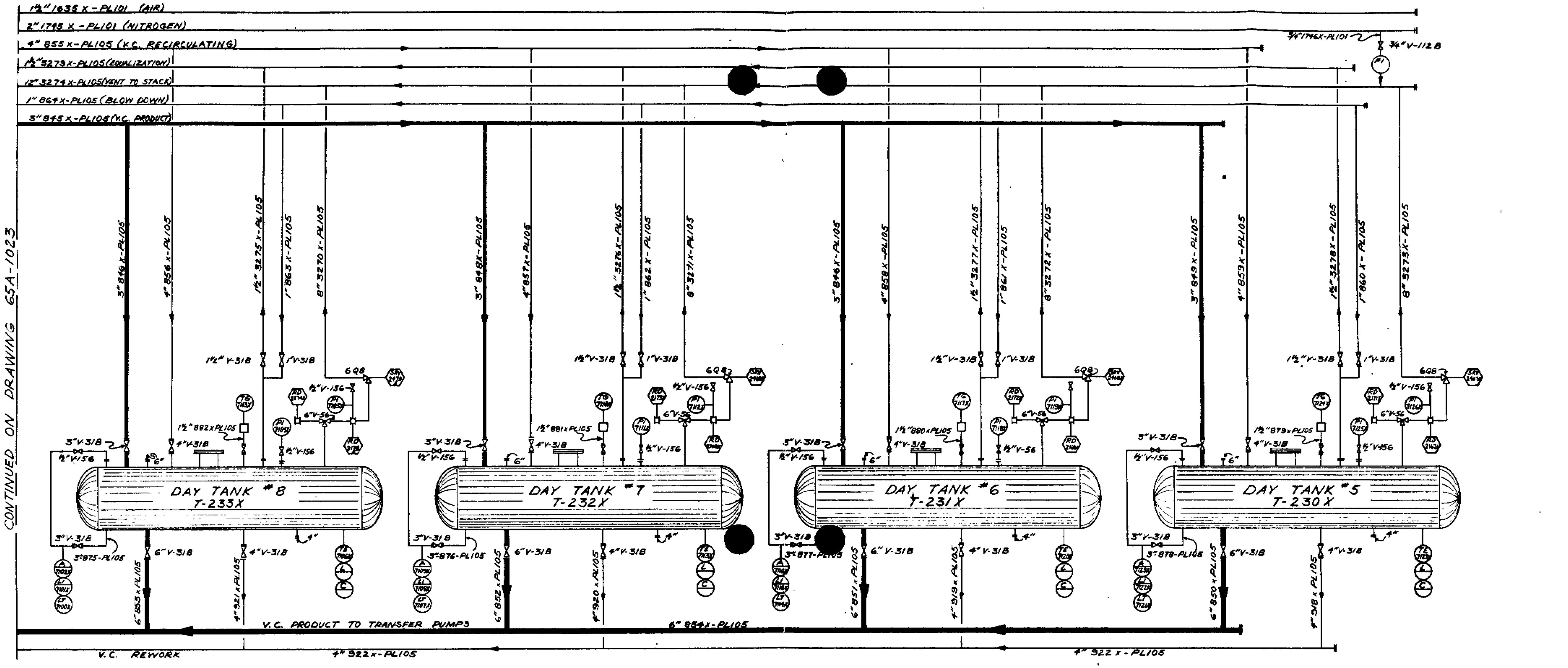

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Fig. 3.21

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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE

MECHANICAL FLOW SHEET
SHEET 15 OF 19

DRAWN BY S.R.G. DATE 5-8-66 SCALE NONE
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APPROVED BY ____ DATE ____ SUB ____
BILL OF MATERIAL ____ DWG. NO. 65A-1024.4

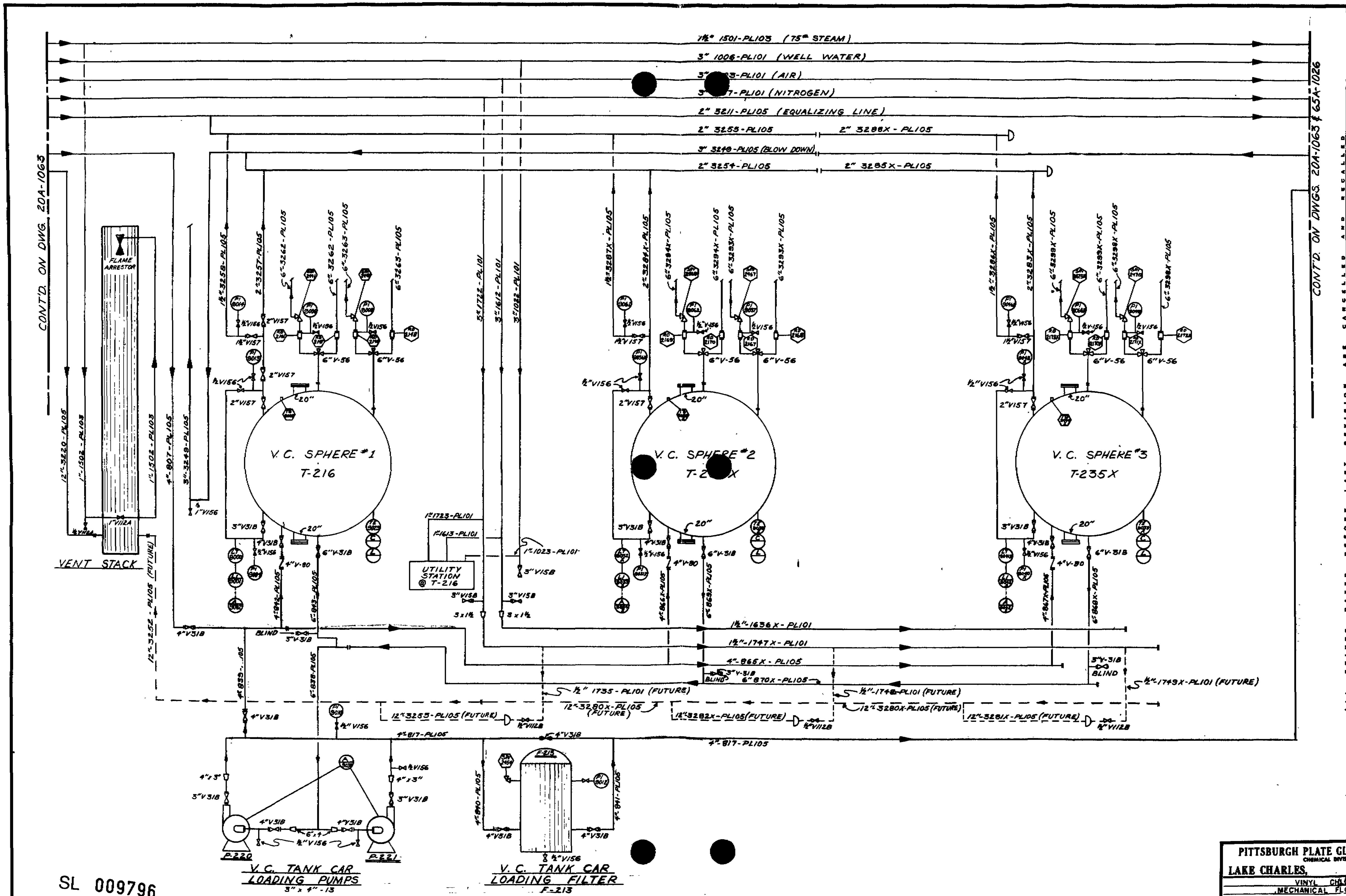

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Fig. 3.22

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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE
MECHANICAL FLOW SHEET

SHEET 16 OF 18

DRAWN BY S. R. GILES DATE 5-11-66 SCALE NONE
CHECKED BY R.T.G. DATE 1-17-67 CHARGE P-741
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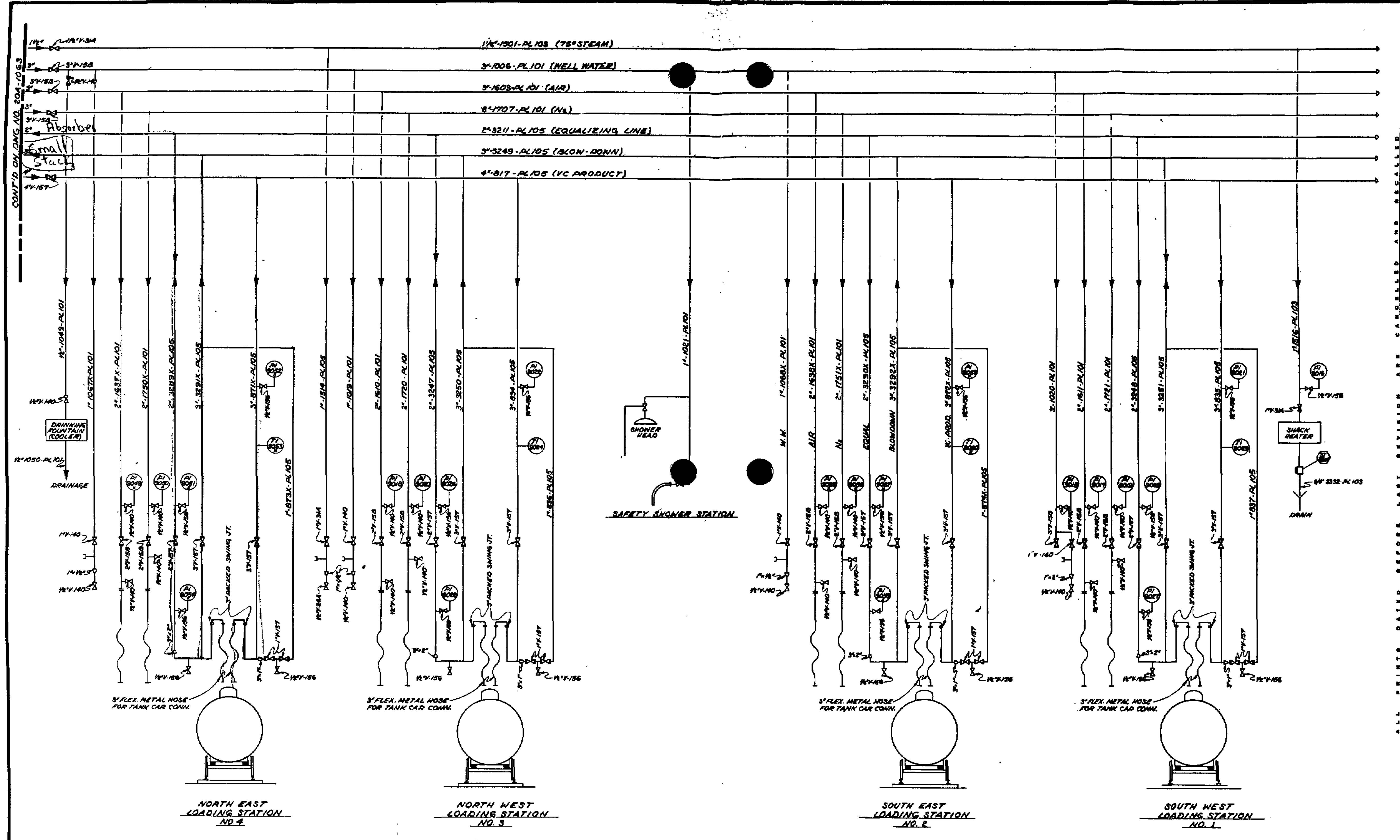

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Fig. 3.23

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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE
MECHANICAL FLOW SHEET

SHEET 17 OF 19

DRAWN BY S.R.G. DATE 5-9-66 SCALE NONE
CHECKED BY R.T.G. DATE 1-17-67 CHARGE P-741
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BILL OF MATERIAL ____ DWG. NO. 65A-10264

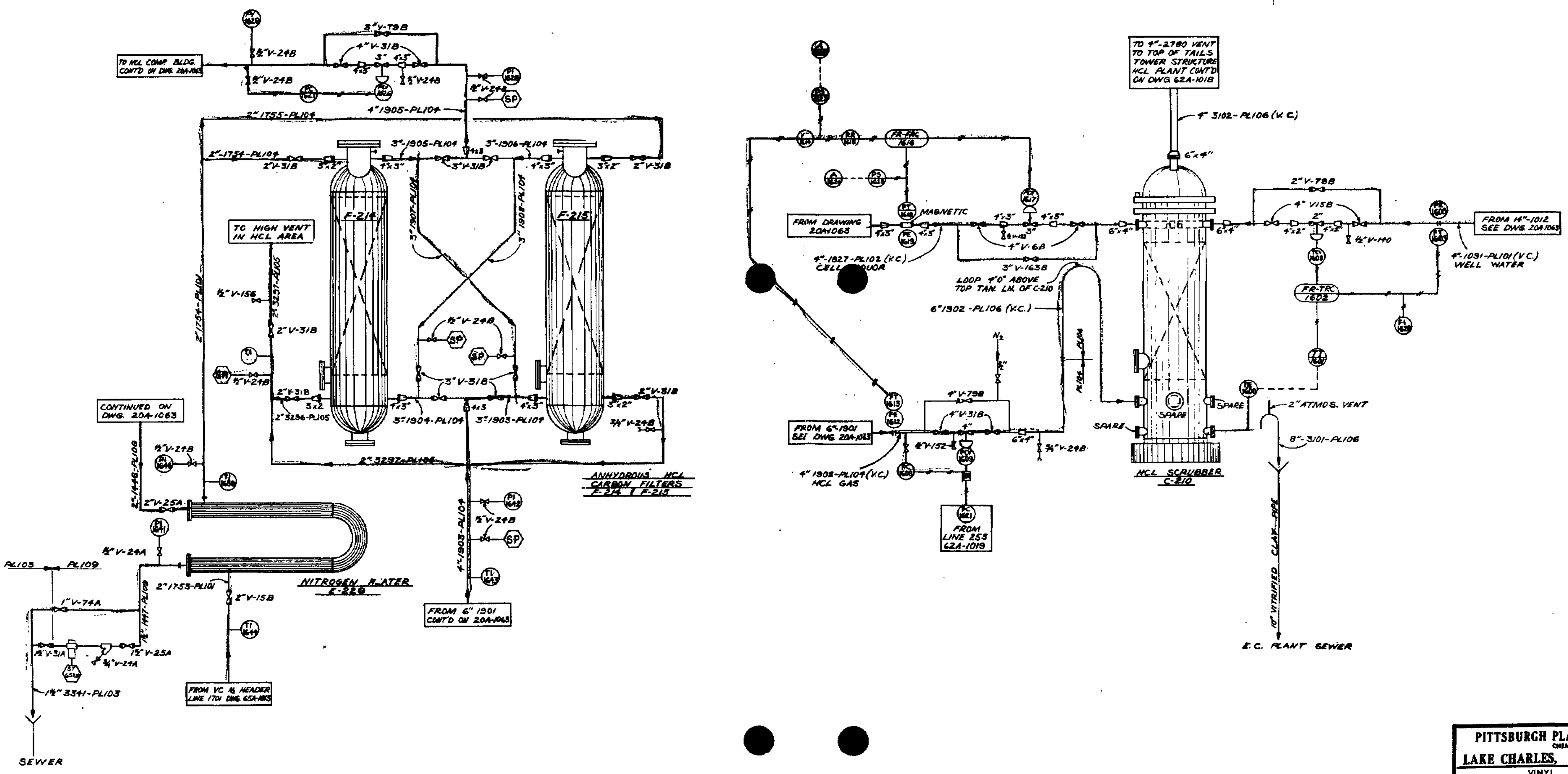

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Fig. 3.25

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PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
VINYL CHLORIDE
MECHANICAL FLOW SHEET
SHEET 19 OF 19

DRAWN BY G.S. DATE 8-20-66 SCALE NONE
CHECKED BY J.H. DATE 1-14-67 CHANGE P-781
APPROVED BY DATE
BILL OF MATERIAL DWG. NO. 65A-1028-1

IV. SAFETY FOR VC PLANT

A. General

Due to the nature of the EDC and VC operations and the chemicals involved, the VC Plant is restricted to authorized personnel only.

Company vehicles will be permitted to travel the roads skirting the VC plant area during normal operations. Special permits will be required for vehicles to enter any of the other areas in this plant.

Never cross a chain, regardless of whether it is up or down, with a vehicle without a pass. Passes for vehicles will be issued by the operating supervision of the area. All passes are immediately revoked if the Area "B" evacuation whistle sounds. If you are operating a vehicle and the emergency horns sound, shut down the vehicle and evacuate the area as quickly as possible on foot. A new pass will be issued to remove the vehicle.

The control room and electrical starter rooms are pressurized for safety precautions; therefore, they are to be utilized by authorized personnel only. The doors and windows must be kept closed.

B. Definitions

Some of the terms used in the following discussion are defined below:

1. Flash Point: The flash point of a solvent is the lowest temperature at which vapor is given off in sufficient quantities so that the vapor-air mixture above the surface of the solvent will propagate a flame away from the source of ignition. It is the temperature below which a solvent may be used or stored in open containers without formation of an explosive vapor-air mixture.

2. Explosive Limits: When combustible vapor is mixed with air in the proper proportions, ignition will produce an explosion. The vapor-air mixtures which will form this proper proportion is called the explosive range. The explosive range includes all concentrations of a mixture of flammable vapor or gas in air in which a flash will occur or a flame will travel if the mixture is ignited. The lowest percentage at which this occurs is the lowe explosive limit and the highest percentage is the upper explosive limit.

Explosive limits are expressed in percent by volume of vapor in air.

3. Maximum Allowable Concentration (MAC): The maximum allowable concentration for a material is the maximum concentration of that material that can be tolerated by personnel for a continuous 8-hour exposure with no ill effects (given as MAC numbers).

C. Chemicals in the VC Area

The chemicals that are required in the manufacture of VC are listed on the next page:

1. Ethylene Dichloride
2. Chlorine
3. Flake Caustic Soda
4. Activated Carbon
5. Freon-12
6. Sulfuric Acid
7. Nitrogen

The properties of most of the materials listed in "C" above, together with others that are formed in the process, are given on the following pages.

NAME: Caustic Soda (Sodium Hydroxide)

USED IN:

VC Product Neutralizers

FORMULA: NaOH

MOLECULAR WEIGHT: 40.00

BOILING POINT: 2534°F

MELTING POINT: 605.1°F

VAPOR PRESSURE: @ 1362°F, 1mm.Hg

LIQUID DENSITY: Normally a solid

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 1.2 ppm by Volume

HAZARDOUS PROPERTIES: This material, both solid and solution, has markedly corrosive action upon all body tissue. Casutic solution is detectable by the slippery feeling of soapy water. Its corrosive action on tissue causes burns and frequently deep ulceration, with ultimate scarring. Prolonged contact with dilute solutions has a destructive effect upon tissue. Mists, vapors, and dusts of this compound cause small burns, and contact with the eyes, either in the solid or solution form, rapidly causes severe damage. Ingestion either in the solid or solution form causes very serious damage to the mucous membranes or other tissues with which contact is made. It can cause perforation and scarring. Thus effects of inhalation vary from mild irritation of the mucous membranes to a severe pneumonitis. It can cause an irritant dermatitis. Caustic soda will react with water or steam to produce heat and will attack organic tissue.

TREATMENT: Where large quantities are handled the area should be well ventilated and face masks should be worn. Speed in removing caustic from contact with the skin is important. Remove all contaminated clothing at once, then flush the skin with water thoroughly. The use of small portions of water, such as by sponging, may cause more serious injury due to heat liberated on dilution. After flushing with water, use liberal quantities of a neutralizing solution such as a 0.5% solution of boric acid, citric acid, or ammonium chloride. If any caustic soda contacts the eyes, they should be irrigated immediately with an abundant amount of water for at least 15 minutes. The eyelids should be held apart during irrigation. The eye should then be washed with a mild saline solution if available. Wash the eye with water for an additional 15 minutes. A physician should be seen immediately after the eye is thoroughly washed.

NAME: Chlorine (Cl_2)

FORMULA: Cl_2

MOLECULAR WEIGHT: 70.91

BOILING POINT: -30.1°F

MELTING POINT: -149.8°F

VAPOR PRESSURE: @ 75°F, 4760 mm. Hg

LIQUID DENSITY: @ 77°F 86.84 lbs. per Ft^3

RELATIVE VAPOR DENSITY: 2.45 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 0.35 to 2 ppm

DETECTABLE ODOR CONC.: 3.5 ppm.

SUPPLIED TO:

Cl_2 Vaporizer

Recycle EDC Chlorination

HAZARDOUS PROPERTIES: Chlorine is a skin, mucous membrane and respiratory irritant. Because of its pungent odor and irritating effect, traces of chlorine in air are readily detected. As the duration of exposure or the concentration increases, general excitement follows as indicated by restlessness, irritation to the throat, sneezing and copious salivation. This is followed by retching and vomiting and by difficult or labored respiration. Respiratory distress increases until eventually death may occur from apparent asphyxiation.

Liquid chlorine and high concentrations of the gas in contact with the skin will cause marked irritations and blistering of the exposed area. Clothing contaminated with liquid chlorine will continue to be a source of chlorine gas and irritation to the patient until the liquid is completely evaporated. In any event, clothing thus contaminated should be removed immediately and the exposed areas flushed with water.

In any atmosphere containing chlorine, short,shallow breathing should be used. Chlorine produces no known cumulative effects, and recovery from mild exposure usually occurs. Chlorine is particularly irritating to persons afflicted with asthma and certain types of chronic bronchitis.

TREATMENT: The following First Aid procedures are suggested, but it is recommended that emergency measures prescribed by your physician be followed.

1. Carry patient from gas area. Preferably, patient should be kept in a room at about 70°F. Supply blankets if necessary. Keep patient warm and quiet. Rest is essential.

2. Place patient on back with head and back elevated.

3. CALL A PHYSICIAN IMMEDIATELY

4. Clothing contaminated with liquid chlorine should be removed promptly and the exposed areas flushed with water. Keep patient warm with blankets.

5. A mild stimulant, such as essence of peppermint, may be given as a relief from throat irritation, provided the patient is conscious.

6. If the patient has inhaled chlorine but still has practical control of his own breathing, oxygen, under intermittent positive pressure, may be administered. Be sure to follow the instructions which come with the oxygen-administering equipment which you are using.

All persons working with chlorine should be acquainted thoroughly with the proper methods of handling this commodity, the use of a gas mask, and procedures in an emergency. Each person liable to exposure should be provided with a gas mask of a design approved for chlorine service by the United States Bureau of Mines. All gas masks should be inspected frequently and the instructions accompanying a mask, concerning its care and use, should be followed implicitly. Too much emphasis cannot be placed on the fact that a faulty gas mask is worse than no mask at all.

Gas masks of the cannister type do not supply oxygen, but merely absorb the chlorine present in the air breathed. Where the chlorine content of the air is greater than 1%, a fresh-air hose mask or an oxygen supply mask is necessary. All personnel who may be required to use gas masks should be instructed properly and required to practice in their application and use. Drills in safety work and evacuation should be held at frequent intervals.

In case of emergency only those persons authorized to make investigation and who are properly equipped with safety equipment should be permitted to enter the contaminated area.

Chlorine is loaded and shipped in carefully inspected containers, but on rare occasions a leak may develop through the failure of mechanical devices beyond human control.

Leaks must be given immediate attention because they will become progressively worse.

All corrective measures must be performed by trained personnel wearing proper safety equipment. All other persons should leave the affected area until safe conditions have been restored. If the leak is extensive, special effort must be made to warn all persons in the path of the fumes.

To locate the point of leakage, a rag tied on a stick and soaked with ammonia water should be passed or swabbed around suspected points. Dense, white fumes will indicate the exact point of leakage.

Always keep on the windward side and at an elevation higher than the leak, if possible.

If the leak occurs in equipment in which chlorine is being used, the chlorine container valve should be closed immediately. A leak around a valve stem can be stopped usually by tightening the packing nut.

If a leak on a chlorine container cannot be stopped readily, an effort should be made to remove the unit to an isolated spot. If the chlorine is escaping as a liquid from a cylinder or ton tank, the container should be turned so that the leak is at the top of the container, thus allowing chlorine gas to escape. Only one-fifteenth as much chlorine will escape as a gas through the same size hole.

Water should never be applied to leaks. Chlorine gas is only slightly soluble in water. The application of water is hazardous because the leak will become progressively worse due to the corrosive action of chlorine and water. The heat supplied even by cold water may cause the liquid in the container to evaporate faster.

If chlorine gas can be withdrawn rapidly enough from the leaking container into the regular operating system, the pressure on the container will be lowered and the leak will be less serious. If the regular process cannot utilize the gas as fast as it can be withdrawn, provisions should be made to absorb it in an alkaline solution. Caustic soda or soda ash can be used for this purpose in the following proportions:

Chlorine Container Size	Caustic Soda Lbs. 100%	Caustic Soda Water Gals.	Soda Ash Lbs.	Soda Ash Water Gals.
100 pounds	125	40	300	100
150 pounds	188	60	450	150
One Ton	2500	800	6000	2000

Alkali and suitable containers to hold the solution should be kept available for emergency use. The chlorine should be passed into the solution near the bottom of the container by means of an iron pipe or a weighted rubber hose.

NAME: Chloropene (2-chloro-1, 3-butadiene)

FORMULA: CH_3 $CHCClCH_2$

MOLECULAR WEIGHT: 88.54

BOILING POINT: 138.2°F

LIQUID DENSITY: @ 32°F, 59.83lbs. per Ft^3

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 25 ppm.

RELATIVE HAZARD:

Chloropene is an impurity in the Product still bottoms and is only present in dilute concentrations.

HAZARDOUS PROPERTIES: Animal experiments have shown that a concentration of 250 ppm in air is toxic, and a concentration of 75 ppm. may be toxic with continued exposure. Exposure to the vapor first causes irritation of the respiratory tract, followed by depression of respiration and if exposure is continued, asphyxia. The vapor is a central system depressant; in animals it causes severe degenerative changes in the vital organs, particularly the liver and kidneys. Blood pressure is lowered. Lung changes accompany exposure to the higher concentrations. Humans exposed to chloroprene have been reported to develop dermatitis, conjunctivitis, corneal necrosis, anemia, temporary loss of hair, nervousness and irritability.

Chloroprene is dangerous when heated to decomposition. It emits highly toxic fumes of chlorides.

TREATMENT: Areas where chloroprene is used should be well ventilated. If a person should be overcome by vapors, he should be removed from the area immediately and a respirator should be used. If not available, use artificial respiration.

SL 009806

NAME: cis-1,2-DICHLOROETHYLENE

FORMULA: ClCHCHCl

MOLECULAR WEIGHT: 96.950

BOILING POINT: 138.2°F

MELTING POINT: -112.9°F

VAPOR PRESSURE @ 105.8°F , 400 mm. Hg.

LIQUID DENSITY @ 77°F, 79.54 lbs. per Ft^3

RELATIVE VAPOR DENSITY: 3.34 (air = 1.0)

FLASH POINT: 43°F

EXPLOSIVE LIMITS: 9.7 to 12.8% by vol.

MAXIMUM ALLOWABLE CONC.: 200 ppm., 794 $mg./m.^3$

RELATIVE HAZARD:

An impurity in all process streams of the Plant in dilute concentrations.

HAZARDOUS PROPERTIES: In high concentrations it is irritating and narcotic. It has produced liver and kidney injury in experimental animals.

It is a dangerous fire hazard when exposed to heat or flame. It is a moderate explosion hazard when exposed to flame. When heated to decomposition it emits highly toxic fumes of chlorides. It can react vigorously with oxidizing materials.

TREATMENT: Remove the patient from toxic area. Remove all contaminated clothing. Wash all exposed skin surfaces thoroughly with soap and water. Flush the eyes with copious quantities of water. Notify a physician.

For fire, use water, foam, carbon dioxide, dry chemicals or carbon tetrachloride.

NAME: trans-1,2-Dichloroethylene

FORMULA: ClCHCHCl

MOLECULAR WEIGHT: 96.950

BOILING POINT: 118.4°F

MELTING POINT: -58°F

VAPOR PRESSURE @ 87.4°F, 400 mm. Hg.

LIQUID DENSITY @ 77°F , 79.34 lbs per Ft^3

RELATIVE VAPOR DENSITY: 3.34 (air = 1.0)

FLASH POINT: 43°F

EXPOLSIVE LIMITS: 9.7 to 12.8% by vol.

MAXIMUM ALLOWABLE CONC.: Unknown

DETECTABLE ODOR CONC.: Unknown

HAZARDOUS PROPERTIES: Exposure to high concentrations of vapor can cause nausea, vomiting, weakness, tremor, and cramps. Recovery is usually prompt following removal from exposure. Dermatitis may result from defatting action on skin.

TREATMENT: See cis- dichloroethylene.

RELATIVE HAZARD:

An impurity in all process streams of the Plant in dilute concentrations.

SL 009808

NAME: Ethylene Dichloride (EDC) (1,2-dichloroethane)

FORMULA: CH_2ClCH_2Cl

MOLECULAR WEIGHT: 98.966

BOILING POINT: 182.3°F

MELTING POINT: -31.9°F

VAPOR PRESSURE: @ 84.9°F, 100 mm. Hg.

LIQUID DENSITY: @ 68°F, 78.47 lbs. per Ft^3

RELATIVE VAPOR DENSITY: 3.35 (air = 1)

FLASH POINT: 64.9°F open up; 55.4°F, closed cup

EXPLOSIVE LIMITS: 6.2 to 15.9% by vol.

MAXIMUM ALLOWABLE CONC.: 50 ppm., 200 mg./$m.^3$

DETECTABLE ODOR CONC. : Much less than maximum allowable

AUTOIGNITION TEMP.: 840°F

OCCURENCE IN PROCESS:

EDC is the feed and main process liquor of the Plant.

HAZARDOUS PROPERTIES: Ethylene dichloride has a distinctive odor and strong local irritating effects, which give warning of its presence in relatively safe concentrations. There is irritation of the eyes and upper respiratory passages. Ethylene dichloride has a specific effect on the cornea. Exposure to the vapor, or, in animals, injection under the skin, produces a clouding which may progress to endothelial necrosis and infiltration of the cornea by lumphocytes and connective tissue cells. The narcotic action of the compound is strong, probably of the same order as chloroform. Its toxic effect upon the liver and kidneys are less than that of carbon tetrachloride, but animal experiments indicate that these organs may show congestion and fatty degeneration. Edema of the lungs has also been reported in animals. Dermatitis in man has been observed.

In short exposures to high concentrations, the picture is one of irritation of the eyes, nose and throat, followed by dizziness, nausea, vomiting, increasing stupor, cyanosis, rapid pulse, and loss of consciousness.

Chronic poisoning, where exposure has occurred over a period of several months, may cause loss of appetite, nausea and vomiting, epigastric distress, tremors, nystagmus, leucocytosis, low blood sugar levels, and possibly dermatitis if there has been skin contact.

Employees exposed regularly to ethylene dichloride should be examined at least semiannually, by a physician acquainted with the occupational hazards involved. Physical examinations should be required also when any systoms of poisoning occur.

Employees who may be subjected to severe exposures of ethylene dichloride vapor as in tank cleaning and repairs in intermittent operations where general ventilation is not practical, in cases of failure of piping or equipment, and in cleaning up spills, should be provided when indicated with proper eye and respiratory protection as follows:

(a) Suitable gas-tight chemical safety goggles,

(b) Rescue harness and life line for those entering a tank or enclosed storage space. An outside attendant should maintain constant observation.

(c) Positive pressure hose masks with hose inlet in a vapor-free atmosphere.

Air-line masks with proper reducing valve and filter suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply,or

Self-contained breathing apparatus with stored oxygen or air, which allows greater mobility but usually requires more highly trained men. In tank work small manholes may make this apparatus unsuitable because of its bulk, although the type known as self-generating is specially designed for entrance and egress through small openings.

Masks and breathing apparatus should be approved by the United States Bureau of Mines and should be equipped with full face pieces.

(d) Industrial gas masks, approved by the United States Bureau of Mines with canisters approved for use in ethylene dichloride vapor should be used only when it is certain that the concentration of vapor is less than 2 per cent by volume (20,000 parts per million) and the atmospheric oxygen is not lower than 16 per cent, and then only for exposures not exceeding one-half hour.

TREATMENT: All contaminated clothing should be removed at once. Clothing, including shoes, soaked in ethylene dichloride should be removed and not worn again until thoroughly dry. All affected areas should be washed thoroughly with warm water and soap. After this an ointment containing lanolin should be applied in order to replace the natural skin oils. For serious or persistent cases of skin trouble and for signs and symptoms of generalized poisoning, a physician should be consulted.

If liquid ethylene dichloride has entered the eyes, they should be washed promptly with copious quantities of water for at least 15 minutes. It is advisable to irrigate the eyes gently with water at room temperature in order to minimize additional pain or discomfort. Ethylene dichloride vapor can produce injury to the eyes if the exposure is intense or prolonged to higher concentrations. Eyes should be irrigated for vapor in the same manner as for the liquid. Medical attantion should be obtained in all these contacts with the eyes.

NAME: Ethylidene Chloride (1,1-dichloroethane)

FORMULA: CH_3CHCl_2

MOLECULAR WEIGHT: 98.966

BOILING POINT: 135.1°F

MELTING POINT: -142°F

VAPOR PRESSURE @ 77°F, 230 mm. Hg.

LIQUID DENSITY @ 68°F, 73.29 lbs per Ft^3

RELATIVE VAPOR DENSITY: 3.44 (air = 1.0)

FLASH POINT: 42°F

EXPLOSIVE LIMITS: 5.6 to 11.4%

MAXIMUM ALLOWABLE CONC.: 100 ppm., 405 $mg./m.^3$

DETECTABLE ODOR CONC.: 100 to 500 ppm.

AUTOIGNITION TEMP.: 855°F

RELATIVE HAZARD:

Found as an impurity in all Plant process streams in dilute concentrations.

HAZARDOUS PROPERTIES: Limited data available. It is detected by its aromatic ethereal odor, hot saccharin taste. Liver injury has been reported in experimental animals.

It is dangerous as a fire hazard when exposed to heat or flame. When heated to decomposition, it emits highly toxic fumes of phosgene. It can react vigorously with oxidizing materials.

TREATMENT: For fire, use water, foam, carbon dioxide, dry chemicals, or carbon tetrachloride.

For treatment of a patient, remove him from the toxic area. Remove all contaminated clothing and wash all exposed skin surfaces with soap and water. Flush eyes with copious quantities of water. Notify a physician.

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NAME: Hydrogen Chloride

FORMULA: HCl

MOLECULAR WEIGHT: 36.47

BOILING POINT: -122.6°F

MELTING POINT: -173.7°F

VAPOR PRESSURE: @ 64°F, 3040 mm. Hg.

LIQUID DENSITY: Normally a gas

RELATIVE VAPOR DENSITY: 1.268 (air = 1)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 10 ppm. for 10-hour working day.

DETECTABLE ODOR CONC.: Unknown

By-Product Of:

By-product of the EDC cracking operation, and sent at high purity to other units or to disposal in the HCl Scrubber. It is an impurity in the stripper feed and is in highest concentration in the Plant in the vent gas stream.

HAZARDOUS PROPERTIES: Anhydrous hydrogen chloride is a gas which has a corrosive action upon the skin or mucous membranes. In this form it will cause rapid and severe burns. It is particularly dangerous to the eyes. It is not flammable; however, the gas is highly soluble in water forming hydrochloric acid, which attacks most metals with the evolution of explosive hydrogen.

TREATMENT: Immediate removal from the toxic area and thorough flushing of the patient's body and/or eyes with large quantities of water is of primary importance. Contaminated clothing should be removed from patient while he is being showered with water. It is essential that all affected body surfaces be washed with copious quantities of water for a sufficient time to remove all hydrochloric acid. No attempt should be made to neutralize the acid with alkaline solutions. Medical assistance should be summoned at the earliest possible moment.

 4-15

NAME: Methane (marsh gas)

FORMULA: CH_4

MOLECULAR WEIGHT: 16.04

BOILING POINT: -258.7°F

FREEZING POINT: -297.8°F

VAPOR PRESSURE: @ -115.8°F, 34,900 mm. Hg.

LIQUID DENSITY: @ -263.2°F, 25.91 lbs per Ft^3

RELATIVE VAPOR DENSITY: 0.555 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: 5.3% to 14.0% by volume

DETECTABLE ODOR CONC.: Odorless

AUTOIGNITION TEMP.: 1000°F

HAZARDOUS PROPERTIES: A simple asphyxiant. A dangerous fire and explosion hazard.

TREATMENT: Fire should be fought with carbon dioxide or dry chemicals.

RELATIVE HAZARD:

Is the main constituent of the fuel gas burned in the furnaces.

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4-16

NAME: Perchloroethylene (tetrachloroethylene)

FORMULA: CCl_2CCl_2

MOLECULAR WEIGHT: 165.848

BOILING POINT: 249.7°F

MELTING POINT: -8.07°F

VAPOR PRESSURE: @ 71.6°F , 15.8 mm. Hg.

LIQUID DENSITY: @ 59°F, 101.82 lbs. per Ft^3

RELATIVE VAPOR DENSITY: 5.83 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 100 ppm. by volume.

HAZARDOUS PROPERTIES: Not corrosive or dangerously reactive, but toxic by inhalation, by prolonged or repeated contact with the skin or mucous membrane, or when ingested by mouth. The liquid can cause injuries to the eyes; however, with proper precautions it can be handled safely. The symptoms of acute intoxication from this material are the result of its effects upon the nervous system.

TREATMENT: Wash any perchloroethylene from the exposed skin with soap and water. If a person has been overcome by vapors, remove him from the area immediately and begin artificial respiration if a respirator is not available.

Rooms with perchloroethylene exposed to the air should be well ventilated.

RELATIVE HAZARD:

A potential heavy compound that might form in the Dopp Kettles; present in dilute concentrations.

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NAME: Sulfuric Acid

FORMULA: H_2SO_4

MOLECULAR WEIGHT: 98.08

BOILING POINT: 626°F

MELTING POINT: 50.9°F

VAPOR PRESSURE: @ 294.8°F, 1mm. Hg.

LIQUID DENSITY: @ 77°F, 114.97 lbs per Ft^3

RELATIVE VAPOR DENSITY: Normally a liquid

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 0.25 ppm by Volume

DETECTABLE ODOR CONC.: 0.12 ppm.

USED IN:

Not used in process, but used as a chemical in the area for cooling tower water treatment.

SL 009815

HAZARDOUS PROPERTIES: Contact with the body results in rapid distruction of tissue, causing severe burns. Repeated contact with dilute solutions can cause dermatitis, and repeated or prolonged inhalation of a mist of sulfuric acid can cause an inflammation of the upper respiratory tract leading to chronic bronchitis. Sensitivity to sulfuric acid or mists or vapors varies with individuals. Normally sensitivity is as follows:

0.125 to 0.50 ppm - mildly annoying
1.5 to 2.5 ppm - definitely unpleasant
10 to 20 ppm - unbearable.

Workers exposed to low concentrations gradually lose their sensitivity to its irritant action. Sulfuric acid can ignite upon contact with combustibles. It will react with water to produce heat. The acid should always be added to water upon dilution, never vice versa because spitting may occur.

TREATMENT: Large quantities of water should immediately be used to wash the material off the body. Remove contaminated clothing during washing. Do not attempt to neutralize the acid in contact with the skin until all areas of contact have been thoroughly irrigated with water. Then applications of mild alkaline solutions may be used. Do not apply oils or ointments to burned area without instructions from a physician. If eyes are involved they should be immediately irrigated with copious quantities of water for at least 15 minutes.

NAME: Symmetrical and Assymmetrical Tetrachloroethane (S.TeCE & A.TeCE)

FORMULA: $CHCl_2CHCl_2$ and CCl_3CH_2Cl

MOLECULAR WEIGHT: 167.864

BOILING POINT: S.TeCE 295.2°F, A.TeCE 266.8°F

VAPOR PRESSURE @ 75°F, S.TeCE 4 mm. Hg; A.TeCE 13 mm. Hg.

MELTING POINT: S.TeCE -46.8°F, A.TeCE -94.4°F

LIQUID DENSITY @ 77°F, S.TeCE 99.14 lbs per Ft^3; A.TeCE 95.70 lbs per Ft^3

RELATIVE VAPOR DENSITY: 5.78 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 5 ppm for 8-hour exposure

DETECTABLE ODOR CONC: Approximately 5 ppm.

RELATIVE HAZARD:

Usually present in all still bottoms streams, especially from the heavies still.

HAZARDOUS PROPERTIES: The tetrachloroethanes are not flammable or explosive but are the most toxic of the chlorinated ethanes that will be handled in the plant.

The tetrachloroethanes are toxic by inhalation, by prolonged and repeated contact with skin or mucous membranes or by oral intake. Although toxic, tetrachloroethanes may be handled safely if proper precautions are constantly observed. Prolonged or repeated exposures to the product in any form are hazardous.

The signs and symptoms of excessive absorption usually appear gradually and only after repeated exposures. In order of appearance they commonly are unusual fatigue, loss of appetite and weight, sick stomach and vomiting, constipation, abdominal pain, jaundice, drowsiness, going on in severe cases to unconsciousness and death. Some cases show marked involvement of the nervous system with headache, numbness and tingling in fingers and toes, trembling and twitching of muscles and even paralysis of some muscles.

The signs and symptoms of tetrachloroethane poisoning given above are due to systemic poisoning characterized by marked damage to the liver, kidneys, heart, blood cells, and nervous system. The clinical picture varies with the type of exposure and the amount of the material which has been absorbed either at one time or at repeated times. Most serious effects are usually on the liver and the blood. The principal route of absorption is by breathing the vapor, although it may be absorbed by the skin. Tetrachloroethane is currently considered the most toxic of the chlorinated hydrocarbon solvents in industrial use.

Continued exposure to high concentrations of the tetrachloroethanes leads to local irritation of the eyes and nose. There may be sick stomach and vomiting, but since tetrachloroethane is less volatile than other hydrocarbon solvents, it does not often have an anesthetic effect.

Subacute tetrachloroethane poisoning is the form usually encountered. This develops gradually as a result of prolonged or repeated work in an atmosphere containing more than 5 parts of tetrachloroethane per million parts of air but under conditions where the amount absorbed causes no immediate reaction. Repeated exposure even to low concentrations seems to increase sensitivity, and may lead to subacute poisoning.

For some time, workers with subacute poisoning may show only such signs and symptoms as unusual fatigue, loss of appetite and weight, constipation and abdominal distress or pain. At any time they may develop more severe evidence of absorption such as vomiting, dizziness, tenderness and pain over the liver, and jaundice. Even if removed from further exposure, the illness may persist and grow worse over a period of days, weeks or even months, and may finally even end in death. However, if after a few months there has been steady improvement, complete recovery is the rule.

Some conditions under which subacute poisoning may occur in employees are as follows:

(a) Where the ventilation is inadequate, resulting in high concentrations of more than 5 parts of tetrachloroethane per million of air.

(b) Where the vapor concentrations are high intermittently, due to faulty handling of the liquid.

(c) Failure of the individual to observe percautionary measures.

Tetrachloroethane is absorbed through the skin so that systemic poisoning can occur by this route with the same signs and symptoms as described above.

Tetrachloroethane may cause dermatitis after repeated or prolonged contact with the skin, such as that which might occur in the handling of rags wet with the chemical product, dipping hands into the liquid, or wearing clothing saturated with it. Reddening, burning and, rarely, blisters may follow such exposure. In certain rare cases, the dermatitis may be caused by hypersensitivity to tetrachloroethane. The skin becomes rough, red and dry due to the removal of skin oils. It cracks easily and is readily susceptible to infection. The skin has a chapped appearance.

Tetrachloroethane may enter the eyes either as a vapor or a liquid (spray or splash). The resultant irritation produces lacrimation, burning and other symptoms of inflammation. It can cause serious eye damage if immediate care is neglected.

The first symptoms after toxic amounts of tetrachloroethane are taken by mouth are those of irritation of stomach and bowels, such as sick stomach, vomiting and diarrhea with bloody stools. It is absorbed very rapidly and even a small amount may go on to produce unconsciousness and a deep flushing of the skin. Death is apt to occur before such systemic changes as liver and kidney damage occur.

TREATMENT: Most important in the case of any poisoning is quick removal from exposure. In the case of tetrachloroethane poisoning, this means first removing the patient from the contaminated atmosphere and, insofar as possible, removing the tetrachloroethane from the patient's skin, or gastro-intestinal tract, if those areas are involved.

The patient should be kept quiet and comfortably warm, but not hot.

A physician should be called immediately. He should be told briefly and clearly what has happened and the exact location of the patient.

A person showing symptoms of tetrachloroethane vapor poisoning should be removed promptly from the contaminated area. In case breathing has stopped, effective artificial respiration, such as that obtained by the prone pressure method or the Eve rocking method should be started immediately, but only if one familiar with the operation of the apparatus is present to administer it. If the patient is conscious, hot tea or coffee may be given as a stimulant. A physician should be called at once.

All contaminated clothing should be removed at once. Clothing, including shoes, soaked in tetrachloroethane should be removed and not worn again until thoroughly free from tetrachloroethane. All affected areas hould be washed thoroughly with warm water and soap. After this an ointment containing lanolin should be applied in order to help in replacing the natural skin oils. For serious or persistent cases of skin trouble, and for signs and symptoms of generalized poisoning, a physician should be consulted.

If liquid tetrachloroethane has entered the eyes, they should be washed promptly with copious quantities of water for at least 15 minutes. (It is advisable to irrigate the eyes gently with water at room temperature in order to minimize additional pain of discomfort.) Medical attention should be obtained in all cases involving contact with the eyes.

If a person has swallowed tetrachloroethane he should be made to vomit, if conscious, by having him drink a glassful or more of lukewarm water in which a teaspoonful of salt to the glassful has been dissolved; a similar amount of warm soapy water may be used. If necessary, the patient should be encouraged to stick his finger down his throat to induce vomiting. When possible, vomiting should be induced at least three times. Following this, a tablespoonful of Epsom Salt dissolved in a glass of water should be given. A physician should be called at once.

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NAME: 1,1,2-Trichloroethane (TCE)

FORMULA: $CHCl_2CH_2Cl$

MOLECULAR WEIGHT: 133.415

BOILING POINT: 236.8°F

VAPOR PRESSURE @ 75°F, 22 mm. Hg.

FREEZING POINT: -31°F

LIQUID DENSITY @ 77°F, 89.39 lbs per Ft^3

RELATIVE VAPOR DENSITY: 4.6 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 25 to 100 ppm.

DETECTABLE ODOR CONC.: Unknown

RELATIVE HAZARD:

Usually present in all still bottoms streams, especially from heavies still.

HAZARDOUS PROPERTIES: Trichloroethane can cause burns of the eyes and has a seriously harmful effect upon the liver. It has a local irritating effect upon the mucous membranes, particularly of the eyes and nose. All contact with the eyes and skin should be avoided. This material should generally be handled with caution, because its toxicological properties have not as yet been adequately evaluated.

TREATMENT: Remove patient from toxic area. Remove all contaminated clothing and wash all exposed skin surfaces thoroughly with soap and water. Flush eyes with copious quantities of water. Notify a physician.

NAME: Trichloroethylene (ethylene trichloride)

FORMULA: $CHClCCl_2$

MOLECULAR WEIGHT: 131.399

BOILING POINT: 188.8°F

MELTING POINT: -124.3°F

VAPOR PRESSURE @ 89.6°F, 100 mm. Hg.

LIQUID DENSITY @ 77°F, 90.87 lbs per Ft^3

RELATIVE VAPOR DENSITY: 4.53 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 100 ppm.

AUTOIGNITION TEMP.: 770°F

RELATIVE HAZARD:

A potential heavy that may be found in the Dopp Kettle bottoms stream in dilute concentration.

HAZARDOUS PROPERTIES: Inhalation of high concentrations causes narcosis and anesthesia. A form of addiction has been observed in exposed workers. Death from cardiac failure due to ventricular fibrillation has been reported. Prolonged inhalation of moderate concentrations causes headache and drowsiness. There is some question as to damage to liver or other organs from chronic exposures. Cases have been reported but are of questionable validity.

High concentrations of trichloroethylene vapor in high-temperature air can be made to burn mildly if plied with a strong flame. Though such a condition is difficult to produce, flames or arcs should not be used in closed equipment which contains any solvent residue or vapor.

Trichloroethylene is dangerous when heated to decomposition. It emits highly toxic fumes of chlorides.

TREATMENT: If a person in overcome by vapors, he should be removed from the area immediately and given artificial respiration if a respirator is not available. Notify a physician.

Employees in continual contact should have regular physical examinations by a physician familiar with the hazards of trichloroethylene.

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NAME: Vinyl Chloride (MVC)

PRODUCT OF:

FORMULA: CH_2CHCl

Main Product

MOLECULAR WEIGHT: 62.501

BOILING POINT: 7.9°F

MELTING POINT: -244.7°F

VAPOR PRESSURE @ 77°F, 2660 mm. Hg.

LIQUID DENSITY @ 77°F, 61.92 lbs per Ft^3

RELATIVE VAPOR DENSITY: 2.15 (air = 1.0)

FLASH POINT: -108.4°F open up

EXPLOSIVE LIMITS: 4% to 22% by volume

SL 009821

MAXIMUM ALLOWABLE CONC.: 500 ppm for 8 hours.

VISCOSITY: @ 77°F, 0.187 cp.

HAZARDOUS PROPERTIES: Present toxicological information indicates that vinyl chloride exhibits a low order of toxicity, but when present in sufficiently high vapor concentrations it has an anesthetic action. Vapor concentrations in work areas should be kept below 500 ppm for eight-hour exposure periods. Concentrations of greater than 500 ppm may cause warning symptoms of dizziness disorientation, and disturbances of equilibrium and coordination similar to drunkenness. Vapor concentrations approaching the lower explosive limit may cause helplessness and unconsciousness on very short exposure.

Pure vinyl chloride has a weak sweet odor, while the commercial product has a faint phenolic odor due to the presence of the phenol inhibitor.

Far more important than any other hazards are the dangers of fire and explosion from vinyl chloride vapor. Precautions must be taken to keep vinyl chloride enclosed and to eliminate all sources of ignition. Fires involving large quantities of vinyl chloride are practically impossible to extinguish. Diking and draining should be provided for confining and disposing of the liquid monomer in case of tank ruptures or spills.

TREATMENT: Liquid vinyl chloride is a primary irritant to intact skin. If sufficient quantities remain long enough in contact with the skin, the rapid evaporation may result in freezing or "frost bite." Consequently, anything which tends to hold vinyl chloride in contact with the skin, such as clothing, shoes, or bandages, increases the risk of freezing.

If spills occur, all contaminated clothing should be removed immediately and the contaminated area washed copiously in running water. If mild irritation has occurred, no further treatment may be required. If inflammation is severe, loose dressings of petroleum jelly should be applied and the patient placed in the care of a physician.

If freezing has occurred, the area should be loosely covered with a clean, perferably sterile, gauze or towel and placed in the care of a physician.

Vinyl chloride which has gotten into the eyes should be washed out immediately with copious amounts of flowing water. Water at room temperature will produce less pain than very cold water, but in an emergency a drinking fountain is a satisfactory source of water. The washing should continue for at least 15 minutes. If injury is apparent in the tissues of the eye after 15 minutes of irrigation, the washing should be continued for another 15 minutes. In all cases except of very minor irritation, the patient should be placed in the care of an ophthalmologist immediately.

Because of the mildness and slow development of symptoms, it is very unlikely that any workman will be overcome to the point where he will require help in escaping the environment or medical care following exposure. Any person with evidence of intoxication from vinyl chloride should be put at rest, either seated or lying, in an uncontaminated atmosphere.

If trapped in an area of high concentration where escape is impossible, deep anesthesia can result. If such an exposure has occurred, the patient should be placed in bed, preferably with the head slightly lowered and with no pillows. If respirations have ceased, artificial respiration will be required. In any case, medical attention should be obtained immediately.

Employees who may be subjected to severe exposure to vinyl chloride, as in tank and equipment cleaning and repairs, in decontaminating extensive areas after large spillage, or in cases or failure of piping or equipment, should be provided, when indicated, with proper eye, respiratory, skin, and mucous membrane protection as follows:

(a) Suitable gas tight safety goggles.

(b) Rescue harness and life line for those entering tank or enclosed storage space.

(c) Hose masks with hose inlet in a vapor-free atmosphere, air line masks with proper reducing valve and filter, suitable for use only where conditions will permit safe excape in case of failure of the compressed air supply, or self-contained breathing equipment with stored oxygen or air (such equipment allows greater mobility but usually requires more highly trained men).

Vinyl chloride should always be handled with full recognition of its volatility and its flammability. In general, precautions should be taken both to keep the material enclosed and to eliminate all sources of ignition. In small laboratory operations, where vinyl chloride vapors may escape, reliance must be placed upon the elimination of sources of ignition and the provision of sufficient ventilation to keep escaping vapors at non-flammable levels. Vinyl chloride vapors can form flammable mixtures with air at all temperatures above -108.4°F.

Fires involving large quantities of liquid are difficult to extinguish since vinyl chloride is not miscible with water and is lighter than water (will float on top of water). Most small fires can be extinguished with carbon dioxide or dry chemical agents if properly applied. Adequate fire extinguishing equipment of carbon dioxide or dry chemical type, fixed and portable, should be provided. Water spray is also satisfactory for extinguishing fires. A direct stream of water on burning vinyl chloride liquid intensifies the fire. Diking and drainage should be provided for confining and disposing of the liquid in case of tank rupture or spills. Precautions should be taken to guard against vinyl chloride entering general sewer system.

If spills or leaks occur, all sources of ignition must be removed from the area immediately and only properly protected personnel should remain in the area. Spills, unless very large, usually evaporate rapidly, but ample ventilation must be provided to prevent the accumulation of toxic or explosive mixtures. Spills and leaks must not be allowed to enter the sewer system because of the explosion hazard involved. An approved flammable gas indicator can be used in testing for vinyl chloride leaks.

At the site of leaks, the phenol inhibitor in vinyl chloride may accumulate by evaporation of monomer and reach sufficient concentration to cause local burns of the skin. In case of such accumulation of inhibitor, the area should be thoroughly hosed down with water after all traces of monomer have evaporated.

NAME: Vinylidene Chloride (VDC)

FORMULA: CCl_2CH_2

MOLECULAR WEIGHT: 96.950

BOILING POINT: 88.9°F

FREEZING POINT: -187.6°F

VAPOR PRESSURE @ 75°F, 560 mm. Hg.

LIQUID DENSITY @ 77°F, 76.04 lbs.per Ft^3

RELATIVE VAPOR DENSITY: 3.35 (air = 1.0)

FLASH POINT: 50°F open cup

EXPLOSIVE LIMITS: 7 to 16% by volume in air

MAXIMUM ALLOWABLE CONC: 220 ppm for 8 hours

DETECTABLE ODOR CONC: 500 to 1,000 ppm.

RELATIVE HAZARD:

Impurity found in dilute concentrations in the plant process streams.

HAZARDOUS PROPERTIES: Vinylidene chloride is a flammable and toxic material. Vinylidene chloride is moderately irritating to the eyes and to the skin. The greatest danger from vinylidene chloride is inhalation. A single exposure for a few mintues to a high concentration of vinylidene chloride vapor rapidly produces a "drunkenness" which may progress to unconsciousness if exposure is continued. Even concentrations too low to cause an anesthetic effect, may produce organic injury to the liver and kidneys.

A secondary danger from vinylidene chloride exists. Unstabilized vinylidene chloride in contact with air will decompose and form explosive peroxides. These peroxides are evident by the presence of a white solid. For this reason, all vinylidene chloride will be stabilized and all equipment will be padded with an inert gas such as nitrogen or methane.

TREATMENT: When the skin is contacted by vinylidene chloride it should be thoroughly washed with soap and water and all contaminated clothing removed and washed. If the eyes become contaminated they should be flushed with water for 15 minutes or more. If a person is affected or overcome from breathing vinylidene chloride vapors, he should be removed to fresh air at once. Medical attention should be obtained immediately. Artificial respiration should be administered if breathing stops.

All pipelines, tanks, etc. in contact with vinylidene chloride after its phenol inhibitor has been removed should be thoroughly rinsed with water if they are to be drained and left standing for any length of time.

NAME: Calcium Chloride

USED IN:

All driers.

FORMULA: $CaCl_2$

MOLECULAR WEIGHT: 110.99

BOILING POINT: 2912°F

MELTING POINT: 1422°F

SOLUBILITY IN WATER: 59.5 parts $CaCl_2$/100 parts H_2O at 16.2°F
347 parts $CaCl_2$/ 100 parts H_2O at 680°F

DENSITY: 156.8 lbs per Ft^3, @ 77°F

RELATIVE VAPOR DENSITY: Normally a solid

FLASH POINT: None

EXPLOSIVE LIMITS: None

HAZARDOUS PROPERTIES: Generally speaking, calcium compounds should be considered toxic only when they contain a toxic component (such as arsenic, etc.) or as calcium oxide or hydroxide.

CONFIDENTIAL: Subject to Protective Order of 14th Judicial District Court No. 91-1145

NAME: Freon - 12 (dichlorodifluoromethane)

FORMULA: CCl_2F_2

MOLECULAR WEIGHT: 120.92

BOILING POINT: -20.2°F

MELTING POINT: -252°F

VAPOR PRESSURE: @ 61°F, 5 atmospheres

RELATIVE VAPOR DENSITY: 4.17 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 1000 ppm in air

DETECTABLE ODOR CONC.: Unknown

HAZARDOUS PROPERTIES: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and flourides. Never allow any open flames to come in contact with F-12 or any vessels containing it.

USED IN:

Used as refrigerant for the York refrigeration system.

CONFIDENTIAL:
Subject to Protective Order
of 14th Judicial District Court
No. 91-1145

D. Electrical Equipment

The characteristics of EDC and VC are such that the materials are clarified in Group D, Class I by the U. S. National Electrical Code. The method and materials of installation are those recommended by Factory Insurance Association. In general, the installation is Class I, Group D, Division 2. Motors are TEFC (Totally Enclosed, Fan Cooled), lighting is vapor-tight. and all arcing devices are explosion-proof with seal-offs. Since the Control Room is pressurized and isolated from the process area, general purpose equipment is used. The Laboratory is not pressurized and is essentially furnished atmospheric air, thus requiring all explosion proof equipment inside.

1. Relamping and Receptacles: Vapor-tight fixtures are used in the process area. The relamping procedure will be to first determine the lamps which need changing by turning on all lights. Then , turn off all lights and relamp. Globes and guards must be replaced after relamping.

2. Grounding; Grounding in the VC plant has been given special attention due to problems peculiar to the handling of hydrocarbons. Motor change-outs should be checked to see that the ground has been replaced.

Due to the tendency for hydrocarbons to build up a static electricity charge as a result of movement, agitation, or free fall through a gas space, a system of jumpers for pipe flanges has been installed to provide continuity of the piping system containing flammable materials. All vessels are grounded at two points. The result is a system of lines, tanks and vessels operating at ground potential. This will not prevent the generation of static charges but should provide adequate leakage to ground to prevent the accumulation of dangerous charges.

A particular hazard is created by the use of cranes with long booms. Under certain conditions, depending on boom length and crane location, it is possible to pick up a voltage high enough to burn the person handling a load that is suspended from the crane. This will occur even if the crane is grounded. It is also conceivable that an arc would occur if the crane hooks touch a grounded object.

It is obviously important that the grounding system be maintained intact. This should be kept in mind when performing maintenance work on any equipment in the area.

E. Tools

Special spark-proff or alloy tolls are not required in the area. However, precautions should be utilized in the handling of tools and equipment. In other words, do not strike a metal object that could cause a spart in the presence of EDC, or VC, and air.

F. Pumps and Equipment

Any piece of equipment that is removed from the VC process must be thoroughly cleaned and inspected at a specified work area before it is permitted to leave the area for the plant shop or other work areas.

G. Safety Rules for the VC Plant

The following list of safety rules is applicable to the VC Plant. These safety rules are designed to provide a systematic approach to safety in the VC area. They are general enough so that the operating personnel, if they have a fundamental grasp of the reasons for the rules, will be able to extend their knowledge to situations not covered in this Manual.

Rules

1. Personnel entering the VC area will deposit lighters, matches, regular flashlights (as opposed to explosion-proof flash-lights), etc. at the gate to the area.

2. Smoking will be permitted in the Control Room only.

3. The usual safety equipment will be required in the VC area, as follows:

   a) Safety hats
   b) Safety glasses
   c) Respirators
   d) Neoprene-coated gloves

4. The established general plant procedure will apply for locking-out electrical equipment and for safe-to-work permits on process equipment.

5. Company vehicles only will be allowed to travel without a permit on the road around the Control Building.

6. A vehicle permit signed by the operating supervisor will be required for any vehicle to go into the VC plant proper.

7. An equipment permit signed by the operating supervisor will be required before the following equipment can be carried into the VC area:

   a) Welding machines
   b) Cutting torches
   c) Electrically-driven drills
   d) Any electrical equipment except explosion-proof flashlights
   e) Gasoline engine driven equipment not previously covered
   f) Lighters, blow-torches or any flame producing equipment
   g) Grinders or chipping equipment

8. Only explosion-proof flashlights will be permitted in the area.

9. Regular rubber plant utility hoses are not to be used for VC transfer or handling purposes.

10. All light circuits outside the Control Room or Electrical Starter Room must be off and tagged-out before relamping is undertaken.

11. Do not dump flammable organics into trapped sewers or openings where vapors could be evolved that would be either harmful to health or create an explosion hazard.

12. Do not leave an open sample or container of organics sitting around to give off vapors.

13. Use Full-Face, Chemox or Scott Air-Pac mask for protection against organic vapors.

14. Do not trap liquid chlorine in the vaporizer or surge drum.

15. Clothing that has been wet with organics should be removed immediately and the body thoroughly washed with soap and water. These clothes should be properly laundered before they are used again.

16. Do not permit air to enter any of the process equipment that contains organics.

17. In the case of an emergency warning, all vehicles and equipment in the area on permits will be shut off immediately.

18. All steam-out nozzles or hose and purge equipment must be properly grounded to prevent the possibility of an arc from accumulated static charge.

19. Do not allow chlorine to be heated above 302°F due to the possibility of decomposition or reaction with metals.

20. No smoking or open flames will be allowed in the Control Laboratory.

21. The Laboratory hood fan is to operate continuously. Do not attempt to run analyses unless the fan is in service.

22. Always put liquid organics into tanks through stand legs or through nozzles in the bottom of the vessels. Falling liquid can generate static electricity.

F. Cleaning of Tanks and Process Vessels

The area supervisor and maintenance supervisor will see that all vessels or tanks are cleaned and checked with an explosion meter before delaring them suitable for maintenance.

The recommended cleaning procedure is:

1. The tank or vessel will be emptied and all valves will be closed and tagged.

2. The vapor contents of the tank will be purged with nitrogen.

3. Blinds will be inserted in all connecting lines.

4. The equipment will be steam purged where possible to vaporize and remove all flammable materials. If steam cannot be utilized, nitrogen will be used.

5. Purge the equipment with plenty of air.

6. The equipment will then be checked with an explosion meter before work is begun.

7. Safety belts and safety lines will be required in top-entry tanks.

I. AREA B. - SAFETY PERMIT FORM

43A STD 4-66

ORGANIC AREA SAFETY PERMIT

To be used to pass restricted equipment into the Organic Area and to be endorsed for the use of such equipment in the ______________________ Unit.

To: ______________ Date: ______________

Location: ______________ Equipment: ______________

Please Check	Yes	No
1. Have workmen been provided with proper safety equipment?		
2. Are adjacent areas and equipment safe?		
3. Has adequate fire protection been provided?		
4. Is presence of operator required?		

Remarks: ______________________

Approved: ______________________

If a siren or emergency horn sounds, I am to turn off my equipment immediately and evacuate the area on foot.

____
Employee's Signature

WELDING OR BURNING PERMIT

This permit, when signed, allows welding or burning at:

____
(Location)

It is good for: Date __________ Time __________ AM / PM

To: Date __________ Time __________ AM / PM

Special Comments: ______________________

____

Signed: ______________________
(Area Production Supervisor)

J. Fire Protection

Fire protection in the VC area is provided in three forms--water, dry chemicals, and CO_2. The dry chemical is the only effective way of fighting a VC fire. Water is good to partially contain the fumes and to keep the vessels and structural steel cool. The CO_2 cylinders are good only for small fires or small electrical fires. CO_2 cylinders are located in the switchgear room and are to be used on small electrical fires. The dry chemical is very effective against VC fires. 30-pound dry chemical units are located throughout. A large portable unit is available at the perimeter of the process area.

The water protection is a manual or automatic sprinkling device, tripped by a deluge valve. The VC still area, the cooling tower, the VC day tank area, and the sphere tank area are each protected with its own deluge system (two for still area). Heat Activated Devices (HAD's) are located throughout each area and a sudden rise in the HAD temperature will cause the deluge valve to open and the respective area to be covered with a water spray. The still area sprinklers may also be tripped manually from the control board or the automatic sprinkler building. The other areas have no manual trip for their systems. The deluge valve must be manually reset each time it is used before further automatic protection is available.

The column skirts and all vertical structural steel is protected with "albi" fireproof paint. The support legs and bottom of the spheres are also protected with this paint.

A post indicator valve southwest of the control building can be open to separate the furnace area from the still area with a forty foot high blanket of water. This valve also supplies a water sprinkle on the Dopp Kettles and the bottom of the quench tower. Turn this water on if there is a danger of organic fumes blowing toward the furnace area.

V. DETAILED EQUIPMENT DESCRIPTION

A. Process Equipment

1. EDC Feed System: The furnace feed pumps (maximum output pressure of 300 psig) withdraw EDC from the heavies still reflux drum and pass it to the furnace feed cooler where the temperature is lowered from 190°F to 105°F. EDC is in the 2-pass shell side and cooling water is in the 4-pass tube side of the exchanger.

The cooled EDC then passes to the furnace feed safety driers. These 3'6" diameter by 21' T/T driers are packed with calcium chloride and should lower the water content of the EDC feed to a maximum of 50 ppm. Two Fulflo filters follow the driers to prevent carryover of $CaCl_2$. The filter elements in these furnace feed filters remove particles down to 5 microns in size.

After being dried, the EDC feed passes through the furnace feed economizer. This stream passes through the fifteen-shell Smithco heat exchanger on the tube side. Its temperature is raised from 105°F to 290°F. Each shell of the exchanger contains 7 tubes; each tube has 20 external fins. The shell side fluid is the EDC lean oil from the bottom of the product vinyl still.

2. Vaporizer Description: EDC enters the top, or convection, section of the vaporizer. The EDC feed to each of the two passes is flow controlled.

The Petro-Chem Iso-flow furnace consists of an upright cylindrical structure with an integral self-supporting stack. The inside of the cylindrical casing is lined with insulation which in turn is protected by a layer of insulating refractory brick to form the combustion chamber. The shell of the convection section forms a 3'10" by 11'5 1/2" rectangle which is 6'11" high. The combustion chamber O.D. is 11' 5 1/2". The total height of the furnace from the ground to the stack top is 63'6".

The two passes of 4" carbon steel pipe next enter the radiant section of the furnace; they descend through this section in a double helical coil pattern. The liquid EDC will vaporize in this section and in doing so will result in a large increase in the volume of EDC being passed through the tubes; therefore, the tube size increases to 6" about halfway through the radiant section. The tube coil diameter is 9'0".

Four burners are installed in the floor of the furnace so that all tubes are equi-distant from the flame burst. Uniform heat transfer rates are obtained by subjecting the heating surface nearest the flame to a controlled amount of radiant heat while the upper sections of the heating surface are subjected to varying proportions of direct radiant, secondary radiant and convection heat. The furnace firing is controlled by regulating the fuel gas feed to the four burners, which is set by the vaporized EDC outlet temperature.

The inlet feed tubes are protected with safety relief valves set at 315 psig. These valves vent to the heavies still reflux drum.

Nitrogen at 100 psig is piped to the furnace inlet piping for purging purposes.

Snuffing steam at 100 psig is piped to the lower part of the vaporizer shell and can be turned on manually from the panel board or the field to snuff out the flame in the furnace in case of a tube rupture.

During operation there will always exist a certain pressure drop between the inlet and outlet tubes depending upon the EDC feed rate and the extent of coking in the tubes. This pressure drop is indicated in the field and on the panel. An increase in the pressure drop across the furnace tubes will result in an increase in the feed inlet pressure. The outlet pressure will remain the same, provided everything else is unchanged. When the inlet pressure increases to a point where the feed control valves are completely open, the feed flows will start to drop off and the furnace will need to be decoked or acidized. Extensive coking is not expected to occur in this particular furnace. Only the non-volatile solids will be laid down in the tube up to the dry point.

3. <u>Petro-Chem Iso-flow Cracking Furnaces</u>: Vaporized EDC is flow controlled to the cracking furnace in four passes. An identical cracking furnace will be installed parallel to the present one at a later date.

The cracking furnaces are similar in design to the vaporizer. The following changes should be noted, though. The shell of each convection section forms a rectangle 3'1 1/4" by 19'8 3/4" which is 7'8" high and the radiation section is 20'6" O.D. The total height of the furnace is 73'11". The convection section contains steel tubes, while the radiation section contains type 304 stainless steel tubes.

There are twelve burners at the bottom of each cracking furnace. Fuel gas flow is controlled by the outlet process temperature. Although there is one temperature sensing device in each outlet pass, only the temperature of one of the passes in each cracking furnace will be used to set the firing rate. The remaining temperatures will be recorded for comparison purposes and can be switched to "control" if desired, leaving the other passes "recorded".

The tube wall temperature of each pass outlet is recorded and will be used as a guide to determine the degree of coking. Coke formation will provide resistance to heat transfer. The differential pressure across each tube will be monitored as another aid in determining the degree of coking.

Snuffing steam at 100 psig may be admitted by remote manual control to either furnace. These steam valves can also be opened in the field manually in case of a tube rupture inside the furnace.

It is expected that coke deposits will build up on the walls of the tubes in the furnaces. Therefore, provision has been made for decoking the tubes. The decoking elements are steam and air; these can be admitted for forward or reverse flow through any pass of the two cracking furnaces.

For safety reasons the decoking elements cannot be turned on to a tube until blinds ("Figure 8" blinds are used) are removed and a removable spool has been replaced in the lines conducting air and steam to the pass to be decoked. In like fashion, the discharge piping from the furnace to the coke knockout drum must be connected up to whatever end of the furnace the effluent gases will be coming from.

The steam and air flows for the decoking operation are measured and transmitted to field indicators. It will be possible to "spall" with steam (200 psig) in both directions, but air will be used only in the forward direction.

In the event routine or emergency purging of a furnace pass must be done, 100 psig nitrogen is piped to, but valved off from, the inlet passes to each furnace.

The turndown ratio of the cracking furnaces is 80%. This is different from conventional reactors becuase the coking rate increases rapidly as velocities decrease and retention time increases.

Methane fuel gas is supplied to the plant at 90 psig. This pressure will be further reduced to 30 psig before the gas is distributed to each furnace. Each furnace has a pressure control valve which controls the pilot supply pressure at 2-5 psig. The fuel gas flow to the burners of each furnace is controlled by the outlet temperature of the process stream from that particular furnace.

The combustion air to each furnace is automatically controlled. Continuous control analyses are run to check for the percent oxygen in the flue gas streams (exhaust gas from the furnaces) and the necessary changes in the air flow to the respective furnace is made accordingly.

4. <u>EDC Vaporizing and Cracking Furnace Flame Control Systems:</u>

a. The flame control systems for each furnace are basically identical. The essential differences between the two systems are:

(1) The vaporizing furnace is interlocked with the cracking furnace so that under operating conditions at least one pilot burner on the vaporizer must be in operation with the Maxon gas valve armed before a cracking furnace can be operated.

(2) In the vaporizing furnace a contact on the Maxon valves is used to operate a relay, VRG1-VRG4. Contacts from these relays are used to operate a local indicating light, a remote indicating light, and furnish the interlocks described above.

In the cracking furnace system, two Maxon contacts are used, one to operate a local indicating light, the other to operate a remote indicating light.

b. Furnace Start-Up

(1) The following discussion relates specifically to the vaporizing furnace, but is applicable to the cracking furnaces. Refer to Drawing 65A-7625 or Drawings 65A-7626 and 65A-7627.

(2) Purge Sequence

(a) Assume that the furnace is down, the horn and alarm lights have been acknowledged. Relays VRC1-VRC4 are energized, relays VRD1-VRD4 are de-energized, relays VRY and VRZ are de-energized. Assume further that the bypass switches VSBP-1 and VSBP-2 (safety bypass switches) are off, relay VRBP is therefore de-energized. Indicating light VLBP on the field panel is off, and a green indicating light at the VSBP-2 control station on the control room panel indicates that the bypass is off.

(b) The operator first closes all factory mutual gas cocks, thereby causing pressure switch PS-2040 contact to close. The furnace damper must be opened completely, thereby causing limit switch VSA1 to close.

With fuel gas pressure at the furnace exceeding the set point of pressure switch PS-2038, relay VR4 is energized and contact VR4-1 is closed. With temperature at the bridge wall below the shutdown setpoint of TI-2161 and temperature at the outlet of the quench tower below the shutdown setpoint of TS-3031, contacts TS-3031 and TI-2161 will be closed energizing relay VR2 and closing contact VR2-1.

(c) When "Purge" pushbutton VPBP is operated, the clutch to timer VHP-2 immediately energizes and seals in thru N.O. clutch contact VHP2-1. With contacts PS-2040 and VSA1 closed, the timing motor of VHP2 and the "purge in progress" indicating light VLPP (located only on the field panel) energizes thru N.C. motor contact VHP2-2.

N.O. clutch contact VHP-4 temporarily shuts the low outlet pressure shutdown contacts VR3A-2 and VR3B-2. The clutch of feed shut-down timer VHP-3 then energizes thru VR4-1, VRZ-5 and VR2-1.

(d) At the end of the purge period, motor contact VHP2-3 times closed energizing relay VRB. Relay VRB immediately seals in thru contact VRB-1. Contact VRB-2 energizes the ignition bus IGN-1 and establishes a permissive circuit to start timer VHP1. Contact VRB-3 energizes the pilot solenoid valve bus PS-1 and VRB-4 establishes a permissive interlock for the Maxon safety valve bus MS-1.

(e) After a short interval contact VHP2-2 times open de-energizing the VHP-2 timing motor (note:at this point that the clutch of VHP2 is still energized) and the "Purge in Progress" indicating light VLPP.

When shunt contact VHP2-4 closed, the clutch of feed shutdown timer VHP3 energized (see section b). N.C. clutch contact VHP3-2 opens, resetting the motor contacts VHP3-1 and VHP3-3 to the closed position.

(f) At this point the purge sequence is complete. Relays VR2, VR4 and VRB are energized, feed shutdown timer VHP3 has been reset, a premissive interlock for the start sequence has been established, and the ignition and pilot solenoid buses have been energized.

(g) By operating one of the bypass switches VSBP-1 or VSBP-2, the Maxon bus MS-1 can be energized. After lighting off one of the pilot flames and arming the Maxon valve for that burner, either of the cracking furnaces can be started.

(3) Start Sequence

(a) To initiate the "Start" sequence, "Start" push button VPBS is operated, energizing the clutch and timing motor for start timer VHP1. The clutch and motor immediately seal in thru N.O. clutch contact VHP1-2. N.O. clutch contact VHP1-3 immediately closes, energizing startup bypass relay VRX. Since indicating light VLBP is not in this circuit, VLBP (on the field panel) remains off and the indicating light at VSBP-2 control station (on the control room panel) remains green.

(b) When startup bypass relay VRX energizes, N.O. shunt contact VRX-1 closes energizing low feed flow shutdown relay VR1; N.O. shunt contacts VRX-2 and VRX-3 close energizing low outlet pressure shutdown relays VR3A and VR3B.

When relay VR1 energizes, N.O. interlock contact VR1-1 closes energizing the Maxon safety valve bus MS-1, completing the last step required for main burner lightoff.

(c) When relays VR3A and VR3B energize, N.O. interlock contacts VR3A-2 and VR3B-2 close (note at this time that these contacts are still bypassed by contact VHP2-4, since the clutch to timer VHP2 is still energized). N.O. interlock contacts VR3A-1 and VR3B-1 close energizing feed solenoid valves SY-2193 and SV-2194 respectively. With solenoid valves SV-2193 and SV-2194 energized, feed flow control valves FCV-2008 and FCV-2015 can be opened and feed flows established after the manual block valves are opened.

(d) To complete the "Start" sequence, assume during the timing interval of VHP1 that:

(1) All burners have been lighted off,
(2) Minimum feed flows have been established closing contacts FS-2019 and FS-2170,
(3) Minimum pressures at the furnace feed outlets have been established closing contacts PS-2165 and PS-2163.

When timer VHP1 times out, N.C. motor contact VHP1-4 opens first, de-energizing the clutch for time VHP2. N.O. clutch contact VHP2-1 opens the seal around pushbutton VPBP and N.O. clutch contact VHP2-4 opens the shunt around contact VR3A-2 and VR3B-2 (since these contacts are closed VRB, VHP3 clutch and bus MS-1 remain energized. Motor contacts VHP2-2 and VHP2-3 reset to the closed and open positions respectively.

After a short time delay, N.C. motor contact VHP1-1 opens, de-energizing the VHP1 clutch and motor. Seal contact VHP1-2 opens immediately. Contact VHP1-3 opens to de-energize VRX and open startup shunt contacts VRX-1, VRX-2 and VRX-3. Relay VR1 remains, energized thru FS-2019 and FS-2170. Relays VR3A and VR3B remain energized thru contacts PS-2165 and PS-2163.

At this point sustained operation of the furnace is totally dependent on the safety shutdowns.

(4) Burner Lightoff

(a) Since the lightoff procedure for all burners is identical, the lightoff of burner #1 only is detailed. Previous steps in the sequence (see section b.2.d. and b.3.b.) will have energized the Maxon safety valve bus MS-1, the pilot solenoid bus PS-1 and the ignition transformer bus IGN-1.

(b) The ignition pushbutton VPB1 and "Pilot Established" indicating light VLP1 are mounted together. When the ignition pushbutton VPB-1 is operated, contact VPB1-4 closes across fireye terminals 3 and A and energizes relay RL1 of flame control unit FFC-2018 (see drawing 65A-7629). Contact RL1-2 (in FFC-2018) then opens de-energizing alarm relay VRC1.

Contact VPB1-2 closes energizing the pilot solenoid SV-2334 and contact VPB1-1 closes energizing the ignition transformer VIGT-1 and lighting the pilot flame. When the scanner (FFD-2167) "sees" the flame, the flame detector circuit energizes the flame relay RL2 (in FFC-2018). Relay RL1 then seals in thru contacts RL1-3 and RL2-2. Contact RL2-4 closes energizing the "Pilot Established" indicating light VLP1.

(c) When VRCI de-energized, N.C. interlock contact VRC1-5 closed sealing the pilot valve around pushbutton contact VPB1-2. N.C. interlock contact VRC1-4 closed enabling the Maxon safety valve holding coil to energize when VPB1 is released.

(d) De-energizing VRC1 also closes contact VRC1-1, energizing relay VRD1. Relay VRD1 then seals in thru contact VRD1-1.. At this point contacts VRD1-2 and VRD1-3 are closed and contacts VRC1-2 and VRC1-3 are open.

(e) When VPB1 was first operated, energizing relay RL1 in FFC-2018, contact RL1-4 closed energizing the total flame failure bus TFF-1. When the bus TFF-1 energizes, relay VRY energizes thru N.C. lockout contact

contact VRZ1. Contact VRY-6 closes to hold the purge complete relay VRB energized. Contact VRY1 seals in relay VRY, contact VRY-2 closes energizing relay VRZ which then seals in thru contact VRZ-2. Shunt contact VRZ-5 opens leaving relay VRB, timer VHP3 and bus MS-1 dependent on the total flame failure interlock contact VRY-6.

At this point contacts VRZ-3 and VRZ-4 are closed, contacts VRY-3 and VRY-4 are open. Contact VRY-5 is open de-energizing the control room panel alarm A-2308. Contacts VRY-7 and VRY-8 are closed establishing power to the control circuits of the cracking furnace flame control units.

(f) When the Maxon safety valve is armed, an integral limit switch closes, energizing relay VRG1. Contact VRG1-1 opens, de-energizing the main burner failure alarm indicating light VLM-1 on the field panel. Contact VRG1-2 opens de-energizing the main burner failure alarm A-2369 on the control room panel. See also section d.

(g) See section b.3.d.

c. Furnace Shutdown

(1) Emergency Shutdown by Operator: Two emergency shutdown pushbottoms are provided, VPBE-1 at the field panel and VPBE-2 at the control room panel. Operating either pushbutton de-energizes the RL1 relay in the flame control units and initiates a total flame failure sequence (see section e.5).

(2) Shutdown Conditions: The following conditions initiate shutdowns of varying degree.

	Condition	Safety Device	Pilot Relay
(a)	Low feed flow in either pass.	FS-2019 & FS-2170	VR-1
(b)	High bridge wall temperature	TI-2161	VR-2
(c)	Low pressure at the outlet of either pass	PS-2165 & PS-2163	VR3A & VR3B
(d)	Low fuel gas pressure	PS-2038	VR-4
(e)	Total flame failure	Contact RLI-4 of flame control units	VRY
(f)	Quench tower high outlet temperature	TS-3031	VR-2
(g)	Individual burner failure	Contact RL1-2 of flame control units	VRC1-VRC4

(3) Reaction to Shutdown Condition

(a) Reaction to the various shutdown conditions are one or more of the following actions:

(1) Trip the Maxon safety valves in the main burner fuel gas lines.
(2) De-energize the pilot solenoid valves in the pilot burner fuel lines.
(3) Indicate an alarm condition at the field panel by means of a red indicating light and an audible horn.
(4) Indicate an alarm condition at the control room panel by means of an indicating light in a first out sequence and an audible alarm. (Control room alarm system has remote horns in the field.)
(5) Closes all of the feed flow solenoid valves after a time delay.
(6) Close any or all of the feed solenoid valves immediately.

(b) The reactions to the various shutdown conditions are as tabulated below:

To Shutdown Condition	Correspond Reactions
a	1 and 4
b	1,4 and 5
c	1, 2, 4 and 6
d	1, 2, 4 and 5
e	1, 2, 3, 4 and 5
f	1, 4 and 5
g	3 and 4 (see section d.7)

Emergency conditions c, d, and e require a repurge of the furnace.

d. Detailed Descriptions of Shutdowns

(1) Low feed flow in either pass: A low feed flow in either one or both passes will de-energize relay VR1. Contact VR1-1 opens de-energizing the Maxon safety bus MS-1. When bus MS-1 de-energizes, the Maxon safety valves trip shutting off gas to the main burners. Enclosed limit switches on the Maxons open de-energizing relays VRG1 - VRG4. Contacts VRG1-1, 2-1, 3-1 and 4-1 energize indicating lights VLM-1 to VLM-4 on the field panel.

Contacts VRG1-2, 2-2, 3-2 and 4-2 energize the Maxon indicating lights (A-2369, A-2368, A-2367 and A-2366) on the control room panel. Flow deviation switches FDS-2005 and/or FDS-2152 indicate a low flow condition (A-2006 & A-2153) on the control room panel.

Refer to Drawing 65A-7626. Contacts VRG1-3, 2-3, 3-3 and 4-3 open in the cracking furnace Maxon safety valve bus MS-2, de-energizing the cracking furnace Maxon safety valves. In addition low feed flow is sensed at the cracking furnace with the same actions described above taking place in the cracking furnace flame controls. Maxon safety valve alarms on the control room panel for No. 1 cracking furnace are A-2370 to A-2380 (these alarms are energized by integral limit switches in the Maxon safety valves, rather than relay contacts as in the case of the vaporizing furnace). Indicating lights for the Maxon safety valves on the field panel for No. 1 cracking furnace are VLM1 to VLM2. Low feed flow alarms on the control room panel for No. 1 cracking furnace are A-2178, A-2188, A-2189 and A-2190.

(2) High bridge wall temperature: When the bridge wall temperature reaches 1400°F, alarm A-2261 on the control room panel is energized.

When the bridge wall temperature reaches 1500°F contact TI-2161 opens dropping relay VR-2. Contact VR2-1 opens de-energizing the Maxon safety valves. The sequence detailed under d.1. then takes place. In addition contact VR2-1 de-energizes the feed shutdown timer clutch. Clutch contact VHP3-2 immediately closes, energizing the timing motor of VHP3 thru N.C. motor contact VHP3-1. After a time delay motor contact VHP3-3 times open, de-energizing the feed solenoid valves and stopping feed flow.

(3) Low pressure at furnace outlet: Assume a low pressure occurs at the outlet of pass No. 1. Pressure switch PS-2165 opens de-energizing relay VR3A. Contact VR3A-1 opens immediately de-energizing SV-2193. The flow in Pass No. 1 immediately stops. Contact VR3A-2 opens de-energizing the pilot solenoids, Maxon safety valves and relay VRB. Contact VRB-2 opens de-energizing the ignition bus IGN-1. The feed shutdown timer clutch is de-energized and feed flow in Pass No. 2 is timed out as in d.2. above. Alarm A-2166 is energized on the control room panel.

(4) Low fuel gas pressure: Pressure switch PS-2038 opens de-energizing relay VR4. Contact VR4-1 opens and the sequence described under d.3. takes place.

(5) Total flame failure: The RL1-4 contacts on all flame control units open de-energizing total flame failure bus TFF-1. When TFF-1 de-energizes, relay VRY de-energizes. Contact VRY-6 opens de-energizing the purge complete relay VRB. Contacts VRY-7 and VRY-8 initiate a total flame failure sequence at the cracking furnaces by de-energizing the RL1 relays in the flame control units.

Contact VRY-3 closes energizing indicating light VLT (on the field panel) and contact VRY-4 closes energizing the alarm horn at the field panel.. Contact VRY-5 closes energizing alarm A-2508 on the control room panel.

When the acknowledge pushbutton VPBA is operated, bus AL-1 is de-energized and relay VRZ de-energizes. When VRZ de-energizes, seal contact VRZ-2 opens preventing VRZ from re-energizing when the push button is released (contact VRY-2 is open since VRY is de-eneirigized). Contacts VRZ 3 and VRZ-4 open de-energizing the horn and indicating light VLT. Contact VRZ-1 closes to allow VRY to energize when TFF-1 is energized. Contact VRZ-5 closes to allow the purge sequence to be completed after initiation of a new purge sequence.

(6) Quench Liquor Failure: This sequence is identical to d.2.

(7) Individual Burner Failure: The following description applies to burner No. 1. Assume that the scanner (FFD-2167) detects a loss of flame at burner No. 1. The flame control unit detector circuit de-energizes the flame relay, RL2, in that unit. Contact RL2-2 opens de-energizing relay RL1. Seal contact RL1-3 opens to lockout relay RL1. Contact RL2-4 opens de-energizing the "Pilot Established" indicating light VLP-1. Contact RL1-4 opens.

Contact RL1-2 closes energizing relay VRC1 (note that VRDI is already energized). Contact VRC1-2 closes energizing indicating light VLB1 (on the field panel). Contact VRC1-3 closes energizing the alarm horn (contacts VRD1-2 and VRD1-3 are closed since VRD1 is energized).

Contact VRC1-4 opens tripping the Maxon safety valve, MS-2338, and contact VRC1-5 opens de-energizing the pilot gas solenoid valve SV-2334. Contact VRC1-1 opens.

When the Maxon safety valve MS-2338 trips an integral limit switch opens de-energizing relay VRG1. Contact VRG1-1 closes energizing indicating light VLM1 on the field panel. Contact VRG1-2 closes energizing alarm A-2369 on the control room panel. Control room panel alarms for burners 2, 3 and 4 are A-2368, A-2367 and A-2366 respectively.

Contacts VRG1-3 and VRG1-4 open in the cracking furnace Maxon safety valve control bus, but the bus remains energized as long as one burner is operative.

When the acknowledge pushbutton VPBA is operated, bus AL-1 de-energizes and relay VRD1 de-energizes. Seal contact VRD1-1 opens to prevent relay VRD1 from re-energizing when the pushbutton is released (contact VRC1-1 is open since relay VRC1 is energized). Contacts VRD1-2 and VRD1-3 open de-energizing indicating light VLB1 and the alarm horn.

The disposition of the VRC and VRD relays for various alarm contact conditions are given in the following table.

Alarm Contact	VLB Light	Horn	VRC Relay	VRD Relay
Normal (open)	Off	Off	De-Energized	Energized
Off-Normal (closed)	On	On	Energized	Energized
Acknowledged Before Return to Normal	Off	Off	Energized	De-energized
Normal Before Acknowledge	Off	Off	De-energized	Energized

e. Bypass

Switches are provided at both the field control panel and the control room panel to bypass shutdown conditions a, b, c, and f. (shutdown conditions a, b, and c on the cracking furnaces).

Operation of either switch, VSBP-1 or VSBP-2, energizes relay VRBP. Contact VRBP-1 energizes relay VRX. ContactsVRX-1, VRBP-2, VRX-2 and VRX-3 shunt the safety shutdown contacts for shutdown conditions a, b, c and f. At the field panel, a red indicating light, VLBP indicates that the system is in bypass condition when either switch is operated. At the control room panel, red and green indicating lights (integral with the switch assembly) indicate that the system is or is not in bypass condition. An integral push-button provides a lamp test for the indicators.

f. Vaporizer-cracking furnace interlocks

Two interlocks are provided between units. Contacts VRY-7 and VRY-8 (on the total flame failure relay) VRY are placed in the power circuits to the RL-1 relays of the cracking furnace flame control units. Ordinarily this will prevent light-off at the cracking furnaces until the vaporizer has been lighted-off.

Further, the VRG relay contacts are interlocked with the Maxon safety valve busses of the cracking furnaces, so that the Maxons at the cracking furnaces cannot be armed until one of those at the vaporizer has been opened.

For dryout purposes these interlocks may be bypassed by:

1. Purging the vaporizing furnace,
2. Placing the system in "bypass" made (by operating VSBR1 or VSBP-2). This bypasses the low flow shutdown and energizes VR1,

3. Lighting off one pilot burner at the vaporizer (energizing VRY and closing VRY-7 and VRY-8),

4. Arming the Maxon safety valve for that burner. This energizes a VRG relay and the -3 or -4 contact of that relay completes the Maxon safety valve busses in the cracking furnace controls.

5. Coke Knockout Drum: A coke knockout drum is provided as a receiver for the vapor and residue discharged from the cracking furnaces during the decoking cycle.

The knockout drum is 5'0" I.D. by 7'8" tangent-to-tangent. The ends are closed with dished heads. The vapor inlet enters tangentially 5'1" from the bottom and is aimed to impinge upon a wear plate. The vapor outlet is at the top through a dip pipe which extends 5'5" down into the vessel. The quench and flush water containing the unburned coke particles pass out the bottom of the drum to the sewer.

The vapor stream from the knockout drum passes to a stack.

A 3" water line is piped to the bottom of the coke drum, and will be used, if necessary, to flush the drum to remove settled carbon particles.

6. Quench Tower: The quench tower is constructed from carbon steel and is 10' I.D. by 30' tangent-to-tangent. It is packed with 13' of 2" Porcelain Intalox saddles. The packing support plate is mounted 10'4" from the bottom so that there is adequate room for the liquid pool and disengaging space as well.

The outlet passes from each cracking furnace into the liquid pool above the bottom of the tower. A rod-out assembly has been installed on each vapor inlet to the quench tower. These will be used to push carbonaceous material into the quench liquor pool. Operational experience will dictate the frequency for using these rod-out assemblies. The quench tower is dumped batchwise automatically into the Dopp Kettle. As the level rises to a pre-set value, a field control circuit will open the dump valve and then close it when a pre-set low level is reached. The level is also transmitted to the control board.

7. Bottoms Removal System: Tars are removed from the front end of the system by withdrawing a small purge stream from the bottom of the quench tower to the Dopp Kettle, where the tars are concentrated and the EDC solvent is vaporized and recycled to the quench tower. Another Dopp Kettle will be installed along with the second cracking furnace.

A steam jacket utilizing 175 psig steam covers the bottom and a little more than half the sides of the kettles. Individual pressure control valves maintain this pressure on each kettle.

Each kettle is provided with a scraper-agitator that turns at 25 rpm. The scraper blades are spring loaded so that contact is made with the wall of the vessel. A double mechanical seal with one ceramic and one graphite face seals the agitator shaft as it passes into each kettle. Each seal is cooled with EDC that passes through the chamber between the two seals and out with some leakage through the seal faces, perhaps. EDC at the proper pressure (at least 15 psi above the kettle pressure) is supplied for this purpose with a pressure control valve. The flow of EDC to each seal is manually controlled. The seal coolant effluent is fed into the kettle for disposal.

Tars are drained from the kettles through Strahman ram-type plug valves.

Each kettle is protected against excessive process pressures by pressure relief valves, which open at 135 psig and discharge into quench tower vapor line.

8. Primary Quench Condenser: Vapor from the quench tower is partially condensed in the primary quench condenser with cooling water. The vapors enter the top shell side of the exchanger in the middle and the uncondensed vapors leave the top at both ends. There is a divided shell side pass and four tube side passes. Condensate leaves the bottom of the exchanger at each end and flows to the quench liquor tank. An identical exchanger will be installed parallel to the existing one during the expansion of this plant.

9. Secondary Quench Condenser: Vapor from the primary quench condenser enters the tube side of the secondary quench condenser. Refrigerant F-12 is on the one-pass shell side and effects further cooling and partial condensation of the forward vapor stream, which is also one-pass. The liquid flows to the quench liquor surge tank while the vapor passes forward to the absorber.

Freon-12 is fed to the exchanger through a level control valve to maintain a constant refrigerant level. Excessive shell pressures are relieved through a rupture disk, set at 300 psig, and a safety relief valve mounted on top of the monel disk; the SRV (safety relief valve) is set to open at

300 psig also. The +34°F Freon-12 vapor leaves the top of the exchanger and passes to the +34 Freon knockout drum. Here the entrained liquid is removed from the Freon vapor and returned to the +34° lean oil cooler. The vapor leaves the top of the knockout drum for return to the Freon compressor.

10. Quench Liquor Tank: The inlet streams to the quench liquor tank enter through dip seal legs to avoid static charge build-up. The horizontal cylindrical tank is 11'10 3/8" I.D. by 24' tangent-to-tangent. A level is recorded on the control board. A monel rupture disk is mounted under a safety relief valve for pressure relief; both are set at 135-psig.

Quench liquor is pumped back to the quench tower through a flow control valve. A flow control valve is also used to maintain a steady level in the tank by sending the excess quench liquor to the stripper. A sightglass is mounted on the tank to provide a visual check of the tank level.

The quench liquor pumps are provided with start-stop stations in the field and at the panel. The discharge line from each pump contains an on-off ball valve which is activated with its respective pump. This setup will enable the operator to quickly establish the quench liquor flow to the quench tower if one of the pumps should fail. It is important to always maintain this flow.

11. Quench Liquor Safety Drier and Filters: The quench liquor pumps discharge into the quench liquor safety drier, which is packed with calcium chloride. This 2'6" I.D. by 21' tangent-to-tangent vessel is protected against excessive pressures by a monel rupture disk mounted under a safety relief valve; both are set to relieve at 160 psig.

Two parallel Fulflo filters have been installed downstream of the safety drier to prevent calcium chloride carryover. The filter elements are capable of removing particles down to 5 microns in size.

12. Vinyl Absorber: The vinyl absorber is designed to remove essentially all of the vinyl chloride from the HCl vent gas stream. This is accomplished by contacting the vinyl chloride-rich vapor stream with a recirculating stream (lean oil) of EDC. The absorption of the vinyl chloride into the EDC lean oil stream is favored by a cold EDC temperature. Since heat is evolved during the absorption operation, this is the reason intercoolers, a vent condenser, and a chilled EDC lean oil must be used.

The absorber is constructed from carbon steel and is 5'6" I.D. by 68'9" tangent-to-tangent. A cylindrical skirt 6' tall supports the column.

The column contains 35 Glitsch ballast trays spaced 18" apart with the following exceptions:

a. The spacing below trays 12 and 14 are 3'0" for manway openings to the column.

b. The 1'9" spacing below trays 7, 8, 9, 10, 13, 14 and 15 is needed for draw-off sumps for the intercoolers. Only two will be used at any one time.

The trays are numbered from bottom to top.

Draw-off sumps for the intercoolers are located at the trays named above. These sumps are designed to seal the vapor on the tray at minimum liquid back-up in the downcomer from the tray above. The design is such that if the external withdrawal system should fail, the liquid passing to the sump will overflow automatically to its respective tray. Liquor withdrawn from a sump for refrigeration in an intercooler is returned to the tray below for passage on down through the column.

The downcomers on all even-numbered trays are rotated 180^{o} from the downcomers of the odd-numbered trays. This assures that liquid flowing onto a tray will have to travel completely across the tray before any further downward flow is possible and is the normal situation in any tray column.

It is planned to use trays 8 and 13 for draw-off points to the intercoolers. It may be found in operations that these draw-off locations are not properly matched to the column heat-load requirements. In this case there are already piped up these alternate draw-off selections: (1) in place of tray 8, ~~tray~~ 10 may be substituted, (2) in place of tray 13, tray 15 may be substituted.

There are two vapor feed streams to the column. One comes from the secondary quench condenser and the other from the top of the stripper. Both enter the bottom of the column under the lowest tray.

The bottom of the column is used as a surge reservoir for feed to the stripper. The liquid is maintained at a constant level by a level control valve. A sightglass is located on the bottom of the column. The column will vent to the atmosphere through a monel rupture disk and safety relief valve if the pressure should reach 135 psig.

13. Absorber Vent Condenser: The vent from the absorber passes to the vent condenser where it is cooled from 50°F to -29°F. The vapor stream enters the top of one end of the one-pass tube side and the vent (HCl) and condensate leave the other end. The vent then goes through an entrainment separator, which has a Teflon mesh mist eliminator, for further condensate removal. The condensate from the mist eliminator and vent condenser combine and flow to the upper intercooler surge tank. The vapor, which is 99+% HCl, then passes through a pressure control valve; this valve controls the absorber pressure at 50 psig.

The one-pass shell side of the absorber vent condenser contains Freon-12 at -40°F. The liquid level is controlled by an inlet level control valve. The Freon vapor flashes to the -40°F knockout drum where the entrained liquid is removed from the Freon vapor and returned to the -40° lean oil cooler. The vapor leaves the top of the knockout drum and returns to the Freon compressor.

14. Absorber Upper and Lower Intercooler System: Vinyl absorber tower liquor flows by gravity into the upper intercooler tanks, from which liquor is withdrawn for refrigeration and return to the absorber. Each intercooler tank is vented back to the same tray at which the overflow sump is located. The upper intercooler system will be described, with the analogous items for the lower intercooler system indicated in parentheses.

Liquor is pumped from the upper intercooler tank through a drier, a filter and the upper refrigerated intercooler. The absorber liquor temperature is lowered from 63°F to 42°F (from 65°F to 5°F in the lower intercooler) in the six-pass tube side of this exchanger (eight-pass for the lower intercooler). Liquor may be recirculated from the intercooler tank, through the intercooler and back to the tank by means of a hand regulated bypass to maintain good tube velocity. The return flow of refrigerated liquor to the column is controlled with a level control valve, which is operated to maintain a constant level in the intercooler surge tank. The flow of liquor to the intercooler is measured and field-indicated. If this flow drops below a preset level, an alarm will sound and cause an on-off valve which is on the liquid inlet line to the intercooler tank to close. This signifies a pump failure.

The intercooler tank is 5'11" I.D. by 14' tangent-to-tangent. The vessel is constructed from carbon steel, and is enclosed with dished heads. The liquid inlet passes nearly to the bottom of the tank for seal purposes. A sightglass and level controller are mounted on the tank. The tank is pressure relieved through a monel rupture disk and a safety relief valve; both are set at 135 psig.

The shell side of the intercooler is protected with a monel rupture disk and a pressure relief valve set at 300 psig.

The intercooler driers are 2'6" I.D. by 21'0" tangent-to-tangent and are packed with calcium chloride. Each is protected against excessive pressures with a monel rupture disk mounted under a safety relief valve (set pressures are 150 psig).

The Fulflo filters have 5 micron filters to remove calcium chloride from the process stream. They also have 150 psig safety relief valves.

15. HCl Stripper: The HCl stripper is used to strip essentially all of the HCl from the EDC stream that passes forward to purification. To effect this separation the stripper contains 40 Glitsch valve trays on 18" spacings.

The stripper is constructed from steel, and is 5'6" I.D. by 71'6" long tangent-to-tangent. Vapor leaves the column from the top. The absorber bottoms stream is pumped to the stripper's top tray. Excess quench liquor from the quench liquor surge tank is also fed here. There are three alternate feed points for this stream: trays 35, 37 and 39. Operations will determine the correct feed tray location for this stream. It is desired to introduce the quench liquor on a tray having the same composition as the quench liquor. The two feed streams to the stripper are measured on flow recorders.

A thermosiphon reboiler is vertically mounted on the side of the stripper. Feed to the reboiler is withdrawn from the bottom of the column. The vapor re-entry point to the column is located about 6' above the bottom of the column. The steam flow to the reboiler is flow controlled. The steam flow will be adjusted to control the HCl content of the reboiler liquor.

The stripper bottom level is maintained by an overflow pipe which goes to the product still feed tank.

The tank is vented back to the stripper just below the first tray. A sightglass is mounted on the bottom of the column.

The stripper is pressure relieved through a monel rupture disk mounted under a safety relief valve set at 135 psig.

16. Vinyl Product Still: The material in the product still feed tank is pumped through a flow control valve to the product still. Here vinyl chloride is separated from the heavies and taken overhead as a pure product, with the exception of HCl contamination, which will be removed in a later processing step. The vinyl still contains 50 Glitsch valve trays with 18" tray spacing.

Two different diameters are used in the vinyl column design because of the large differences in vapor and liquid loading between the top and the bottom of the column. The column changes diameter between trays 35 and 36 from 7'0" I.D. to 4'9" I.D. The lower section is 63'4 1/4" from the bottom tangent line to the reducing section. The top of the still is 25'10 1/4" from the reducing section to the top tangent line. The reducing section itself adds 2'0" to the column height.

A thermosyphon reboiler provides the boil-up for this column. The steam flow is controlled by the temperature on tray 19. This temperature controller measures the temperature of tray 19 in the still. It may seem strange that this temperature is the one selected for reboiler control, and not the temperature of the reboiler itself. However, it should be seen that the reboiler liquor is essentially pure EDC, and as such the reboiler will have only one temperature for a given operating pressure. Temperature at this point would thus be a poor point to control from: either the liquid would boil or it would not, and if boiling were taking place excessive heat could be applied to the reboiler without any change taking place in the reboiler temperature. However, in the column, and tray 19 is a reasonable choice, the composition of the major components EDC-VC is not "fixed", and so a variation in temperature with boilup rate will be possible. Tray 19 was selected because there the temperature change will be greatest for a given change in composition.

The reboiler level is held at the desired setting by a level control valve on the EDC recycle stream to the heavies still feed tank. Additional reboiler liquor is pumped through a flow control valve to the absorber as lean oil.

The vinyl still is protected against excessive pressures by a monel rupture disk and safety relief valve set at 135 psig.

The overhead vapors are condensed on the one-pass shell side of the product still condenser with cooling water. The tube side consists of 4 passes. The condensate leaves the exchanger at the bottom and flows to the product still reflux tank through a stand leg.

Vapor leaving the condenser must pass through the refrigerated vent condenser before being vented through the still pressure control valve. The still is pressure controlled through split ranging by either adding dry nitrogen to the vent condenser outlet or through bleeding off excess pressure through another parallel pressure control valve. Thus much of the vapor space in the upper part of the vinyl still system contains nitrogen. The vent condenser is then necessary to keep vinyl chloride from being vented from the still with the nitrogen purge stream.

The vent condenser contains one tube pass through which the still condenser vent stream passes. Refrigerant F-12 is fed to the shell side through a level control valve. Freon vapor leaves the top of the exchanger and passes to the -30°F Freon knockout drum. Here the vapor is separated from the entrained liquid and returned to the compressor suction. The Freon liquid is returned to the shell side of the lower intercooler. The condensate (vinyl chloride) from the product still vent condenser drains to the product still reflux tank through a stand leg.

The product still reflux drum is 6'5" I.D. by 16'0" tangent to tangent. Reflux for the still is pumped from this tank to the top tray of the still through a flow control valve. A constant vinyl chloride level is maintained in the tank by a level control valve which allows the excess liquor to pass forward to the product neutralization system and on to the day tanks.

17. Absorber Lean Oil System: EDC from the bottom of the vinyl still divides into two streams; one stream (29% of total) is sent to the heavies still and the other (71% of total) is cooled and returned to the top tray of the absorber as lean oil. The lean oil stream is flow controlled, while the recycle stream is controlled by the product still reboiler level.

The lean oil stream undergoes four stages of cooling in the furnace feed economizer, 90° lean oil cooler, 34° lean oil cooler, and the -40° lean oil cooler.

The furnace feed economizer has already been described. The lean oil passes thru the shell side of this exchanger and is cooled from 315°F to 170°F.

The 90° lean oil cooler lowers the lean oil temperature to 105°F. The lean oil passes through the one-pass shell side while cooling water is on the two-pass tube side.

The next exchanger that the lean oil flows through is the 34° lean oil cooler. The lean oil's temperature is lowered to 40°F on the one-pass tube side. 34°F Freon is on the one-pass shell side. The Freon level in the exchanger controls the Freon feed rate. Freon vapor leaves the exchanger and passes to the 34° Freon knockout drum, which has already been discussed. The shell is pressure-relieved at 300 psig through a monel rupture disk and a safety relief valve.

The final lean oil cooling step takes place in the -40° lean oil cooler. There are six tube passes through which the lean oil flows. The exit lean oil temperature is -29°F. Freon at -40°F is vaporized on the shell side of the exchanger. A constant Freon level is maintained by a level control valve on the liquid Freon inlet line. Freon vapor leaves the top of the exchanger and passes to the -40° knockout drum. The exchanger shell is pressure relieved at 300 psig.

Proper control of the effluent lean oil temperature is very important because the EDC is near its freezing point, which is -32.2°F. The temperature of the lean oil from this exchanger can be controlled by use of a manual by-pass around the 34° lean oil cooler. This allows a stream of "hot" lean oil to be mixed with the "chilled" lean oil from the 34° lean oil cooler before entering the -40° lean oil cooler. In the case of impending freeze-up, the by-pass valve can be opened completely until the absorber feed temperature is sufficiently high to avoid freezing.

18. Recycle EDC: The level at the bottom of the vinyl still is maintained by withdrawing EDC for recycle to the heavies still feed tank. This stream is equivalent to 50% of the EDC fed to the furnaces at 50% conversion. There is adequate pressure at the bottom of the still to provide the head necessary to transfer the recycle stream to the heavies still feed tank.

The recycle EDC stream first passes to the EDC recycle cooler. Here its temperature is lowered to 180°F on the one-pass shell side. Cooling water is on the tube side, which has two passes. The stream next passes through a level control valve, which is controlled by the product still reboiler level.

A gaseous chlorine stream is then injected into the recycle EDC line to carry out the chlorination of chloroprene. A two-minute minimum retention time is required for this reaction to take place; therefore, the chlorinated stream goes to a 2' I.D. by 9' tangent-to-tangent reaction tank. The recycle stream then passes to the heavies still feed tank.

Gaseous chlorine is obtained from the Tri-Ethane plant chlorine vaporizer. A connection is also available for hooking up a ton cylinder of chlorine during a vaporizer outage. A flow control valve will regulate the gaseous chlorine flow.

10. Heavies Still: The heavies still is designed to remove all high boiling impurities from the liquid EDC. The carbon steel still is 7'0" I.D. by 95'3" tangent-to-tangent. A cylindrical skirt 16'6" tall supports the still.

The temperature of the liquor in the reboiler will vary proportionately to the EDC concentration; therefore, the bottom temperature is used to control the steam flow to the reboiler.

The column contains 54 Glitsch valve trays with 18" spacing. Feed to the column can be introduced on tray 27, 31, 35, or 39. Reflux is returned to the column's top tray.

A monel rupture disk is mounted under a safety relief valve to prevent pressures on the still from exceeding 50 psig.

The bottoms stream from the heavies still is pumped through a level control valve to the EDC plant bottoms storage tank. This control valve maintains a constant heavies still reboiler level. This bottoms flow is field-indicated and also recorded on the control board.

Vapor from the heavies still passes to the heavies still condenser where complete condensation takes place. The EDC vapors enter the top shell side of the exchanger in the middle and the condensate leaves at the bottom of each end of the shell side. There are two tube passes through which cooling water flows.

The condensed EDC flows by gravity to the reflux tank. The reflux pumps withdraw liquid from this tank to provide reflux for the column and the furnace feedpumps withdraw liquid for feed to the EDC vaporizer.

The condenser and reflux drum are both maintained at a constant pressure (slightly positive) with a nitrogen pad. The still is, therefore, held at a constant pressure, which is necessary to prevent temperature fluctuations. The vent passes to the heavies still stack seal. This 3' I.D. by 12' tangent-to-tangent Haveg 41 vessel is packed with 7' of 1 1/2" Intalox saddles. Water is introduced through a rotometer into the top and it absorbs the HCl in the vent stream. This vessel is vented through a Haveg pipe which extends up the side of the heavies still.

20. Product Vinyl Chloride Treatment: The vinyl chloride product is pumped from the product still reflux tank to the product cooler. It passes through the one-pass shell side and is cooled by cooling water, which is on the four-pass tube side.

The product stream next goes to a 2' I.D. by 4' tangent-to-tangent phase separator and is contacted with water. A wet product stream is much easier to neutralize than a dry one.

Two flake caustic neutralizers are provided so that one can be in service while the other is being recharged. Each is 3' I.D. by 17' tangent-to-tangent and is filled with flake caustic. A roll of fiberglass will be installed above the flake caustic. Each vessel is protected with a monel rupture disk and safety relief valve set to relieve at 200 psig.

When a freshly charged neutralizer is being put on the line, the contained vapor in the vessel will be vented to the vinyl still condenser. This venting must be done slowly so as not to cause an upset in the still pressure.

When a neutralizer is to be taken off the line the vinyl chloride in the unit will be purged to the inlet of the other neutralizer by putting nitrogen pressure on the top of it.

Another 2' I.D. by 4' tangent-to-tangent phase separator follows the product neutralizers. The function of this vessel is to prevent any phase water from passing through to the storage tanks and to provide a means for visual inspecting for caustic carryover. Any caustic-water solution entrainment can be drained from this phase separator.

The product stream next passes through two parallel product filters, which contain 5 micron filter elements.

21. Vinyl Chloride Product Storage: The vinyl chloride next passes to one of eight horizontal cylindrical day tanks. These tanks are 12' I.D. by 78' tangent-to-tangent each. The liquid feed to the vessels enters through a stand leg to reduce the hazard of static electricity formation. Monomer that has been given analytical cleanance will be transferred to either the 54'9" I.D. spherical tank or a larger 60'6" I.D. sphere.

All of these tanks have level indicators and transmitters (the level is shown on the control board).

Each tank is pressure relieved through a monel rupture disk and safety relief valve at 150 psig. A 3-way plug valve is mounted under the rupture disk to allow for maintenance to be performed on the disk or safety relief valve. This valve opens to a line which has only a monel rupture disk on it for protection. The tank should be vented to this rupture disk only for short periods of time as the top of the disk is open to the atmosphere.

The product transfer pumps can be used to circulate a tank's contents, to transfer material from one day tank to another, or to transfer a day tank's contents to one of the spherical tanks.

If either of the day tanks or spherical tanks should reach a higher pressure than is desired (say, over 80 psig), then this pressure can be bled through a special line to the bottom of the absorber. Also, equilization lines connect all of the storage tanks. Therefore, vinyl chloride should never have to be vented from this area.

22. HCl Distribution: The HCl which passes through the absorber pressure control valve can be handled in several ways. Some of it will be passed through two activated carbon filters, which will remove the remaining organics from the HCl gas. These 4' I.D. by 12' tangent-to tangent vessels are piped such that they can be operated in series or parallel. Hot nitrogen can be used to regenerate these filters. The pure HCl effluent stream then passes through a pressure control valve. This valve controls the pressure on the downstream side, which is the suction line for No. 3 HCl compressor. The discharge from this compressor combines with that of No. 5 HCl compressor to supply an outside customer.

The HCl which does not pass through the carbon filters goes to the suction of No. 1 and No. 2 HCl compressors. These compressors also draw from the wet HCl system. They will be used to supply HCl gas to the Ethyl Chloride Plant and the Oxyhydrochlorination (OHC) Plant. The suction line to these compressors from the Vinyl Chloride Plant will have a manual loaded valve on it. This valve will be set manually in the field so that no HCl gas flows to the HCl scrubber.

If the pressure in the HCl distribution line reaches a pre-set value, a backpressure control valve will open and let the gas flow to the HCl scrubber. As soon as a flow passes through this line a cell liquor pump in the caustic area will start and a flow control valve on the cell liquor line will open, allowing cell liquor to flow to the top of the scrubber. Water is also added to the scrubber; the rate is determined by the temperature of the neutralized solution flowing to the sewer from the bottom of the scrubber. The vent line is constructed from Haveg 41 and extends to the top of the tails tower structure in the HCl plant. The 4'0" I.D. by 16'0" tangent-to-tangent scrubber is constructed of Haveg 61.

The by-pass valve on the inlet water temperature control valve will remain slightly open to keep a small water flow going into the scrubber at all times. This should prevent corrosion on the steel water line. The HCl gas enters the scrubber through a loop which is 4 feet higher than the scrubber. This keeps liquid from getting into the steel distribution header. A small nitrogen purge will be kept on this loop as a further precaution.

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B. Auxiliary Equipment

1. Vent Headers: Most of the process relief valves are tied into a 36" header. which vents to two 6" stacks. One stack is mounted on the heavies still and the other is on the stripper. In addition, a 12" header is provided for vent streams from the eight day tanks in the vinyl storage area. This line has a vent stack also. Each header is continuously purged with nitrogen to maintain an inert atmosphere. Liquid which collects in the 36" header can be drained to several pump suction lines within the plant.

2. Rework Lines: During start-up operations or in the case of plant upsets, off-spec. material will likely be produced. If this material reaches the plant storage area it will have to be reworked. A rework line has been provided so that this material can be returned to practically any vessel within the plant. A double-block-and-bleed-valve arrangement has been installed wherever this line connects to a process vessel or line to prevent possible contamination.

3. York Centrifugal Refrigeration System: There are seven exchangers in the Vinyl Chloride Plant which require refrigeration. A F-12 York centrifugal compressor will supply the refrigerant at the following temperature levels:

Temperature (°F)	Tons of Refrigeration
-40	160
-3	158
+34	307
	625

The 625 ton unit is driven by a 1250 HP motor, which is sized for 2300 V. operation. An identical compressor and motor will be installed parallel to the existing one at a later date.

Pertinent operating details of the refrigeration system are given below:

Compressor

Suction Inlet	
Size connection, inches	10
Pressure, PSIA	8.8
Temperature, °F	-40
Side Connection #1	
Size connection, inches	2-4's
Pressure, PSIA	21.9
Temperature, °F	-3

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Side Connection #2	
Size connection, inches	2-4's
Pressure, PSIA	45.9
Temperature, °F	+34
Side Connection #3 (Economizing Only)	
Size connection, inches	3
Pressure, PSIA	81.8
Temperature, °F	68

Condenser

Condensing Temperature, °F	108
Condensing Pressure, PSIA	147
Water Flow, GPM	2130

Following is a description of the refrigeration control system:

GENERAL

The refrigeration system consists essentially of two centrifugal compressors operating in parallel on a three stage cooling load. Refer to drawing 65A-6008 and York drawing 5-7403-1.

The compresser freon vapor leaving the compressor is liquified in two freon condensers and collected in a surge receiver, T-201. Freon vapor from the surge receiver is returned to the fourth stage suction of the compressors as a side load for economizing purposes.

Liquid freon from the surge receiver flows to the first load, which consists of three process chillers, primary quench condenser, upper intercooler and the +34° lean oil cooler, operating at +34°F. Freon vapor from these exchangers is returned thru a knockout drum, T-228, to the third stage of the compressors as a side load. Liquid freon drawn from the 34° exchangers flows to the second load consisting of the lower intercooler and the product still vent condenser, operating at -3°F. Freon vapor from these chillers is returned thru knockout drum T-227 to the second stage of the compressors as a side load.

Liquid freon drawn from the -3° exchangers flows to the third load consisting of the absorder condenser and the -40° lean oil cooler, operating at -40°F. Freon vapor from these exchangers flows to the first stage compressor suction thru knockout drum T-226.

PNEUMATIC CONTROL SYSTEM

SL 009856

A. General

Refer to drawing 65A-6008 and York drawings 5-7403-3 and 5-7403-4.

The pneumatic controls consist essentially of pressure and flow controls for each compressor suction load, motor load override (to prevent overloading the electric driver) and balancing controls for the compressor side loads during parallel operation.

Hot gas by-passes are provided to return hot vapor from the Compressor discharge to each suction stage. These by-passes are utilized during start-up (when the refrigeration load is low) or during sustained periods of operation with low refrigeration requirements.

Valves are also provided to inject liquid freon into the hot gas by-pass streams to control compressor overheating while hot gas is being utilized for compressor load balancing.

During the following discussions control system components will be referred to by the process number appearing on the flow sheets, followed by the York designation in parenthesis, e.q., SOL-4145 (1-SOL).

B. First Stage Suction Controls (-40°F)

1. The -40°F refrigeration temperature achieved by establishing a pressure parameter for the freon vapor from coolers E-204 and E-210. The controller used to establish this pressure is PRC-4098(PRC) located on the control room panel. The controller output positions the prerotation vanes on the first wheel of the compressor to control the suction pressure.

Controller output also positions hot gas by-pass valve TCV-4101(BV-5) (pressure switch PS-4102 (PE-1) energizes liquid injection valve FCV-4120(LIV-1) when hot gas is flowing thru TCV-4101). Solenoid SOL-4160 (7-SOL) functions thru a reverse acting positioner to keep closed prior to startup.

Controller PRC-4098 is also provided with a manual loading station, MLS-4099, mounted on the field panel. The control set points on both the board mounted controller and the field manual loading station are automatically synchronized for "Bumpless" transfer of control location.

The #1 compressor cannot operate at less than 10% of the 625 ton design load capacity. The prerotational vanes enable the first wheel to operate down to 40% of design without hot gas by-passing. Hot gas is required from 40% of design load down to 10%. At that point, the unit must be shut down or surge will occur with likely damage to the compressor.

2. One Compressor Installed: With one compressor installed the output of controller PRC-4098(PRC) will position the prerotation vanes of #1 compressor (J-206) thru the current limiting relay CLR and solenoid valve SOL-4118. The current limiting relay, CLR, will modulate the controller output signal in response to the current drawn by the driver to prevent motor overload. Solenoid valve SOL-4118 (5-SOL) is energized during startup to allow the prerotation vanes to open while the driver is accelerating, subject to permissive action of CLR. This is especially important as the motor current acceleration time curve

has been adjusted (electrically) to be compatible with the compressor torque load-acceleration time curve.

3. Two Compressors Installed: With two Compressors installed, the output of controller PRC-4098 (PRC) will determine the set point of a flow controller in each first stage suction line. With identical flow parameters established for each first stage suction line, the individual flow controllers position the prerotation vanes thru the current limiting relays CLR and solenoid valves to maintain the flow parameter. The current limiting relays and solenoid valves operate as described under B.2 above.

C. Second and Third Stage Suction Controls

1. General: The second and third stage suction controls are basically identical. Only the second stage controls are described.

The second stage (-3°F) refrigeration load is determined by establishing a pressure parameter for the freon vapor from coolers E-205 and E-212. The pressure controller, PIC-4107 (PC-), maintains the pressure parameter by positioning a control valve PCV-4103 (BV-1).

During operation a minimum flow parameter is established with flow controller FIC-4142(FC-1). The 2nd and 3rd stage wheels cannot operate below 70% of design freon flow thru each individual wheel. Flows below 70% will result in compressor "surge" with likely damage to the compressor, therefore, automatic hot gas by-pass control is necessary. The flow controller FIC-4142 positions hot gas bypass valve FCV-4143(V-6) to maintain a minimum freon flow, and pressure switch PS-4144 (PE-2) energizes liquid injection valve SOL-4146 (LIV-2) when required.

2. One Compressor Installed: With one compressor installed the set point for PIC-4107 will be manually adjusted and the pressure control system will function as described in C.1 above. The output of the flow transmitter FT-4505 will be sensed by FIC-4142 (FC-1) thru SOL-4145(I-SOL) and the low selector relay SR-4700, (whose second input will be a dummy 20 PSI load). Flow controller FIC-4142 (FC-1) will then function as described in C.1 above.

3. Two Compressors Installed: With two compressors installed, the second compressor will function as the master unit and #1 compressor (J-206) will function as the slave unit.

The pressure control loop for the second compressor will function as outlined under C.2 above. The output of the flow transmitters in the second stage suction lines will serve two purposes.

In the first case, the output of the flow transmitters will each be connected thru a solenoid valve to the low selector relay SR-4700. The lower of the two signals (indicating the smaller of the two flows) will be sensed by FIC-4142 (FC-1) and the remainder of the flow control loop functions as described under C.1 above. The purpose of each solenoid valve is to apply a dummy 20 PSI signal to the low selector relay when the unit with which it is associated is not in operation.

In the second case, the output of the flow transmitters are utilized to balance the side loads. The side load flows are continuously compared thru the balancing control, BC-4708, and the set point of the slave unit (J-206) pressure controller, PIC-4113, is manipulated to balance the side load between the two compressors. The pressure control loop for the slave unit then functions as described under C.1 above.

D. Fourth Stage Suction Controls

The fourth stage suction controls are identical to the second and third stage suction controls with the single exception that an external liquid injection valve is not required since hot gas superheat is removed in the surge receiver.

ELECTRICAL CONTROL SYSTEM

A. General

Refer to drawings 65A-7632 and York drawing 5-7403-2. The electrical controls for each compressor are identical and with the exceptions noted below are all contained in a unit panel furnished by York.Specific exceptions are field mounted devices and switches SW-4603, 4605, 4607, 4609, 4611, 4613, 4615. These switches are mounted on the field refrigeration panel. Although a distinction has been made between the "York" panel and the "field refrigeration" panel, these panels are located side by side for convenience of operation.

B. Compressor Startup

1. Prior to attempting to start a compressor, the following steps should be taken:

a) Check to be sure that the Oil Cooler cooling water is shut off. Compressor oil heaters (electrical insert heaters in Compressor base) should be energized. Start auxiliary oil pump by turning switch to "manual" position and circulate oil until a temperature of 170°F is reached.

b) Using the 15 HP pumpout unit compressor, pump down the main Compressor to a pressure of at least 40 PSIG. This lower pressure allows PS-1 pressure switch to open to a permissive startup position for the main compressor protection circuit. Red light on control panel will stay on, however, until reset by pushing 1 PB "Reset" button.

2. Operate reset pushbutton 1PB, thus de-energizing the malfunction indicating lights 1LT to 8LT, and tripping relays 3R thru 9R and relay 12R.

With these relays de-energized, interlock contacts 3RI (24-25), 4RI (25-26), 5RI (26-27) 6RI (27-28), 7RI (28-29), 8RI (29-30), 9RI (30-6), and 12RI (7-31) are closed. With freon surge receiver level, motor bearing temperatures and suction pressure conditions normal, interlock contacts LS-4159 (6-6), TS-4501 (6A-7A), TS-4205 (7A-7), HP (31-32) and LP (32-33) are also closed. The auxiliary oil pump switch 2-SW is now put in the "automatic position."

3. When the compressor "on-off" switch 1-SW, is placed in the "on" position, then a closed circuit exists thru the interlock contacts described above to wire #33. The "ready" light (green), , 9LT, immediately energizes. Relay 2R energizes thru AOP (33-37), 2TR (37-38, times closed) and 2-SW. Contact 2R closes energizing the motor starter, 2M, for the auxiliary oil pump motor, 2MTR. The auxiliary oil pump starts contact 2R de-energizes the motor heaters, 1H and 3H.

When the differential pressure in the oil system (referred to sump pressure)reaches 30 PSI, pressure switch COP closes energizing relay 10R. Contact 10R (41-42) opens to prevent 3R1 from energizing 1TR thru contact 11R (34-36).

At the end of the 1TR timing interval (field adjusted), contact 1TR(33-9) closes energizing wire #9. When wire #9 energizes, SOL-4160 (7-SOL), SOL-4118 (5-SOL) timer 2TR, timer 3TR and relay 11R immediately energize.

When relay 11R energizes, contact 11R (9-34) closes sealing in the devices described above thru contact 10R(33-34). Contact 11R (34-36) opens de-energizing timer 1TR, resetting the timer contacts, 1TR ((-34) to the closed position. An 11R contact energizes the starter 1M for the compressor driver, and the main motor starts.

When timer 2TR energizes, all 2TR contacts transfer immediately (the auxiliary oil pump is momentarily de-energized during contact transfer but for all practical purposes continued to run). Instantaneous contact 2TR (37-38) is now closed and instantaneous contact 2TR (38-39) is now open. Timed contact 2TR (37-38) is now closed. Timed contact 2TR (37-41) is now closed.

When the differential pressure in the oil system (referred to sump pressure) reaches 40 PSI, pressure switch AOP operates opening contact AOP (33-37) and closing contact AOP (33-36). The auxiliary oil pump continues to run thru contact 1TR (33-37). When contact AOP (33-36) closes timer,1TR reenergizes and begins to time. At the end of the timing interval,contact 1TR (9-33) closes and contact 1TR (33-37) de-energizing 2R and the auxiliary Oil Pump motor. As long as the differential in the oil system remains above 40 PSI, AOP remains operated, 1TR remains energized and the auxiliary oil pump remains off.

4. When wire #9 was energized, 3TR began to time. After a time delay of 30 seconds, to allow oil pressure to develop in the gear increaser, contact 3TR (12-45) closes. If the oil pressure in the gear increaser is 20 PSI or higher, contact GLOP is open and 8R1 does not energize.

5. When wire #9 was energized, solenoid SOL-4160 (7-SOL) and SOL-4118 (5-SOL) energized admitting controlled air from PRC-4098 (PRC) to TCV-4101(BC-5), PS-4102 (PE-1) and the prerotation vane of the compressor (see section II).

6. With the compressor operational,the operator closes switches SW-4603 thru SW-4615, then closes switches 3-SW, 4-SW and 5-SW, in that order. These switches energize the dump solenoids which have held the cooler level controls and suction pressure controls inoperative. They also energize the dummy leading solenoids which have held the suction flow controls, liquid injection valves and hot gas bypasses inoperative.

7. The cooling water to the main compressor oil cooler is then opened up.

C. Shutdowns

1. General: Circuitry is provided to shutdown as individual unit under the following conditions:

a) Low oil pressure (shutdown @ 27 PSI differ.)

b) High oil temperature (shutdown @ 185°F.)

c) High discharge temperature (shutdown @ 250°F.)

d) Low suction pressure (shutdown @ 15" Hg.)

e) High discharge pressure (shutdown @ 157 PSIG.)

f) Gear increaser low lube oil pressure (shutdown @ 15 PSIG.)

g) Gear increaser high oil temperature (shutdown @ 165°F.)

h) High suction pressure (shutdown @ 147 PSIG.)

i) High motor bearing temperature (shutdown @ ______ °F.)

In addition, circuitry is provided to shutdown both units in the event of freon receiver high level. Indicating lights are provided on the unit panels for shutdown conditions "a" thru "h" alarms are provided on the control room panel for shutdown conditions b(A-______), c(A- ______), g(A-______), i(A-______) and high freon receiver level (A-______).

2. Operations of Shutdown conditions

a) Shutdown Condition A: If the compressor oil pressure falls below 35 PSI differential, then switch AOP (33-36) opens , de-energizing timer 1TR. Relay 2R energizes and starts the auxiliary oil pump. If the compressor oil pressure then drops below 27 PSI differential, switch COP opens, de-energizing relay 10R. When 10R ~~de~~-energizes, contact 10R(41-42) closes, energizing latch coil 3R1. When 3R ~~latches~~, contact 3R1 (XX1-47) closes , energizing indicating light 1LT.

When 10R de-energized contact 10R (33-34) opens, de-energizing wire #9. Relay 11R de-energizes to stop the main motor. Relay 2R de-energizes closing instantaneous contact 2TR(38-39). Contact 2TR(XXI-39) remains closed (times open) energizing relay 2R and starting the auxiliary oil pump. Instantaneous contact 2TR(37-38) opens and timed contact 2TR (37-38) remains open to prevent wire #33 from energizing. At the end of the time delay 2TR (SS1-39) times open de-energizing 2R and stopping the auxiliary oil pump.

Contact 3R1 (24-25) is now open and the motor cannot be restarted until 1PB is operated, resetting the alarm relays.

B. Shutdown Conditions B thru H

The operation of each of these shutdowns is identical, hence only shutdown condition "b" is described.

In the event of high oil temperature (185°F), contact HOT (XX1-10) closes energizing latch coil 4R1. Contact 4R1(XX1-48) closes energizing indicating light, 2LT. Contact 4R1 (25-26) opens to de-energize wire #33. When wire #33 de-energizes, relay, 11R de-energizes to stop the motor. Timer 2TR de-energizes and starts the auxiliary oil pump as described under C.2a, paragraph 2.

C. High Motor Bearing Temperature Shutdown

If a motor bearing temperature exceeds the set point of temperature switch TS-4501 (fan end) or TS-4205 (shaft end), either contact TS-4501 (6A-7A) or contact TS-4205 (7A-7) opens, de-energizing wire #33 and relay 11R. thereby stopping the motor. When oil pressure drops below 35 PSI differential, AOP operates and starts the auxiliary oil pump as described under C.2a, paragraph 2.

D. High Freon Receiver Level

The operation of the high freon receiver level shutdown is identical to the high motor bearing temperature shutdown, except that both units are shutdown.

<u>SEQUENCE OF OPERATION</u>

A. One Compressor Only

1. <u>Normal Startup</u>:

a) Auxiliary oil pump switch should be in "auto" position.

b) Startup-normal switches should be in "normal" position.

c) All safety shutdown relays should be in normal position. (Relays are 3R1 thru 9R1, 12R1 and 13R.) HLSD and two

BTD safeties will be closed.

d) When compressor "on-off" switch is turned to "on" position control power will be supplied to relay 2R, which will start the auxiliary oil pump. Oil pressure will close COP, which energizes relay 10R. Normally open 10R contact closes to energize timer 1TR. Two minutes later 1TR contact closes to energize Relay 11R which energizes the compressor motor starter to start the compressor. Timer 3TR is also energized. At the end of 30 seconds 3TR contact closes. If gear oil pressure has not been established, GLOP will remain closed to energize relay 8R1, which will open the circuit to 11R and, thus, stop the compressor.

e) When 11R is energized, prerotation vane air dump solenoid 5SOL is energized which permits the pneumatic controller to open the vanes.

f) Solenoid valves 1SOL, 2SOL, 3SOL, 4SOL, 6SOL and 8SOL are energized which opens compressor side connection butterfly valves and permits flow controllers to open hot gas bypass valves, if necessary.

g) Solenoid Valve 7SOL is energized to permit opening of low stage hot gas bypass, if required.

h) Normally open,11R contact also permits energizing liquid injection valve, LIV-1, LIV-2, and LIV-3 are energized respectively by closing of pressure switches PE-1, PE-2 and PE-3 (See York Dwg. 5-7303-4).

i) After the compressor is close to design speed (which occurs a few seconds after startup) auxiliary oil switch AOP transfers contacts. Two minutes after relay 1TR is energized, 1TR contact opens to de-energize relay 2R and stop the auxiliary oil pump.

j) Off delay contacts on 2TR timer will operate auxiliary oil pump for two minutes after 2TR is de-energized. This occurs on <u>any</u> shutdown, except on an electric power failure.

B. Identification Of Symbols

Temperature Level	-40 d.F.	-3 d.F.	+34 d.F.	+65.4 d.F.
Line Number	A	B	C	D
Hot Gas Air Dump Value	7SOL	1SOL	2SOL	3SOL

Pressure Electric Switch	PE-1	PE-2	PE-3	*
Liquid Injection Valve	LIV-1	LIV-2	LIV-3	*
Hot Gas Bypass Valve	V-5	V-6	V-7	V-8
Suction Line Butterfly Air Dump Valve	-	4SOL	6SOL	8SOL
Suction Line Butterfly Valve	-	V-1	V-2	V-3

* PE Switch and LIV not required for Line D

C. Safety Controls

The following safety controls will, on malfunction, prevent startup or cause shutdown:

	DESCRIPTION	Symbol	Annunciator Light Provided on York Panel
1)	Compr. Discharge Pressure	HP	Yes
2)	Compr. Suction Pressure	LP	Yes
3)	Compr. Main Oil Pressure	COP	Yes
4)	Compr. High Disch. Temperature	HDT	Yes
5)	Compr. High Oil Temperature	HOT	Yes
*6)	Gear Low Oil Pressure	GLOP	Yes
7)	Gear High Oil Temperature	GHOT	Yes
8)	Compr. High Suction Pressure	PS-1	Yes
9)	Compr. Motor High Bearing Temp.	BTD	No
10)	High Level Shutdown	HLSD	No
11)	Motor Starter Control Power Relay	13R	No

* Timer 3TR permits startup without gear oil pressure. Oil pressure must be established 30 seconds after the starting sequence is initiated; otherwise a gear oil pressure failure will be indicated and the compressor cannot be operated.

Malfunction of Item one thru eight above will open circuit to stop compressor. At same time red annunciator light be energized. Light will stay on until "Reset Button" is pushed. If malfunction has been corrected, light will turn off and compressor can be restarted. If malfunction is still present, light will stay on when button is released and unit cannot be restarted.

Note light for <u>GLOP</u> and <u>COP</u> will stay off once reset button is pushed.

Alarm contacts have been provided on BTD's, HOT, HDT, GHOT for use by Pittsburgh Plate Glass Company. Six motor winding temp detector switches (RTD) have been provided in motor windings for use by Pittsburgh Plate Glass Company.

D. Compressor Sump Oil Heaters

The oil heater circuit is designed to be energized any time the compressor is stopped and the auxiliary oil pump is stopped.

Relay 11R is de-energized when the compressor is stopped. Normally closed 11R contact in heater circuit is then closed.

Relay 2R is de-energized when the auxiliary oil pump is stopped. Normally closed 2R contact in heater circuit is then closed.

When 11R and 2R are both de-energized, oil heaters will be energized (except heater 3H will be off if thermostat is satisfied).

E. Pump Out Compressor

Pump out compressor motor can be started with on-off switch provided by PPG. Two safety switches have been provided for compressor protection as follows:

1. High Pressure cutout. Open at 150 psig.

2. Low Pressure cutout. Open at 16 psig.

F. Parallel Operations (Reference: York Dwg. 5-7403-4 and 5-7403-3.)

Low stage suction pressure controller PRC senses suction pressure. As the suction pressure decreases below the set point, PRC pneumatic signal reduces which lowers the set point of controllers FC. FC controllers sense flow to low stage suction of respective compressors. FC adjusts position of compressor prerotation vanes. As required flow reduces, FC closes vanes to reduce compressor capacity. PRC also opens the hot gas bypass valve to maintain minimum flow to low stage suction.

Butterfly valves in side connection suction lines are controlled by pressure controllers to maintain design upstream pressure. Signal from flow transmitter of Master Compressor and Slave Compressor is received by balance controller BC to readjust pressure controller PC on slave compressor, which readjust butterfly valve to maintain flow equal to that on master compressor.

Flow transmitters send signals to selector relay SR. Lowest of two signals reaches flow controller FC which controls bypass valve to maintain minimum blow into compressor side connection.

3-way solenoid valves are required as shown on Dwg. 5-7403-4 to position butterfly valves and PRV operator to closed position on respective compressor on shutdown to prevent back spin.

Current limiting relays CLR are shown on each compressor. This relay senses motor current. When motor current reaches overload condition, CLR throttles PRV closed to reduce motor current preventing shutdown during overload condition.

Speed of response in control system should be adjusted. For example: slave compressor control system should be slower than master compressor to prevent hunting.

G. Special Startups

Some "hot" startup conditions may require that "startup-normal" switches for the -3, +34 and +65.4°F level be placed in the "start-up" position prior to starting.

When two compressors are operating, in parallel, startup of the second compressor, when the first compressor is operating, will always require that these three switches be placed in the "start-up" position PRIOR to startup.

Safety switch settings on the following page.

SL 009867

SAFETY SWITCH SETTINGS

MANUFACTURER	MFG. MODEL NO.	DESCRIPTION	SYMBOL	CIRCUIT OPEN	CIRCUIT CLOSE	
United Electric	J99A-272	Discharge pressure	HP	148	152	Alarm
				157	153	Cut Out
United Electric	J95-300	Suction pressure	LP	15 In. Hg.	13 In. Hg.	
United Electric	J99K-357	Compr. Main Oil Press.	COP	27 # diff.	30# diff.	
United Electric	J99K-357	Compr. Aux. Oil Press.	ACP	40 # diff.	35# diff.	
United Electric	C99A-108	Compr. Discharge Temp.	HDT	242°	250°	Cut Out
				232°	240°	Alarm
United Electric	C99A-102	Compr. Oil Temp.	HOT	179°	185°	Cut Out
				169°	173°	Alarm
United Electric	J96A	Gear Oil Pressure	GLOP	15 #	10 #	
United Electric		Gear Oil Temp.	GHOT	179	185	Cut Out
				169	175	Alarm
United Electric	J95-270	High Starting Pres. Switch	PS-1	40 #	44 #	

5-35

4. METHANE FUEL GAS SYSTEM

Methane is supplied to the process area at 90 PSIG, but a pressure control valve lowers this pressure to 30 PSIG. Individual pressure control valves maintain 2-5 PSIG pressure to each furnace's pilots. The outlet process temperature of each furnace controls the gas rate to its main burner gas header through a temperature control valve. Electrically-operated valves have been installed in the line to each pilot and burner; these valves are connected electrically to the shutdown system and can be closed immediately if furnace malfunctions warrant such action.

5. NITROGEN HEATER

The nitrogen heater is used to supply a hot nitrogen stream for regenerating a carbon filter which is no longer removing a sufficient amount of organics from the anhydrous HCl. Approximately 100,000 SCFH of 100 PSIG nitrogen will be heated to 350°F by 200 PSIG steam in this exchanger. Nitrogen passes through the shell side while steam is on the tube side; both sides are one-pass.

6. CONDENSATE SYSTEM:

The steam condensate from the VC plant will flow through the condensate collection header to the condensate collection tank. This tank is vented through a stack to the atmosphere. Cooling tower water may be injected into this stack to prevent excess venting of steam.

The condensate is pumped through a level control valve, controlled by the condensate collection tank level, to a header which returns condensate to the powerhouse for boiler feed.

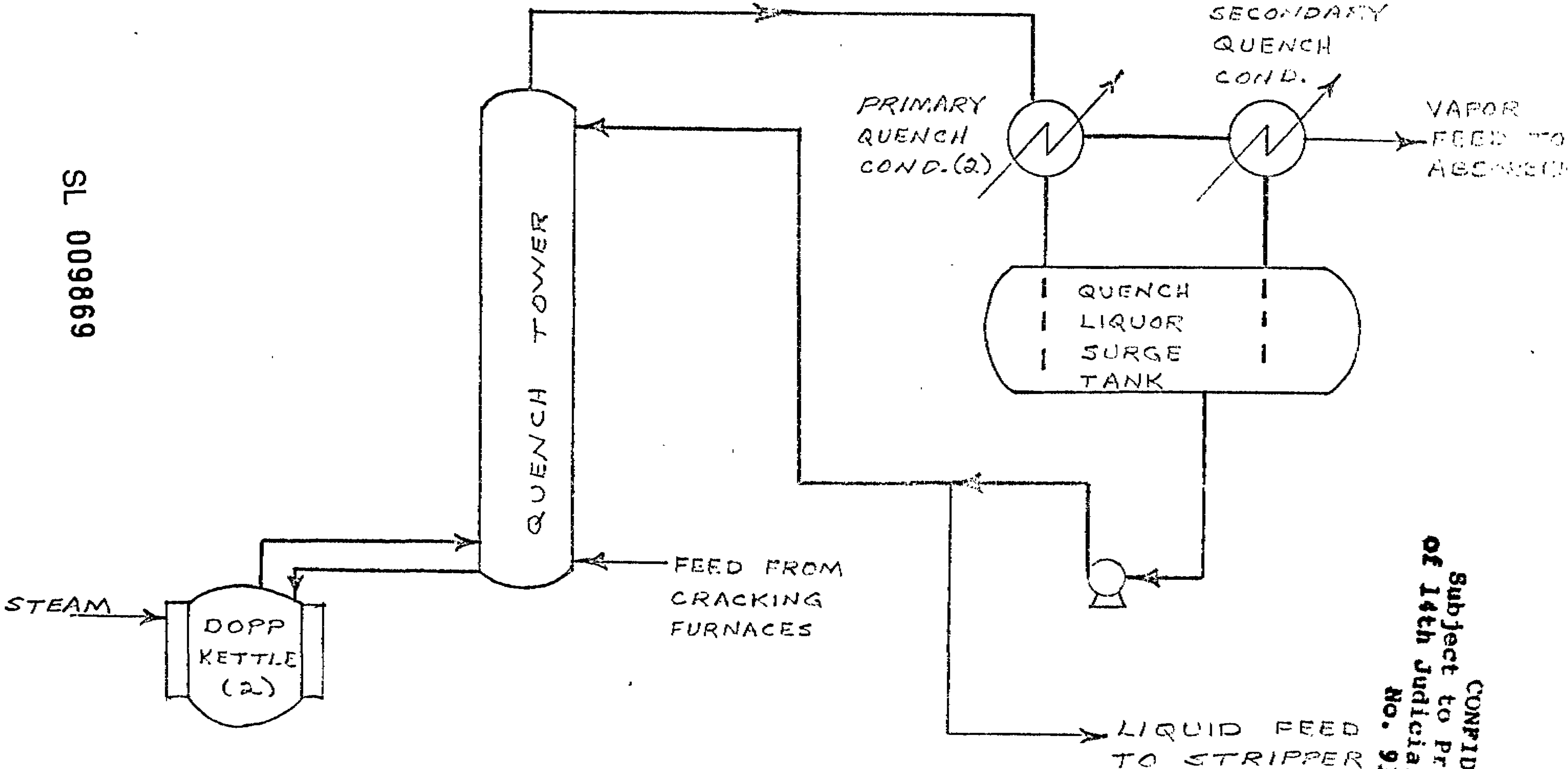


FIG. 5.1

FLYWHEEL NO. 1

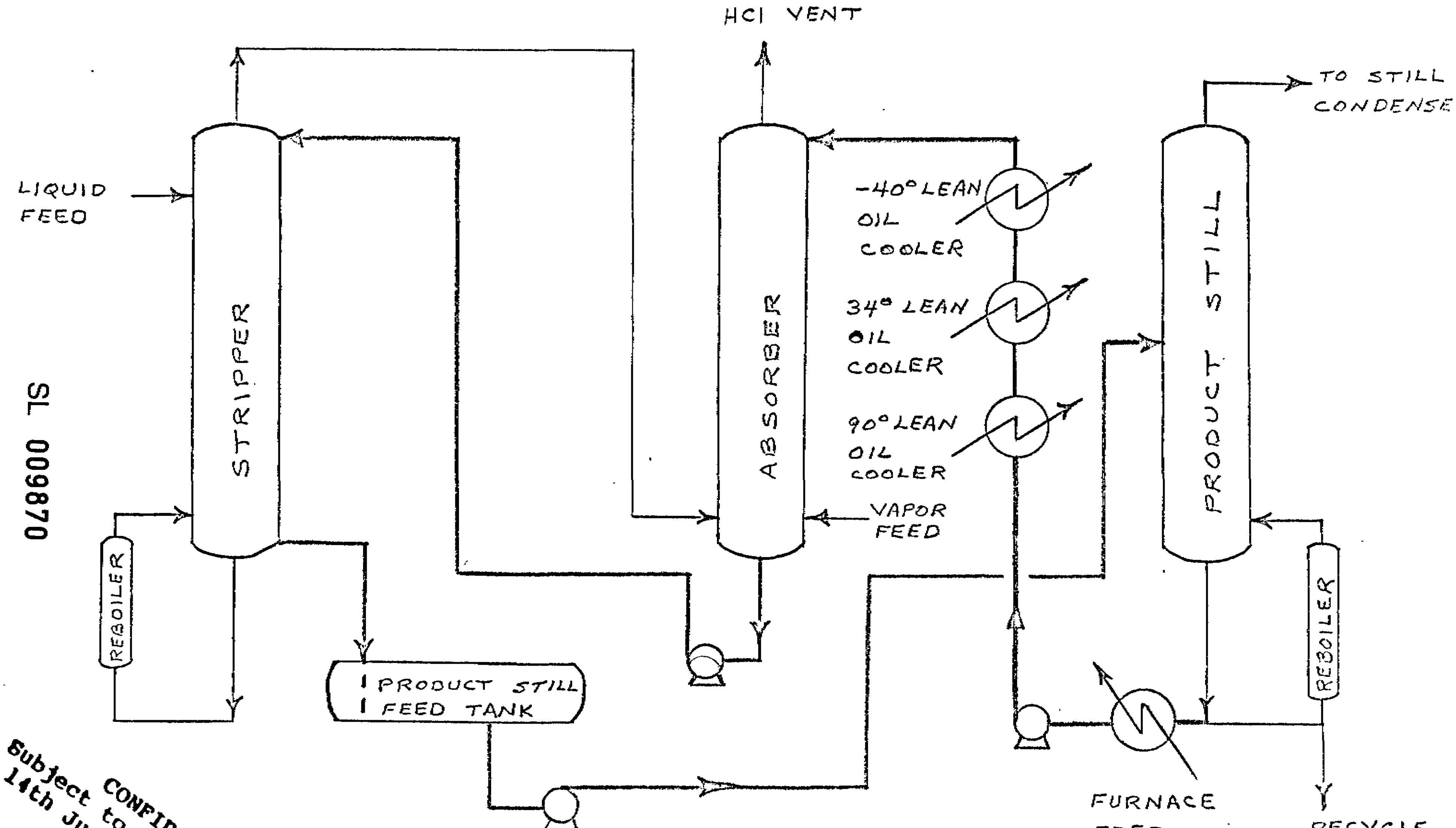
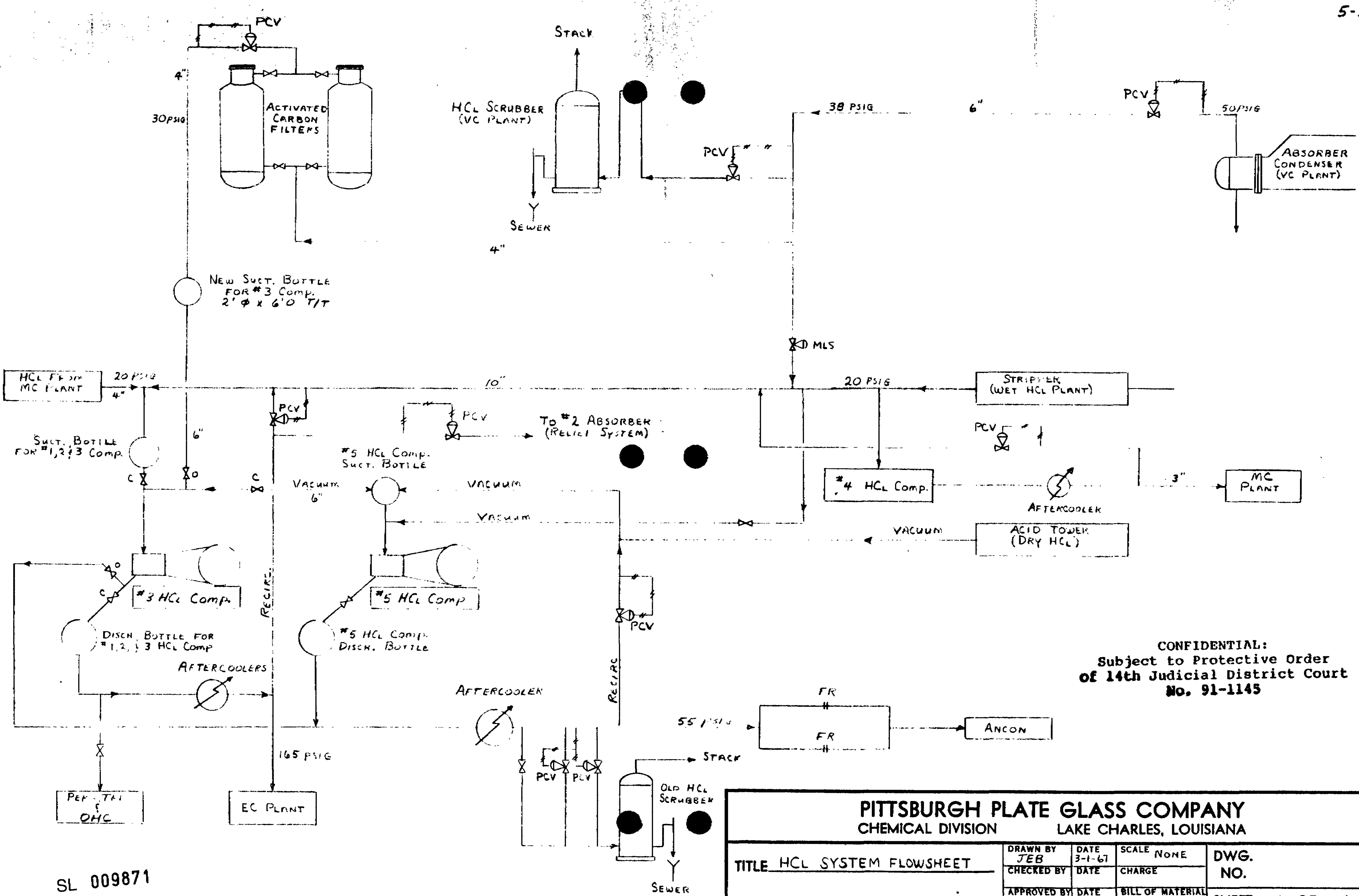


FIG. 5.2

FLYWHEEL NO. 2



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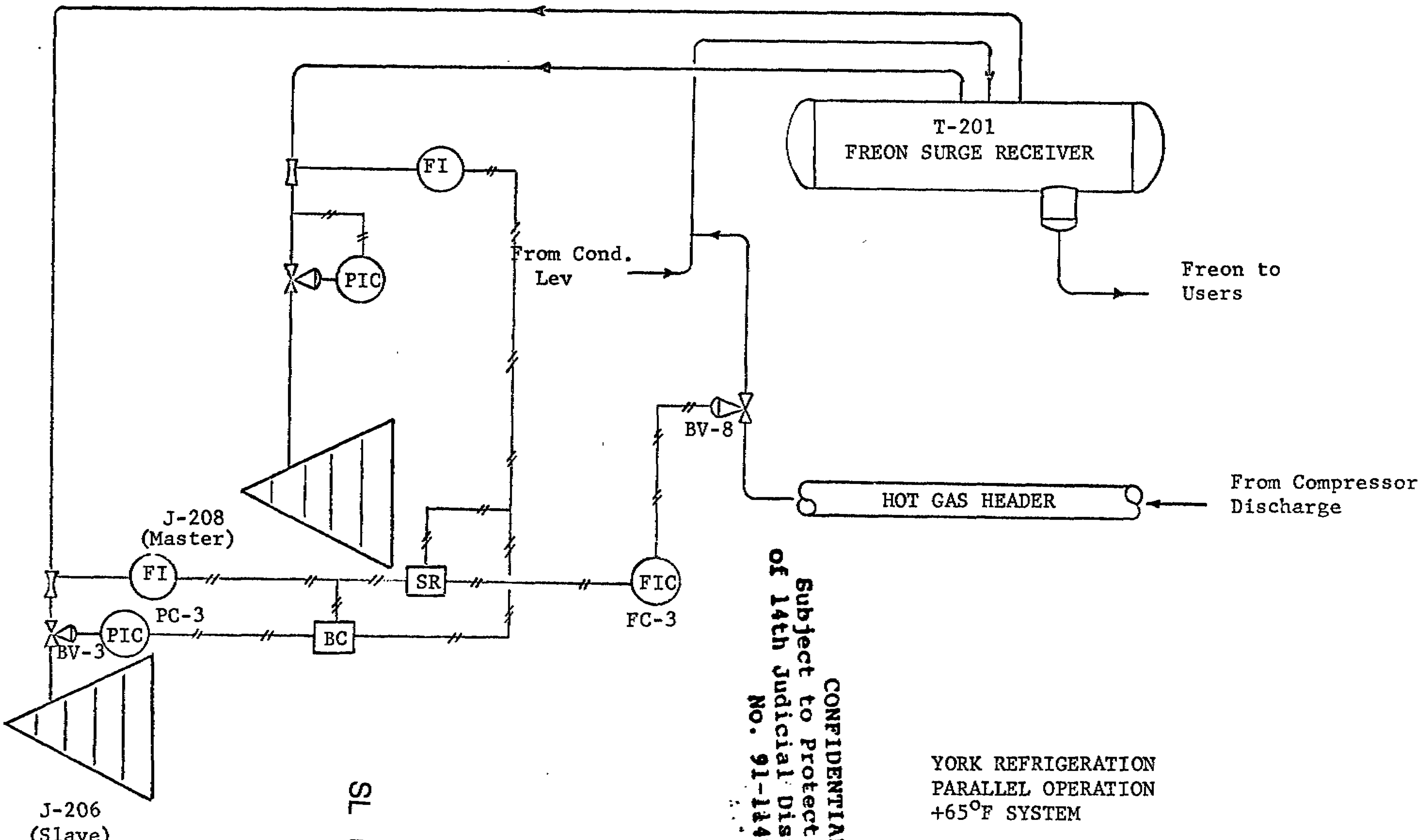
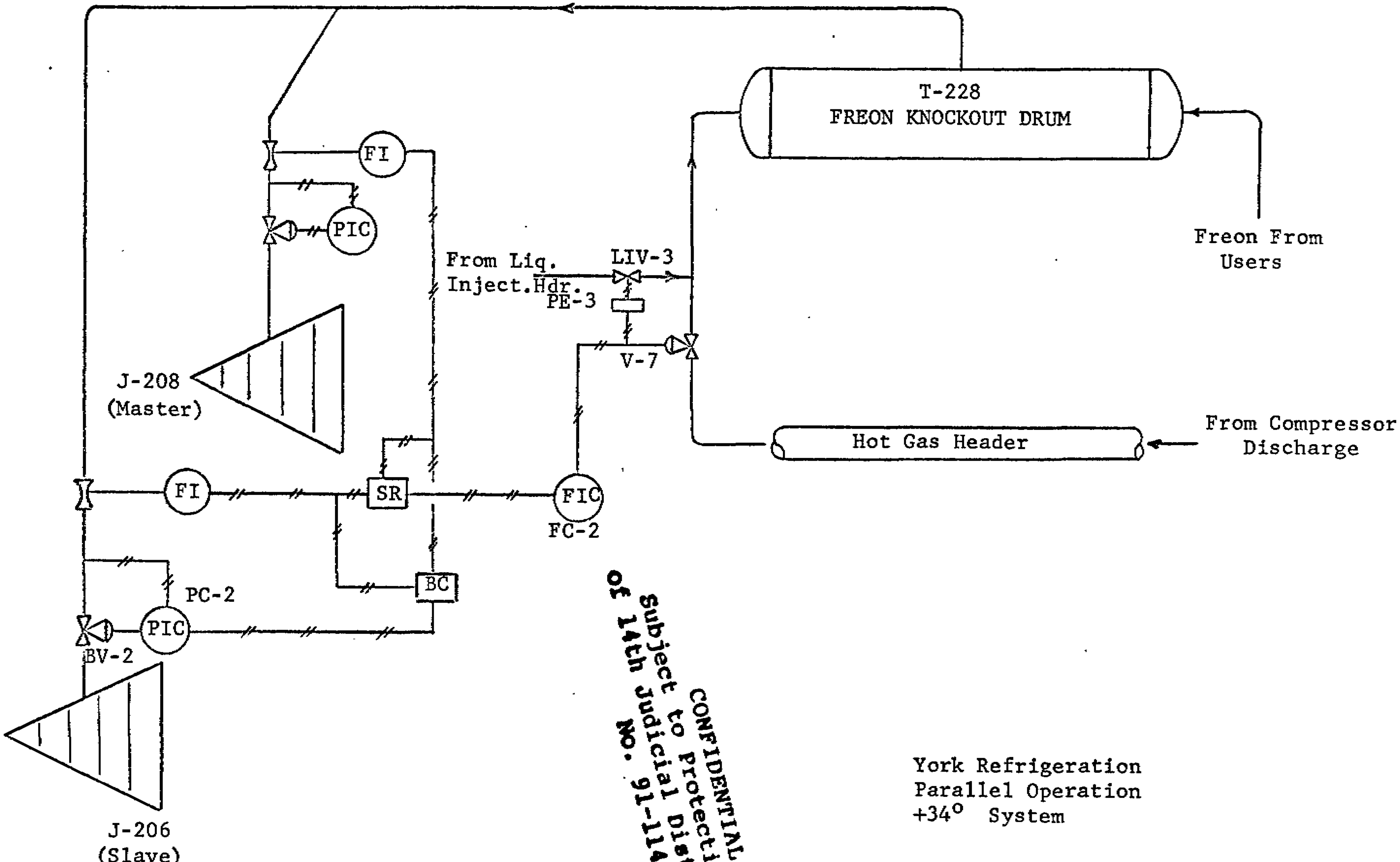
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION LAKE CHARLES, LOUISIANA

TITLE HCL SYSTEM FLOWSHEET	DRAWN BY JEB	DATE 3-1-67	SCALE NONE	DWG. NO.
	CHECKED BY	DATE	CHARGE	
	APPROVED BY	DATE	BILL OF MATERIAL	SHEET 1 OF 1

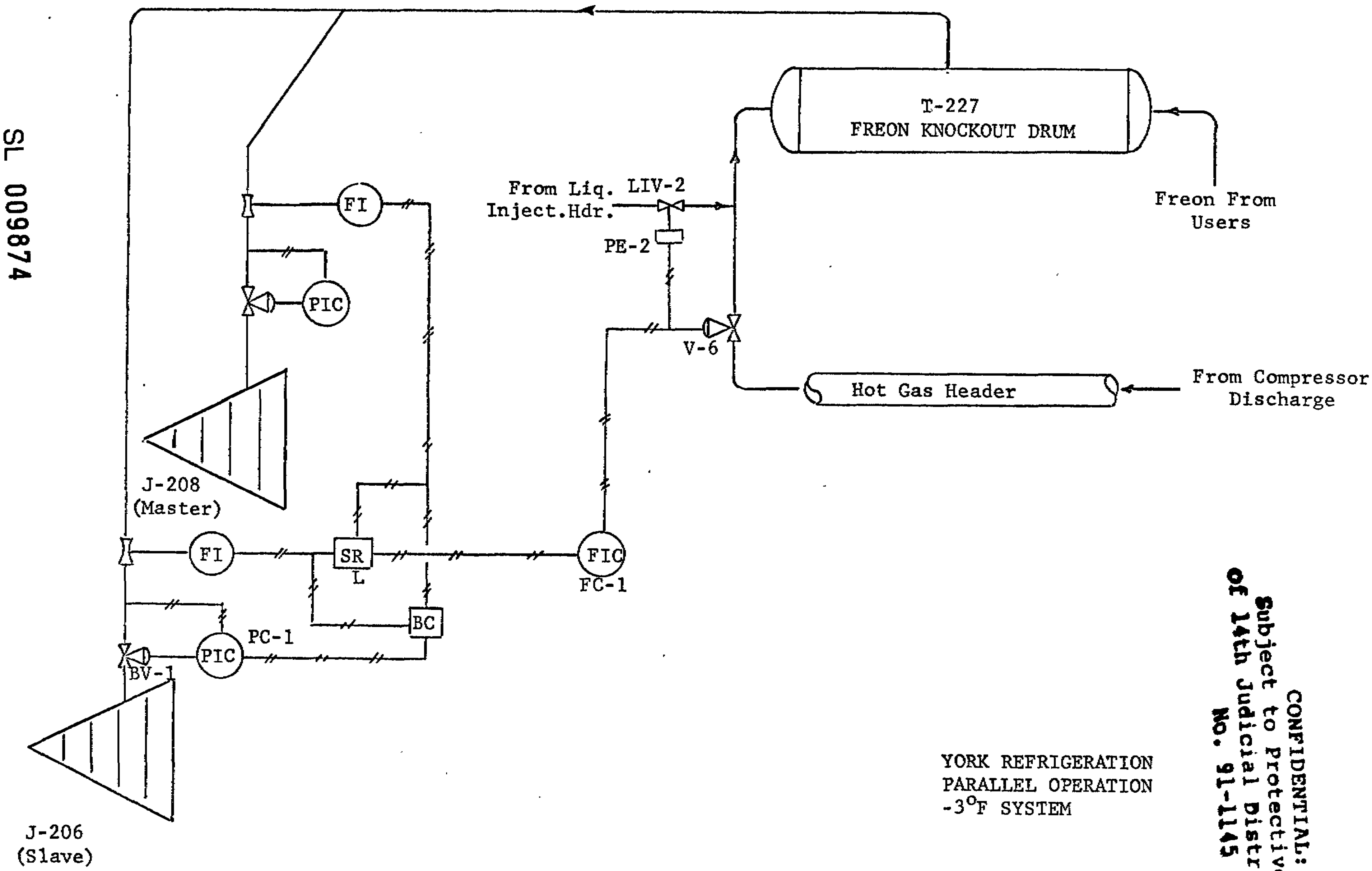
SL 009871



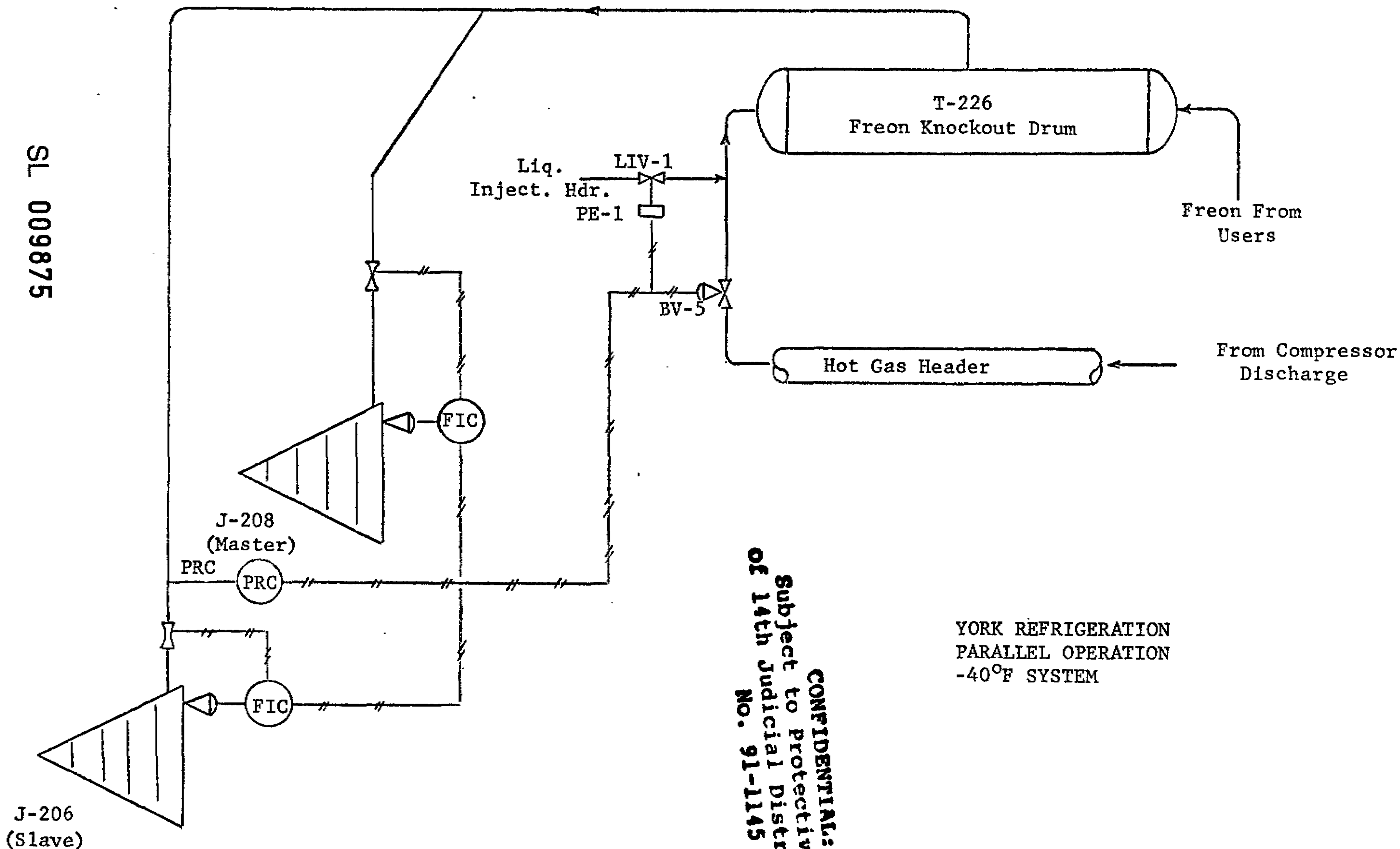
YORK REFRIGERATION
PARALLEL OPERATION
+65°F SYSTEM



York Refrigeration
Parallel Operation
+34° System

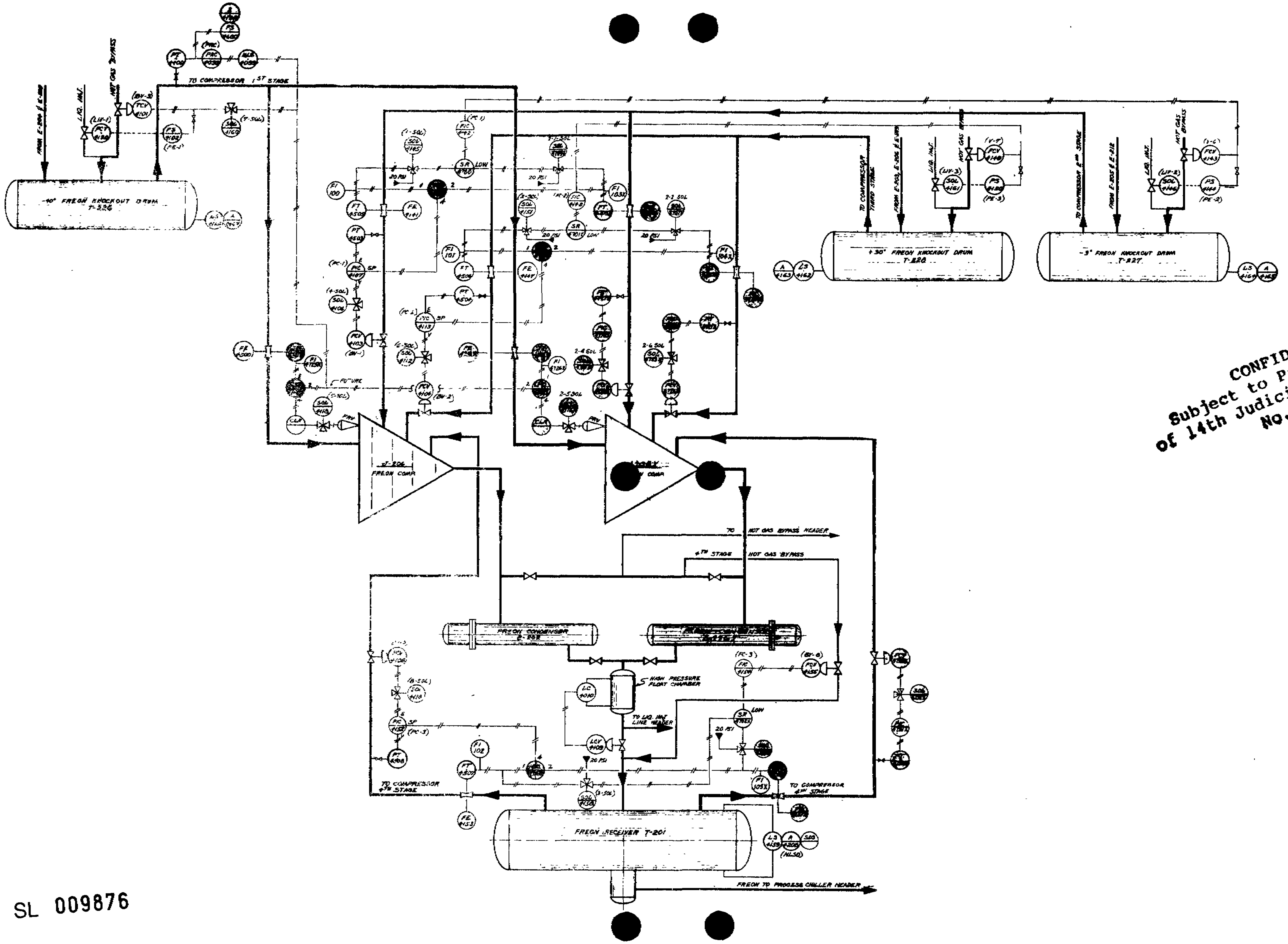


YORK REFRIGERATION
PARALLEL OPERATION
-3°F SYSTEM



YORK REFRIGERATION
PARALLEL OPERATION
-40°F SYSTEM

REVISIONS



GENERAL NOTES:

1. All instruments and equipment shown shaded on this Dwg. are for installation with future freon compressor.
2. Instrument identification numbers shown in parenthesis are York identification nos. See York Dwg. No. 5-7403-4.

REFERENCE DRAWINGS:

65A-1016	VC Plant - Mechanical flow sheets. Sheet 7
65A-1017	VC Plant - Mechanical Flow Sheets, Sheet 6
65A-7632	VC Plant - Elec. Instr. Refrigeration control system Elec Schematic

SL 009876

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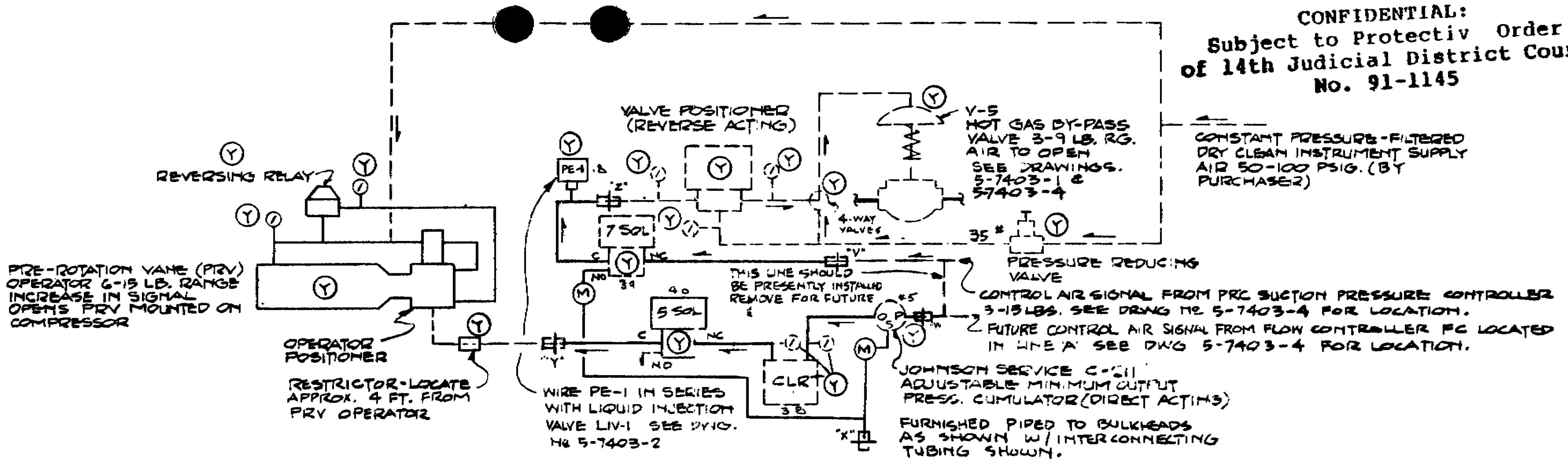
Construction Corporation
NEW YORK MONROE, LA.
APPROVED Fuw 5-31-66

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
V. C. PLANT——PNEU INSTRUMENTATION

REFRIGERATION CONTROL SYSTEM
PNEUMATIC SCHEMATIC

DRAWN BY N. BRUNSON DATE 5-24-66 SCALE NONE
CHECKED BY HB Cassay DATE 5-26-66 CHARGE C-741
APPROVED BY DATE 7-29-66 SUB
BILL OF MATERIAL DWG. NO. 65A-6008

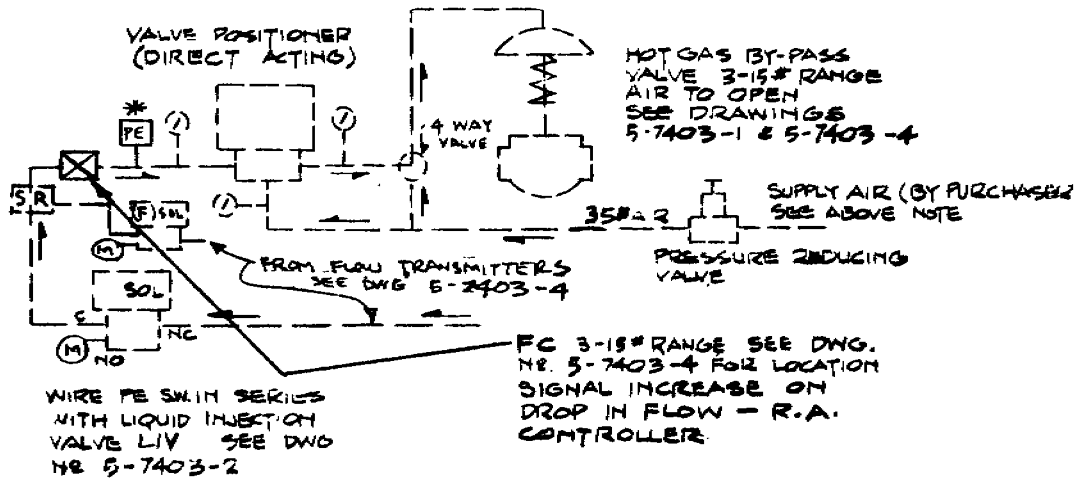


PNEUMATIC CONTROL PIPING

FOR PRE-ROTATION VANES & HOT GAS BYPASS TO SUCTION LINE A

NOTE:

1. HOT GAS VALVES CLOSE ON SHUT DOWN.
2. PE-1 MAKES CONTACTS ON DROP IN SIGNAL PRESSURE TO OPEN LIV-1.
3. PE-2, PE-3 & PE-4 MAKES CONTACTS ON RISE IN SIGNAL PRESSURE TO OPEN LIV-2, LIV-3, & LIV-4 RESPECTIVELY.
4. (Y) - DENOTES FURNISHED BY YORK
5. (M) - DENOTES 20# CONTROL AIR SUPPLY BY CUSTOMER
6. (F) DENOTES FUTURE ITEM.
7. SR - DENOTES SELECTOR RELAY



PNEUMATIC CONTROL PIPING

FOR HOT GAS BY-PASS TO SUCTION LINE B, C & D
SEE SCHEDULE AT RIGHT FOR NUMBERS OF ITEMS

ITEMS	LINE B	LINE C	LINE D
	ITEM NO	ITEM NO	ITEM NO
AIR DUMP SOLENOID VALVE	1 SOL	2 SOL	3 SOL
PRESSURE ELECTRIC SWITCH	PE-2	PE-3	*
LIQUID INJECTION VALVE	LIV-2	LIV-3	*
HOT GAS BYPASS VALVE	V-6	V-7	V-8
AIR DUMP SOLENOID VALVE BETWEEN FC & CONTROL VALVE	4 SOL	6 SOL	8 SOL
CONTROL VALVE	V-1	V-2	V-3

* PE SWITCH & LIV NOT REQ'D FOR LINE 'D'

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION - LAKE CHARLES, LOUISIANA
PROJECT NO. P-741 P. O. NO. 2H
EQUIPMENT NO. 65A-56-181
SERVICE Freon Compressor J206
DATE REC'D. 8/23/66 APPROVED

8/16/66 REV. D ONLY ONE FC ON LINES B, C & D

DATE	REVISIONS		BY
1-7-66	A		CLS
3-14-66	REV B CONFORMED FOR PRESENT UNIT (ONLY) ADDED (M) & (Y)	5/19/66 REV. C. ADDED NOTE 6 & * ALSO ADDED (F) SOL & SR ADDED 4 BULKHEADS & YORK PIPING	
DATE	DISTRIBUTION	DATE DISTRIBUTION	

PPG PROJECT CHARGE NO. P-741-41B
PPG EQUIPMENT NO. 65A-56-181 & 65A-50-1943
INQ. # 6-2-H
YORK ORDER NO. 65-780, 691F

CONTRACT 5-7403 CU. ORDER 7-H

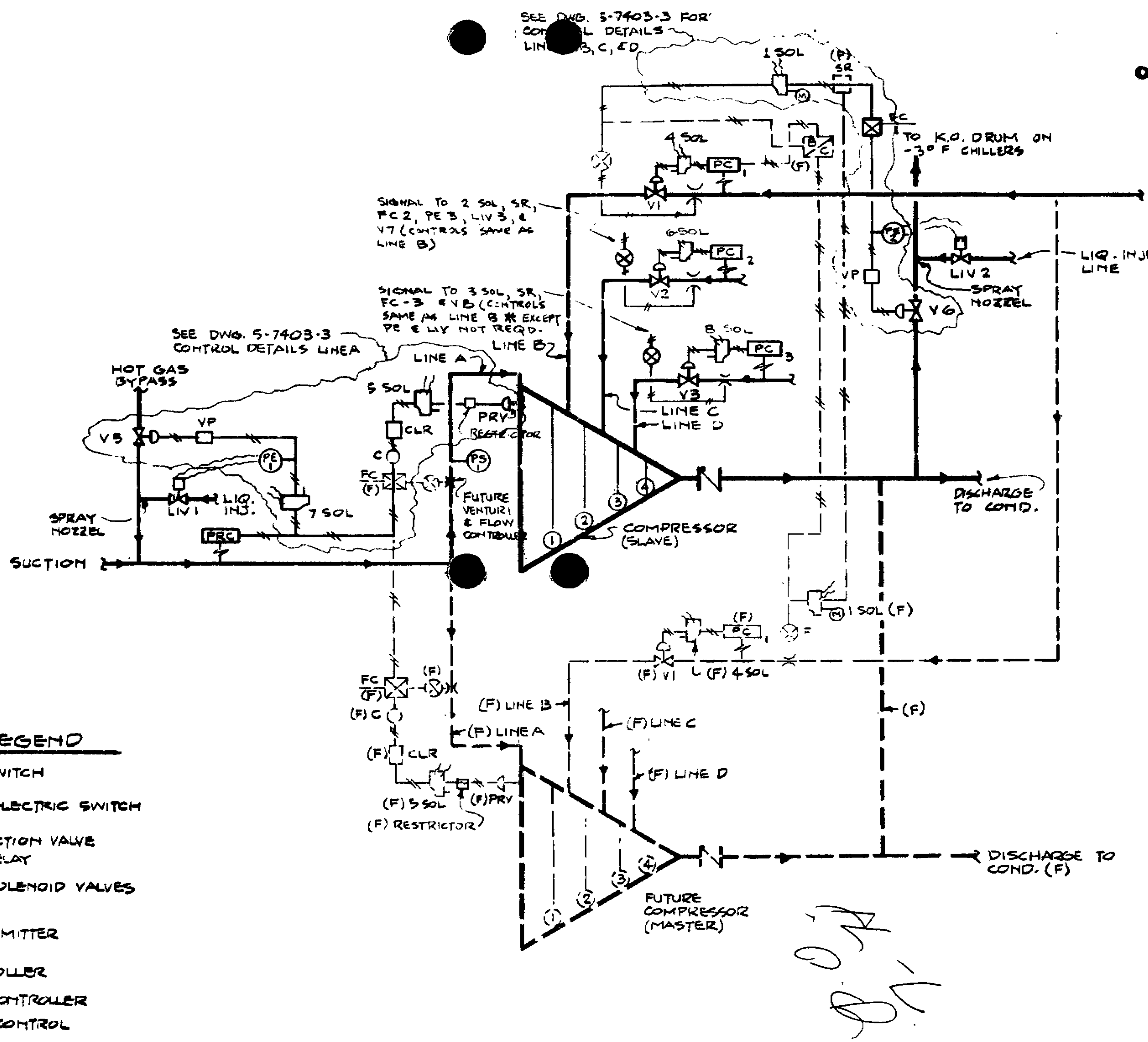
PITTSBURGH PLATE GLAS
CHEMICAL DIVISION
LAKE CHARLES, LA.

PNEUMATIC CONTROL PIPING SCHEMATIC

YORK CORPORATION
SUBSIDIARY F B RG-WARNER CORP.
YORK, PENN.

SOUTHWEST REGION, HOUSTON, TEXAS

DATE 12-6-65 SCALE NONE
DRAWN CLS CK. BY TAL
DRAWING NO. 5-7403-3



NOTE:

1. SEE DRAWING Nº. 5-7403-3 FOR PNEUMATIC DETAILS OF PRV & HOT GAS BYPASS CONTROL
2. CONTROLS FOR LINE C & D WHICH ARE NOT SHOWN TO BE SAME AS SHOWN FOR LINE B. *
3. SEE DRAWING Nº 5-7403-1 FOR CONTROL VALVE LOCATION & PIPING. THIS DWG. CONTROL SCHEMATIC ONLY.
4. SEE DWG. Nº 5-7403-2 FOR WIRING.
5. ALL DOTTED LINES & EQUIPMENT ARE FOR FUTURE. SOLID LINES REPRESENT EQUIPMENT FOR PRESENT INSTALATION.
6. SPRAY NOZZELS NECESSARY FOR LIQUID INJECTION.

* 7. (SEE 2 ABOVE) EXCEPT LINE "D" DOES NOT REQUIRE A PE SW. OR LIV.

SL 009878

SYMBOLS & LEGEND

- (PS) — PRESSURE SWITCH
- (PE) — PRESSURE ELECTRIC SWITCH
- — LIQUID INJECTION VALVE
- SR — SELECTOR RELAY
- O SOL — AIR DUMP SOLENOID VALVES
- — FLOW TRANSMITTER
- FC/O — FLOW CONTROLLER
- PC — PRESSURE CONTROLLER
- BC — BALANCING CONTROL
- VO — CONTROL VALVE
- PRV — PRE-ROTATION VANE MOTOR ON COMPRESSOR
- PRC — SUCTION CONTROLLER
- C O — MINIMUM OUTPUT CUMULATOR
- CLR — CURRENT LIMITING RELAY
- VP — VALVE POSITIONER
- (F) — DENOTES FUTURE

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION - LAKE CHARLES, LOUISIANA
PROJECT NO. P-741 P. O. NO. 7-H
EQUIPMENT NO. 6SA-56-181
SERVICE Freon Compressor J206
DATE RECD. 11-10-66 APPROVED T Sach

PPG PROJECT CHARGE Nº P-741-413
PPG. INQ. Nº 6-2-H
YORK ORDER Nº 65-780, 691F

CONTRACT 5-7403 CU. ORDER 7-H

PITTSBURGH PLATE GLASS
CHEMICAL DIVISION
LAKE CHARLES, LA.

CONTROL SCHEMATIC

10-24-6	CHANGED SIGNAL LOCATION TO V-1 V-2 V-3	Jett
DATE	REVISIONS	BY

A	REMOVED RATIO CONTROLLER	C	5/19/66 ADDED "SR"
B	RE-DRAWN 3-11-66		NOTE 7 - TIED DISCHARGES
	TO SHOW PRESENT &		TOGETHER
	FUTURE. ADDED SPRAY NOZZ	D	8/N/66 ONLY ONE FC ON LINES B,C, & D
DATE	DISTRIBUTION	DATE	DISTRIBUTION

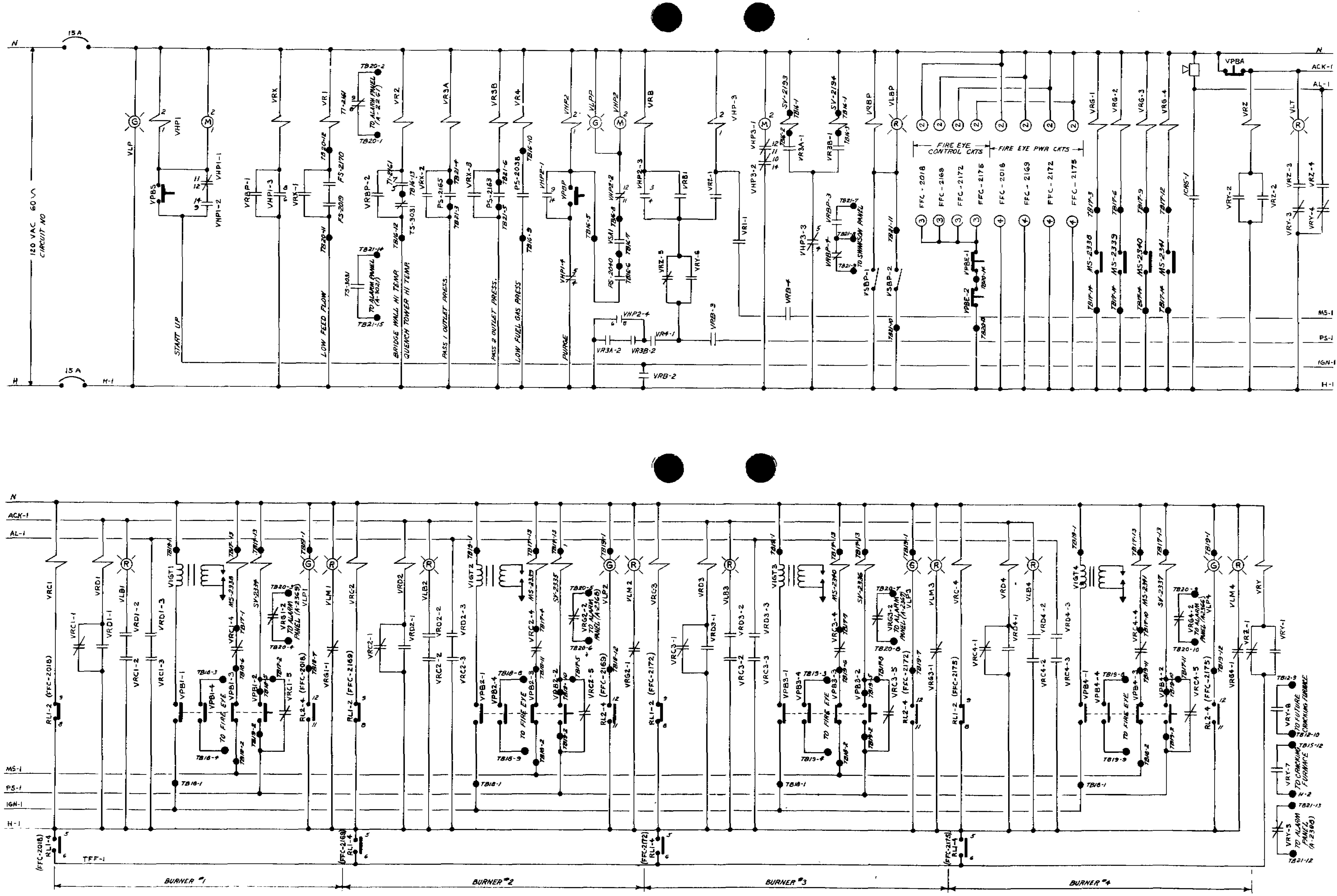
YORK CORPORATION
SUBSIDIARY OF BORG-WARNER CORP.
YORK, PENN.

SOUTHWEST REGION, HOUSTON, TEXAS

DATE 3-11-66 SCALE NONE
DRAWN CLS CK. BY TAL
DRAWING NO. 5-7403-4

REVISIONS

Fig. 5.11



GENERAL NOTES:

1. All Relay Contacts shown with coil deenergized.
2. For device identification see Drawing No.65A- 628.
3. Maxon safety valve limit switches are shown with valve in tripped position.

REFERENCE DRAWINGS:

65A-5[illegible]4	VC Equipment-Flame Control System Panel, Sheet 1 of 2
65A-5205	VC Equipment-Flame Control System Panel, Sheet 2 of 2
65A-76[illegible]8	VC Electrical Instr. Vaporizing Furnace Wiring Diagram, Sheet 1 of 2.
65A-76[illegible]9	VC Electrical Instr Vaporizing Furnace Wiring Diagram, Sheet 2 of 2.

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

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NEW YORK MONROE, LA.

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE ELECTRICAL INSTRUMENTATION
EDC VAPORIZING FURNACE
FLAME CONTROL SYSTEM
SCHEMATIC

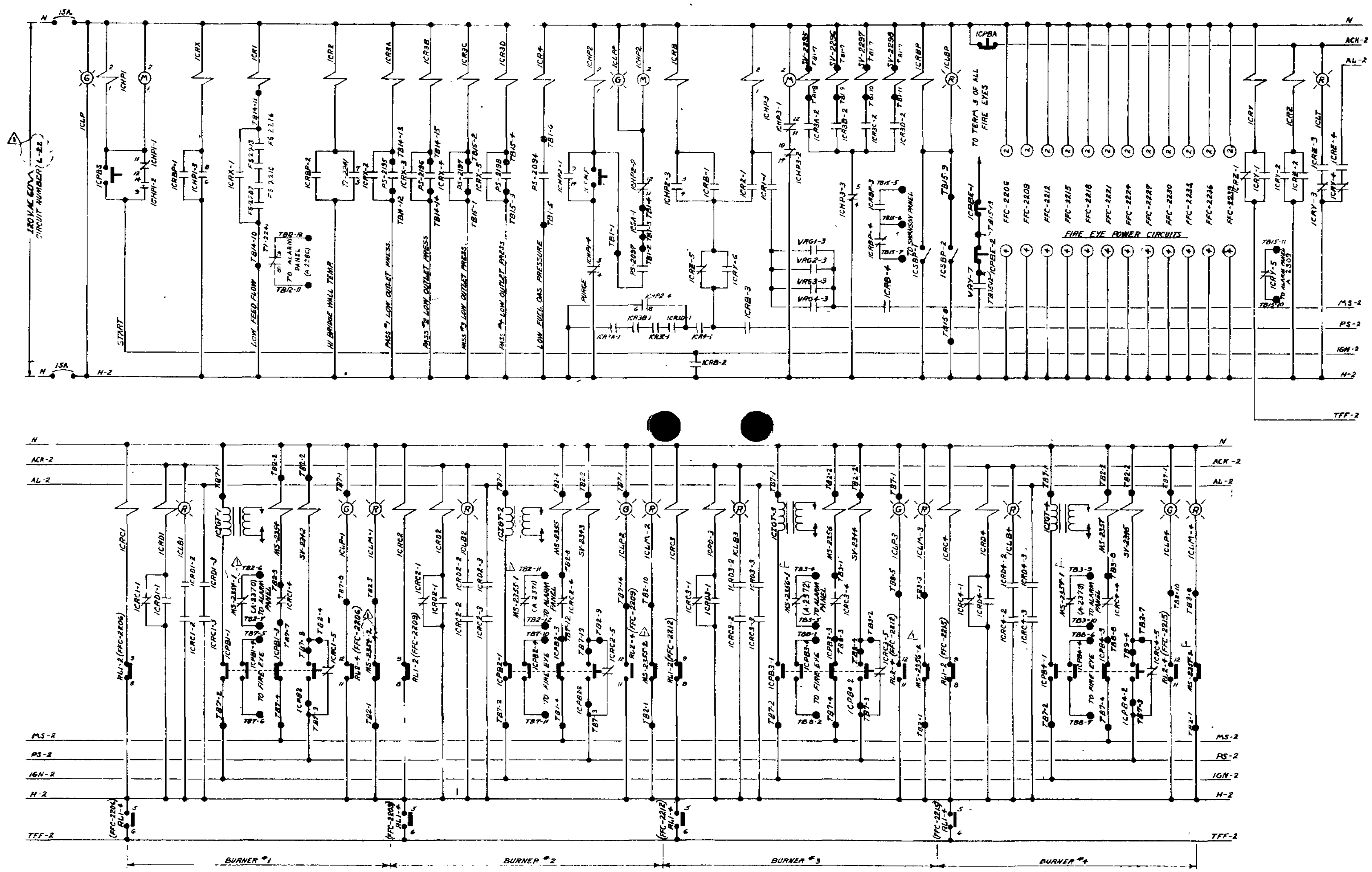
DRAWN BY J.CANTERBURY DATE 2-28-66 SCALE NONE
CHECKED BY H.A.Curry DATE 3-15-66 CHARGE [illegible]
APPROVED BY [illegible] DATE 2-29-66 SUB
BILL OF MATERIAL NONE DWG. NO.65A-7625

SL 009879

REVISIONS

Page 5-48

Fig. 5.12



GENERAL NOTES:

1. All Relay Contacts shown with coil deenergized.
2. For device identification see Drawing No. 65A-76__.
3. Maxon safety valve limit switches are shown with valve in tripped position.

REFERENCE DRAWINGS:

65A-5204 VC Equipment-Flame Control System Panel, Sheet 1 of 2
65A-5205 VC Equipment-Flame Control System Panel, Sheet 2 of 2
65A-7620 VC Electrical Instr.-Cracking Furnace Wiring Diagram, Sheet 1 of 2
65A-7621 VC Electrical Instr.-Cracking Furnace Wiring Diagram, Sheet 2 of 2.

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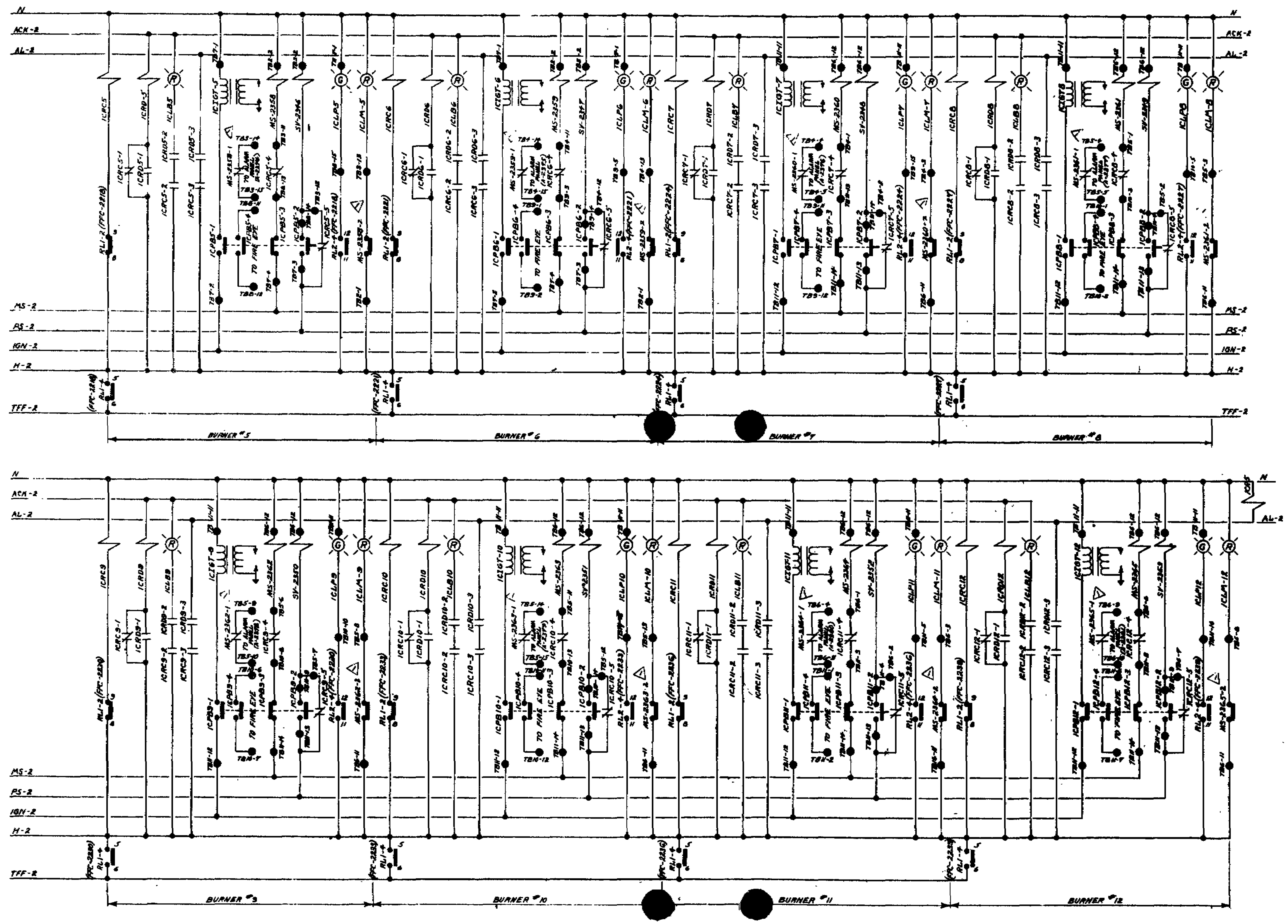
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

V C PLANT — ELECTRICAL INSTRUMENTATION
EDC CRACKING FURNACE
FLAME CONTROL SYSTEM
SCHEMATIC-SHEET 1 OF 2

DRAWN BY N. BRUNSON DATE 3/2/66 SCALE NONE
CHECKED BY H.G. Guy DATE CHARGE P741
APPROVED BY DATE 7-29-66
BILL OF MATERIAL None DWG. NO. 65A-7626.1



REVISIONS

INTERCHANGED CONT'S 1&2 ON ... VALVES TO AGREE WITH FIELD WIRING.

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Page 5-59
Fig. 5.13

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NOTE:

For General Notes and Reference Drawings, see Dwg. 65A-7626.

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CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

V C PLANT — ELECTRICAL INSTRUMENTATION
EDC CRACKING FURNACE
FLAME CONTROL SYSTEM
SCHEMATIC – SHEET 2 OF 2

DRAWN BY H. BRUNSON DATE 5/3/66 SCALE NONE
CHECKED BY DATE 5-15-66 CHARGE P-761
APPROVED BY DATE 7-29-66
BILL OF MATERIAL None DWG. NO. 65A-7627, 1

SL 009881

ALARM POINT SCHEDULE

ALARM UNIT					PRIMARY DEVICE								SEQUENT ALARM	SEQUENT GROUP	ALARM SET POINT
ALARM PANEL OR RELAY CHASSIS №	POINT №	RELAY №	DWG. №	NAME PLATE ENGRAVING	PRIMARY DEVICE	PRIMARY DEVICE №	LOCATION	FUNCTION	DWG. NO.	MARK NO	CODE	PROCESS NO.			
1	110	B1	65A-5031	NITROGEN TO VC PLANT	PRESSURE SWITCH		PANEL	LPA		PS-8040	D	A-8019			
1	110	C1		AIR TO VC PLANT	PRESSURE SWITCH		PANEL	LPA		PS-8041	D	A-8013			
1	13	A1	"	EDC VAPOR FURN PASS #1 FEED FLOW	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-2005	C	A-2006	YES	1	
1	13	B1	"	EDC VAPOR FURN PASS #2 FEED FLOW	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-2152	C	A-2153	YES	1	
1	13	C1		EDC VAPOR FURN. BRIDGE WALL TEMP	TEMPERATURE INDICATOR		FIELD	HTA		TI-2161	B	A-2261	YES	1	
1	110	D1	"	NATURAL GAS TO VC. FURNACES	PRESSURE SWITCH		PANEL	HLPA		PS-2000	A	A-2053			
1	13	D1	"	EDC VAPOR. FURN. PASS #1 OUT PRESS	PRESSURE SWITCH		PANEL	LPA		PS-2165	D	A-2166	YES	1	
1	14	A1	"	EDC VAPOR. FURN. PASS #2 OUT. PRESS	PRESSURE SWITCH		PANEL	LPA		PS-2163	D	A-2164	YES	1	
1	15	C1	"	EDC VAPOR. FURN. OUTLET TEMP.	TEMP. RECORD. CONT.	80-3665	PANEL	HLTA		TRC-2035	C	A-2036	YES	1	
1	14	C1	"	EDC VAPOR FURN BURNER #1	RELAY CONTACT		FIELD	MBFA		VRG1-2	B	A-2369			
1	14	D1	"	EDC VAPOR FURN BURNER #2	RELAY CONTACT		FIELD	MBFA		VRG2-2	B	A-2368			
1	15	A1	"	EDC VAPOR FURN. BURNER #3	RELAY CONTACT		FIELD	MBFA		VRG3-2	B	A-2367			
1	15	B1		EDC VAPOR FURN. BURNER #4	RELAY CONTACT		FIELD	MBFA		VRG4-2	B	A-2366			
1	14	B1	65A-5031	EDC VAPOR FURN COMPLETE SHUT DOWN	RELAY CONTACT		FIELD	FSDA		VRY-5	B	A-2308	YES	1	
1	15	D1		EDC CRACK. FURN. PASS #1 FEED FLOW	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-2061	C	A-2178	YES	2	
1	16	A1		EDC CRACK. FURN. PASS #2 FEED FLOW	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-2069	C	A-2188	YES	2	
1	16	B1		EDC CRACK. FURN. PASS #3 FEED FLOW	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-2077	C	A-2189	YES	2	
1	16	C1		EDC CRACK FURN. PASS #4 FEED FLOW	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-2085	C	A-2190	YES	2	
2	21	B1		EDC CRACK FURN. PASS #1 OUT PRESS	PRESSURE SWITCH		PANEL	LPA		PS-2195	D	A-2199	YES	2	
2	22	A1		EDC CRACK FURN. PASS #2 OUT. PRESS.	PRESSURE SWITCH		PANEL	LPA		PS-2196	D	A-2200	YES	2	
2	22	B1		EDC CRACK FURN PASS #3 OUT. PRESS.	PRESSURE SWITCH		PANEL	LPA		PS-2197	D	A-2201	YES	2	
2	22	C1		EDC CRACK FURN. PASS #4 OUT PRESS.	PRESSURE SWITCH		PANEL	LPA		PS-2198	D	A-2202	YES	2	
2	21	A1		EDC CRACK FURN. OUTLET TEMP.	TEMP. RECORD. CONT.	80-3660	[illegible]EL	HLT[illegible]		TRC-2113	C	A-2114	YES	2	
1	16	D1		EDC CRACK FURN BRIDGE WALL TEMP.	TEMPERATURE INDICATOR		[illegible]D	HT[illegible]		TI-2241	B	A-2286	YES	2	
1	17	B1		EDC CRACK FURN BURNER #1	MAXON SAFETY VALVE		FIELD	MBFA		MS 2354	B	A 2370			
1	17	C1		EDC CRACK. FURN. BURNER #2	MAXON SAFETY VALVE		FIELD	MBFA		MS-2355	B	A-2371			
1	17	D1		EDC CRACK FURN BURNER # 3	MAXON SAFETY VALVE		FIELD	MBFA		MS-2356	B	A-2372			
1	18	A1		EDC CRACK. FURN BURNER #4	MAXON SAFETY VALVE		FIELD	MBFA		MS 2357	B	A-2373			
1	18	B1		EDC CRACK. FURN. BURNER #5	MAXON SAFETY VALVE		FIELD	MBFA		MS-2358	B	A-2374			
1	18	C1		EDC CRACK. FURN. BURNER #6	MAXON SAFETY VALVE		FIELD	MBFA		MS-2359	B	A-2375			
1	18	D1		EDC CRACK FURN. BURNER #7	MAXON SAFETY VALVE		FIELD	MBFA		MS 2360	B	A-2376			
1	19	A1		EDC CRACK FURN. BURNER #8	MAXON SAFETY VALVE		FIELD	MBFA		MS 2361	B	A-2377			
1	19	B1		EDC CRACK. FURN BURNER #9	MAXON SAFETY VALVE		FIELD	MBFA		MS 2362	B	A-2378			
1	19	C1		EDC CRACK FURN. BURNER #10	MAXON SAFETY VALVE		FIELD	MBFA		MS-2363	B	A-2379			
1	19	D1		EDC CRACK FURN BURNER #11	MAXON SAFETY VALVE		FIELD	MBFA		MS-2364	B	A-2380			
1	110	A1		EDC CRACK. FURN. BURNER #12	MAXON SAFETY VALVE		FIELD	MBFA		MS-2365	B	A 2381			
1	17	A1		EDC CRACK FURN COMPLETE SHUT DOWN	RELAY CONTACT		FIELD	FSDA		ICRY-5	B	A-2309	YES	2	
3	31	A1		DOPP KETTLE AGITATOR	MOTOR STARTER		MCC	MSDA			E	A-3003			
4	42	B1		QUENCH TOWER LEVEL	LEVEL RECORDER	80-3675	PANEL	HLLA		LR-3010	C	A-3011			
4	42	A1		QUENCH TOWER OUTLET TEMP.	TEMPERATURE SWITCH		FIELD	HTA		TS-3031	B	A-3021			
4	42	C1		QUENCH LIQUOR TO QUENCH TOWER	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-3014	C	A-3030			
5	51	A1		QUENCH LIQUOR PUMP №1	MOTOR STARTER		MCC	MSDA			B	A-3039			
5	51	B1		QUENCH LIQUOR PUMP №2	MOTOR STARTER		MCC	MSDA			B	A-3090			
4	42	D1		QUENCH LIQUOR TANK LEVEL	LEVEL RECORDER	80-3677	PANEL	HLLA		LR-3052	C	A 3053			
4	43	D1		CONDENSATE PUMP	MOTOR STARTER		MCC	MSDA			E	A-4009			
4	44	A1		UPPER INTERCOOLER PUMP	MOTOR STARTER		MCC	MSDA			B	A-4026			
4	46	B1		LOWER INTERCOOLER PUMP	MOTOR STARTER		MCC	MSDA			B	A-4041			
5	52	B1		STRIPPER FEED PUMP	MOTOR STARTER		MCC	MSDA			B	A 4035			
4	41	C1		UPPER INTERCOOLER FLOW	PRESSURE SWITCH		PANEL	NFA		PS-4073	B	A-4017			
4	44	B1		UPPER INTERCOOL. SURGE TK. LEVEL	PRESSURE SWITCH		PANEL	HLLA		PS-4138	C	A-4020			
4	44	D1		LOWER INTERCOOLER FLOW	PRESSURE SWITCH		PANEL	NFA		PS-4075	B	A-4047			
4	46	A1		LOWER INTERCOOL SURGE TK. LEVEL	PRESSURE SWITCH		[illegible]EL	HLL[illegible]		PS-4139	C	A-4039			
5	52	A1		ABSORBER LEVEL	PRESSURE SWITCH		[illegible]EL	HLL[illegible]		PS-4033	C	A-4032			
4	46	C1		ABSORBER PRESSURE	PRESS. RECORD. CONT.	80-3694	PANEL	HLPA		PRC-4078	C	A-4067			

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ALARM FUNCTION LEGEND

FSDA - Furnace Shutdown Alarm
HTA - High Temperature Alarm
HLFA - High Low Flow Alarm
HLLA - High Low Level Alarm
HLPA - High Low Pressure Alarm
HLTA - High Low Temperature Alarm
LPA - Low Pressure Alarm
MBFA - Main Burner Failure Alarm
MSDA - Motor Shutdown Alarm
NFA - No Flow Alarm

ALARM CODE SCHEDULE

A - Bulls Eye - Tricolor
B - Bulls Eye - Normal Green - Off Red
C - Back Lighted Name Plate - Tri-Color
D - Bulls Eye - Normal Green - Low Amber
E - Back Lighted Name Plate - Green Normal - Red Off
F - Back Lighted Name Plate - Green Normal - Amber Off

NOTES:

1. Sequential Alarm Column indicates Alarms in a First-out Visual sequence. Sequential Group Column indicates those Alarms in each First-out Group.

REFERENCE DRAWINGS

65A-7621 VC Electric Instr. Alarm Point Schedule, Sheet 2.

65A-7622 VC Elec. Instr. Alarm Point Schedule, Sh.3

PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

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Curry Feb. 21 66

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE — ELECTRICAL INSTRUMENTATION
ALARM POINT SCHEDULE
SHEET 1 OF 3

DRAWN BY LONDON DATE 2 8 66 SCALE NONE
CHECKED BY HB Curry DATE 3-15-66 CHARGE P-141
APPROVED BY [illegible] DATE 3-29-66
BILL OF MATERIAL NONE DWG. NO. 65A-7620 X

Figur 5.15

REVISIONS

X ADDED 300M EXPAN CHG P-741 1-10-67 JRC

ALARM POINT SCHEDULE

ALARM UNIT: ALARM PANEL OR RELAY CHASSIS №	POINT №	RELAY №	DWG. №	NAME PLATE ENGRAVING	PRIMARY DEVICE: PRIMARY DEVICE	PRIMARY DEVICE №	LOCATION	FUNCTION	DWG. NO.	MARK NO.	CODE	PROCESS NO.	SEQUENT. ALARM	SEQUENT GROUP	ALARM SET POINT
5	53	A1		PRODUCT STILL FEED TANK LEVEL	LEVEL RECORDER	80-3679	PANEL	HLLA		LR-5026	C	A-5027			
5	53	B1		PRODUCT STILL FEED PUMP	MOTOR STARTER		MCC	MSDA			B	A-2059			
5	53	D1		PRODUCT STILL TEMPERATURE	TEMP. RECORD CONT.	80-3667	PANEL	HLTA		FR/TRC-6002	C	A-6009			
5	53	C1		PRODUCT STILL LEVEL	PRESSURE SWITCH		PANEL	HLLA		PS-6130	C	A-6008			
5	54	C1		LEAN OIL PUMP	MOTOR STARTER		MCC	MSDA			B	A-6012			
5	54	D1		CHLORINE TO EDC RECYCLE TK.	FLOW DEVIATION SWITCH		PANEL	HLFA		FDS-6137	C	A-6111			
5	55	A1		HEAVIES STILL FEED TANK LEVEL	LEVEL RECORD - CONT	80-3680	PANEL	HLLA		LRC-6035	C	A-6037			
5	55	B1		HEAVIES STILL FEED PUMP	MOTOR STARTER		MCC	MSDA			B	A-6051			
5	54	A1		PRODUCT STILL REFLUX TANK LEVEL	PRESSURE SWITCH		PANEL	HLLA		PS-6141	C	A-6060			
5	54	B1		PRODUCT STILL REFLUX PUMP	MOTOR STARTER		MCC	MSDA			B	A-6062			
5	52	D1		PRODUCT STILL PRESSURE	PRESS. RECORD. CONTROL.	80-3682	PANEL	HLPA		PRC-6091	C	A-6142			
1	11	B1		HEAVIES STILL LEVEL	PRESSURE SWITCH		PANEL	HLLA		PS-1046	C	A-1002			
1	11	A1		HEAVIES STILL TEMP.	TEMP. RECORD. CONT.	80-3668	PANEL	HTA		TRC/FR-1012	C	A-1015			
1	12	A1		HEAVIES STILL BOTTOMS PUMP	MOTOR STARTER		MCC	MSDA			B	A-1008			
1	12	D1		FURNACE FEED PUMP	MOTOR STARTER		MCC	MSDA			B	A-1032			
1	12	C1		HEAVIES STILL REFLUX TANK LEVEL	LEVEL RECORDER	80-3685	PANEL	HLLA		LR-1029	C	A-1030			
1	12	B1		HEAVIES STILL REFLUX PUMP	MOTOR STARTER		MCC	MSDA			B	A-1033			
5	55	C1		DAY TANK #1 LEVEL	LEVEL INDICATOR	80-3707	PANEL	HLLA		LI-7005	C	A-7006			
5	55	D1		DAY TANK #2 LEVEL	LEVEL INDICATOR	80-3708	PANEL	HLLA		LI-7011	C	A-7012			
5	56	A1		DAY TANK #3 LEVEL	LEVEL INDICATOR	80-3709	PANEL	HLLA		LI-7002	C	A-7003			
5	56	B1		DAY TANK #4 LEVEL	LEVEL INDICATOR	80-3710	PANEL	HLLA		LI-7008	C	A-7009			
3	33	A1		V.C. REWORK PUMP	MOTOR STARTER		MCC	MSDA			E	A-7025			
5	56	C1		VC PRODUCT TRANSFER PUMP	MOTOR STARTER		MCC	MSDA			B	A-7027			
3	33	B1		FREON COMPRESSOR,	MOTOR STARTER		MCC	MSDA			E	A-4097			
5	52	C1		FREON COMP. SUCTION PRESS.	PRESSURE SWITCH		PANEL	HLPA		PS-4600	C	A-4194			
3	35	A1		FREON COMPRESSOR DISCHG. PRESS.	PRESSURE SWITCH	YORK № HP	FIELD	HLPA		PS-4195	E	A-4196			
3	35	B1		FREON COMPRESSOR DISCHG. TEMP.	TEMPERATURE SWITCH	YORK № HOT	FIELD	HLTA		TS-4197	E	A-4198			
3	35	C1		FREON COMP. REDUCTION GEAR OIL TEMP.	TEMPERATURE SWITCH	YORK № GHOT		HTA		TS-4199	E	A-4200			
3	35	D1		FREON COMP. LUBE OIL TEMPERATURE	TEMPERATURE SWITCH	YORK № HOT	FIELD	HTA		TS-4201	E	A-4202			
3	33	C1		FREON COMP. MOTOR WINDING TEMP.	TEMPERATURE SWITCH	YORK № RTD	MCC	HTA		TS-4203	E	A-4204			
3	37	A1		FREON COMP. MOTOR BEARING TEMP.	TEMPERATURE SWITCH		FIELD	HTA		TS-4205 TS-4501	E	A-4206			
3	37	B1		FREON RECEIVER LEVEL	LEVEL SWITCH		FIELD	HLA		LS-4153A	E	A-4208			
3	33	D1		FREON PUMPOUT COMPRESSOR	MOTOR STARTER		MCC	MSDA			E	A-4125			
3	37	C1		30° FREON KNOCKOUT DRUM LEVEL	LEVEL SWITCH	80-3846	FIELD	HLA		LS-4162	E	A-4163			
3	37	D1		-4° FREON KNOCKOUT DRUM LEVEL	LEVEL SWITCH	80-3845	FIELD	HLA		LS-4164	E	A-4165			
3	39	A1		-40° FREON KNOCKOUT DRUM LEVEL	LEVEL SWITCH	80-3844	FIELD	HLA		LS-4166	E	A-4167			
3	39	B1		#1 INSTRUMENT AIR COMP.	MOTOR STARTER		MCC	MSDA			E	A-8000			
3	39	C1		#1 INSTRUMENT AIR COMP. LUBE OIL TEMPERATURE	TEMPERATURE SWITCH		FIELD	HTA		TS-	F	A-8001			
4	41	A1		-5° FREON TEMPERATURE	TEMP. RECORDER	80-3958	PANEL	HTA		TR-1	E	A-4512			
4	41	B1		+34° FREON TEMPERATURE	TEMP. RECORDER	80-3956	PANEL	HTA		TR-1	F	A-4510			
5	57	A1		VC TK CAR LOADING PUMPS	MOTOR STARTER		MCC	MSDA			E	A-9030			
5	59	A1		ABSORBER TRAY #8	TRI	80-3956	PANEL	HTA		TRI-1	E	A-4514			
5	59	B1		ABSORBER TRAY #30	TRI	80-3958	PANEL	HTA		TRI-3	E	A-4515			
5	59	C1		STRIPPER VAPOR OUT	TRI	80-3958	PANEL	HTA		TRI-10	E	A-5060			
5	59	D1		STRIPPER TRAY #17	TRI	80-3958	PANEL	HTA		TRI-9	E	A-5061			
5	56	D1		VC-SPHERE #1 LEVEL	LEVEL INDICATOR	80-4161	PANEL	HLLA		LI-9001	C	A-9002			
3	39	D1		#1 AIR COMP. DISCHG TEMP	TEMPERATURE SWITCH		FIELD	HTA		TS-E1	E	A-507			
4	45	A1		FREON COMPRESSOR	MOTOR STARTER		MCC	MSDA			E	A-4733			
4	45	D1		FREON COMPRESSOR DISCHG. PRESS.	PRESSURE SWITCH	YORK NO. HP	FIELD	HLPA		PS-4745	E	A-4746			
4	45	C1		FREON COMPRESSOR DISCHG. TEMP.	TEMPERATURE SWITCH	YORK NO. HOT	FIELD	HLTA		TS-4743	E	A-4744			
4	47	A1		FREON COMP. REDUCTION GEAR OIL TEMP.	TEMPERATURE SWITCH	YORK NO GHOT	FIELD	HTA		TS-4737	E	A-4738			
4	47	B1		FREON COMP. LUBE OIL TEMP.	TEMPERATURE SWITCH	YORK NO HOT	FIELD	HTA		TS-4739	E	A-4740			
4	45	B1		FREON COMP. MOTOR WINDING TEMP	TEMPERATURE SWITCH	YORK NO RTD	MCC	HTA		TS-4741	E	A-4742			
4	47	C1		FREON COMP. MOTOR BEARING TEMP.	TEMPERATURE SWITCH		FIELD	HTA		TS-4734 TS-4736	E	A-4736			

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ALARM FUNCTION LEGEND

FSDA - Furnace Shutdown Alarm
HTA - High Temperature Alarm
HLFA - High Low Flow Alarm
HLLA - High Low Level Alarm
HLPA - High Low Pressure Alarm
HLTA - High Low Temperature Alarm
LPA - Low Pressure Alarm
MBFA - Main Burner Failure Alarm
MSDA - Motor Shutdown Alarm
NFA - No Flow Alarm

ALARM CODE SCHEDULE

A - Bulls Eye - Tricolor
B - Bulls Eye - Normal Green - Off Red
C - Back Lighted Name Plate - Tri-Color
D - Bulls Eye - Normal Green - Low Amber
E - Back Lighted Name Plate - Green Normal - Red Off
F - Back Lighted Name Plate - Green Normal - Amber Off

NOTES:

1. Sequential Alarm Column indicates Alarms in a First-out Visual sequence. Sequential Group Column indicates those Alarms in each First-out Group.

REFERENCE DRAWINGS:

65A-7620 VC Elec. Instr. Alarm Point Schedule, Sh.1

65A-7622 VC Elec. Instr. Alarm Point Schedule, Sh.3

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Ford, Bacon & Davis
Construction Corporation

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

VINYL CHLORIDE - ELECTRICAL INSTRUMENTATION
ALARM POINT SCHEDULE
SHEET 2 OF 3

DRAWN BY LONDON DATE 2-7-66 SCALE NONE
CHECKED BY [illegible] DATE 3-15-66 CHARGE P741
APPROVED BY [illegible] DATE 7-29-66
BILL OF MATERIAL None DWG. NO. 65A-7621X

VI. START-UP AND OPERATIONAL PROCEDURES

A. Overall Start-Up Procedures

1. Preparation: The following conditions must be satisfied prior to the initial start-up. No assumption is made in the outline below as to the previous history of the VC plant. Thus, the plant could have been down for several months, or for a few hours, and the procedure would not be affected. However, certain of the procedures may be abbreviated or omitted during start-up if adherence to these procedures would be redundant.

a. The plant process equipment must be clean, dry, leak-tested and in operating condition before any start-up attempt is made. In particular, the furnace refractory must be dried and cured using procedures covered in detail later on.

b. Water must be removed from the system by adequate purging with air and then with nitrogen to remove the air. A final flush with dry EDC should have been made.

c. The system should be pressurized to 30 psig with dry nitrogen. This will prevent re-contamination with air or moisture.

d. All utilities must be readied to supply the demands imposed by full-scale plant operations. Check to see that the following utilities can be supplied at the stated conditions:

(1) Instrument air at 100 psig.

(2) Nitrogen at 100 psig.

(3) Steam at 200 psig.

(4) Well water

(5) Electrical power at 440 and 2300 volts.

(6) Fuel gas at 90 psig.

e. The fire water system must be in working condition.

f. The cooling tower must be in operation with water circulation through the following:

(1) Primary quench partial condenser.

(2) Refrigeration Freon condenser.

(3) Pump out compressor condenser.

(4) 90^{o} lean oil cooler.

(5) Recycle EDC cooler.

(6) Product still condenser.

(7) Product vinyl cooler.

(8) Heavies still condenser.

(9) Furnace feed cooler.

g. The safety valve vent header nitrogen purges should be set.

h. Make certain filters, driers and neutralizers contain their proper charge.

i. The system must be filled with dry EDC to the correct operating levels.

j. Have the HCl scrubber and carbon filters ready for service.

k. Make sure that chlorine is available for the recycle EDC chlorination. The chlorine line should be pressurized up to the chlorine flow control valve.

l. Make sure methane fuel gas is available at the desired pressures.

If these conditions are satisfied, the plant is ready for start-up.

2. Plant Start-Up Sequence:

a. Start the heavies still and put it on total reflux.

b. Start up Flywheel No. 2 (Purification Train--see Fig. 5.2)

(1) Pressurize the product still to 75 psig with nitrogen and activate the still pressure controller. Make sure that there is no leakage through the relief valve and that the system is otherwise tight. Put the product still on total reflux. Pressurize the absorber to 50 psig with N_2. Have the valve on the vent line from the secondary quench condenser closed so that the two flywheels will be isolated.

(2) Start the York refrigeration system and F-12 flows to all users. This will serve to load the unit until the stripper reboiler is started and will begin to cool down the system.

(3) Immediately after Step 2 above, start the lean oil circulation in the purification train (Flywheel 2). By-pass the furnace feed economizer for the time being.

(4) When the absorber is cool about halfway down the column, start the stripper reboiler. Set the steam rate as close as possible to that used when the plant is in full operation.

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(5) Start the upper and lower intercooler systems. Make sure lean EDC is flowing into the tanks from the absorber and is being properly returned. (Note: A recirculation rate will have to be established through the by-pass lines before the cylinder-operated valves will open, allowing liquid to flow from the absorber to the surge tanks.)

(6) Check the sightglasses and level controllers for the Freon level in all refrigerated exchangers.

(7) Start vinyl chloride recycle from the product still reflux drum through the recycle flow control valve to the bottom of the stripper. Set a flow consistent with the lean oil flow (keep approximately 15% by wt. VC in the stripper bottoms stream to duplicate design conditions).

c. Start up Flywheel No. 1 (Quench System--see Fig 5.1)

(1) Check to see that the desired level of EDC is in the quench liquor surge tank, quench tower, and Dopp Kettles.

(2) Check to make sure that the ten pass outlets from the two cracking furnaces are closed.

(3) Open the Dopp Kettle vapor lines to the quench tower and the Strahman rod-out bottom valves on the quench tower. Also open all liquid dump line valves except the automatic dump valves.

(4) Put one quench liquor pump on and establish a quench liquor flow.

(5) Turn on the Dopp Kettle agitators and automatic dump control valves from the quench tower. Turn on steam to the Dopp Kettle jackets. Make sure seal liquid is flowing through the mechanical seal before starting the agitator.

d. Start the vaporizer

(1) Start the furnace feed pumps and establish an EDC flow up to the vaporizer feed flow control valves. This can be done by using the recycle line which returns the EDC to the heavies still reflux tank. Put the furnace feed economizer in service.

(2) The furnaces to be started should be purged on the tube side with N_2, then pressurized to 50 psig and isolated from each other.

(3) Turn on the by-pass switches for all low flow and low pass outlet pressure shutdown relays.

(3(1)) [illegible] - pilot

(4) Start the purge cycle for the vaporizer and cracking furnace to be used. Light all pilots after purge is completed. Factory Mutual plug valves have been installed upstream of the Maxon valves on the line to each main burner. These valves have been drilled and tapped and then connected pneumatically so that all of them on a particular furnace must be closed before any of the pilots on that furnace can be started.

(5) Put EDC through the vaporizer to the Dopp Kettles (use the start-up line which by-passes the cracking furnaces) and increase the vaporizer outlet temperature as fast as good furnace operation permits (100°F/Hr) by starting up the burners individually. Use manual control on all flow valves when starting up.

(6) The objective now is to raise the EDC exit temperature from the vaporizer so that complete vaporization is being accomplished. When the vaporizer outlet temperature reaches 400°F, light all burners on the cracking furnace. Burners should be at low rates. Bring the bridgewall temperature on the cracking furnace up to that corresponding to that on the vaporizing furnace.

(7) As this temperature is reached, slowly valve off to the kettles while opening to the cracking furnace. Use manual control on the flow controllers for the cracking furnace pass flow control valves. Do not open the valves downstream of the cracking furnace until the pressure on each pass is greater than that on the quench tower. This will prevent the carboneous material from getting into the pass outlet lines.

(8) Balance the forward feed rates to all of the passes.

(9) Check quench liquor flow. Flow enough material to maintain a level above the gas inlets to the quench tower.

(10) Bring the cracking furnace exit temperature up stepwise to 800°F. Get conversion analysis run and balance the system before proceeding. After checking conversion, raise the above temperature to 850°F. Then repeat the above sequence every 50°F until the proper percentage conversion is attained.

(11) Light off the other cracking furnace in a similar manner. Bring the furnace exit temperature up stepwise at the same rate of rise as the other cracking furnace, checking conversions along the way.

(12) Whenever there is a recycle EDC flow to the heavies still feed tank, start the chlorine flow to the recycle line and control the chlorine rate analytically by testing for chloroprene in the reaction tank.

(13) Reduce the recycle vinyl chloride to the stripper from the product still reflux drum as the conversion from the furnaces increases.

(14) As soon as the level in the product still reflux drums starts to increase, begin forward flow of vinyl chloride to the product neutralizers.

(15) Either one or the other of the product neutralizers will be used at a time. The neutralizer to be used should be piped up so that vinyl chloride can flow through it to the product storage area and into one of the eight monomer day tanks. When vinyl chloride begins filling the neutralizer, the neutralizer should be manually vented back to the product still condenser. When the neutralizer is full of monomer, the venting should be discontinued.

(16) Adjust flows and levels of refrigerant, flows of cooling water and by-pass EDC flow to the lean oil cooling exchangers so that the desired lean oil feed temperature to the absorber top tray is obtained. It is intended that during normal steady operations, the lean oil by-pass around the 34° lean oil cooler should be closed.

(17) Feed to the heavies still, which is already on total reflux, should be started as soon as the vaporizer receives feed. There is no need to start the make-up EDC flow to the heavies still feed tank until the cracking furnaces start converting EDC to vinyl chloride and HCl. Then add make-up EDC to hold a constant heavies still feed tank level.

(18) The HCl gas sent out the top of the absorber will vent to the HCl scrubber initially, but it can be started to any of the consumers as soon as a sustained flow has been established.

B. Detailed Equipment Start-Up

1. Reboiler Start-Up and Operation: Three thermosyphon reboilers are used in the vinyl chloride plant; one is on the stripper, one is on the product still, and one is on the heavies still. The principle of the thermosiphon reboiler is to obtain a rapid circulation through the exchanger tubes by vaporizing the liquid in the tubes and allowing the vapors to leave the top of the exchanger and enter the side of the column below the first tray or support plate. The vaporized material is replaced by liquid which comes down from the first tray in the still through a liquid leg into the bottom of the exchanger. This vaporization creates a natural circulation of liquid (thermosiphon) through the reboiler, thus eliminating any need for pumps. The rapid circulation rate through the exchanger accomplishes two purposes; first, a high rate of heat transfer to the liquid is effected due to the high thermosiphon liquid velocity obtained; secondly, this high liquid velocity makes the formation of scale or tars on the exchanger walls more difficult and thereby either eliminates the need for cleaning the exchanger walls or greatly extends the period of operation between cleanings over what would be experienced in a static kettle-type reboiler.

Three very important items must be remembered when starting up and operating a thermosiphon reboiler. First, never let a reboiler run dry or operate with a low level. This allows some or all of the tubes to become dry and heat up to the temperature of the steam. This excessively high temperature can cause baking of the tars on to the tube, decomposition of the material in the reboiler, or even formation of more tars which can plug the reboiler tubes. The liquid level in the column should always be operated at a level which can be seen in the sightglass.

Secondly, when starting up a cold reboiler, drain all accumulated steam condensate out of the shell of the exchanger and start the steam feed slowly. Gradually increase the steam until the reboiler comes up to temperature. Leave the steam condensate valve at the bottom of the reboiler open a slight amount and purge wet steam until the tubes have a chance to warm up. This procedure prevents bumping which occurs when live steam contacts cold condensate and it also prevents slugging of the liquid phase in the reboiler tubes. Either of these conditions can damage a reboiler if they become violent enough.

Thirdly, never run a reboiler with a high level, especially when the liquid in the reboiler blocks or partially blocks the vapor outlet of the reboiler. This will stop the thermosiphon and drastically reduce the heat transfer. If this happens, the still must be shut down, the reboiler level lowered to the proper level and the still started up again to re-establish circulation.

If a reboiler is failing to supply the design heat flux, and fouling is not involved, check out the steam supply and/or the condensate trap. The trap may be inoperable and cause water to back up into the reboiler. When steam is at the proper pressure and the condensate trap is working, but there is still no heat transfer, chances are the tubes are fouled.

2. Start-Up and Operation of Process Pumps: All process pumps in the VC plant are centrifugal pumps with internal mechanical seals, with the exception of the condensate pump, which has a packing gland. Mechanical seals are susceptible to damage, and care must be taken when starting up or operating a pump with a seal in order to prevent seal damage.

The mechanical seals used in the plant contain a ceramic and a graphite seal ring. The ceramic seal ring should be protected from mechanical or thermal shock or it will crack. Do not spray water (during washing down the area, for example) on a hot seal. Mechanical shock to either a running or an out-of-service seal will probably damage the seal. The seals used in the plant are balanced and are Crane model 9.

The seals are equipped with a back-flush line so that the seal faces can be flushed with clear liquor to wash out foreign matter. The seal can be damaged if particulate matter remains on the seal faces. A high seal flush line pressure can cause the seal to leak. Therefore, regulate the flush flow to prevent this difficulty. If the seal leaks and the flush flow is off, then the seal is probably defective.

A centrifugal pump produces the greatest head at no flow; this is also the point where the power demand is the smallest. It is good practice to start up a pump at the point where the power demand is the least, so close completely the pump discharge valve until the pump is up to speed. Then slowly open the discharge valve to keep from slugging liquid through the piping. When starting a pump on dead shut-off, the discharge pressure could cause the mechanical seal to leak if the flush line control valve were open too much. For this reason, always have the flush line valve almost closed when starting the pump. The flush valve should be opened to the proper setting when the pump discharge valve is opened all the way.

A centrifugal pump can be run with a closed discharge valve for a short period of time only without harm being done to the seal. When run for any length of time with a closed discharge, the liquid in the casing will heat up due to friction and cause vapor lock. The seal will then run dry and begin to heat up, and if the condition persists the seal will be permanently damaged and will probably crack. This also points up another axiom: A centrifugal pump with a mechanical seal should never be operated dry. The seal must always be completely wetted with process liquor to prevent damage from over-heating. Therefore, open the discharge valve as soon as possible after achieving pump speed at shut-off.

A centrifugal pump should not be operated at the no-load condition of reduced flow for very long, because excessive forces may bear on the shaft, thus leading to deflection and consequent mechanical troubles.

Excessive flow can also cause cavitation with consequent reduced output, lower efficiency and vibration, which in turn can damage impeller, casing, packing, seals or bearings. Cavitation is characterized by a rattling noise in the pump. It is corrected either by increasing suction pressure or suction pipe diameter, or by reducing flow by throttling the discharge.

Pumps should be primed fully before starting. Adequate suction head to prevent vapor locking should be provided.

If discharge pressure does not develop a vapor lock is indicated. Try priming the pump (bleed vapor from pump casing until only liquid is withdrawn). If this still does not start flow, cool the casing with water or other means to insure that the liquid being pumped is not being continually vaporized. Another item to check is the pump suction, which could be plugged or starved. A starved suction can generally be traced to plugged screens in the intake or to a suction pipe that is too small. A leaking seal that allows air to be sucked in may be another cause of vapor lock.

When a fluctuating pressure is noted on a pump, pinch back on the discharge valve to eliminate surging.

Be sure the pump impeller rotates in the right direction. If the motor is hooked up to run in the reverse direction, it is possible that threads will be stripped or the impeller run off the shaft. This condition will also cause the pump output to be much less than the design value. This rotation direction check should be done specifically after each overhaul where the electrical has been disconnected.

If there appears to be no valid reason why the specified output can not be obtained, check the operating curves for the pump to be sure the proper design has been installed.

Caution is necessary when using pumps on liquids other than those for which they were designed. Thus checking out a pump designed for EDC by using water will not give true performance characteristics.

In general, remember that the quantity of liquid delivered by a centrifugal pump is proportional to both impeller diameter and impeller speed. Discharge head is proportional to the square of the speed, and horsepower to the cube of the speed. Thus, if the speed of a pump is doubled, twice the flow is obtained at four times the head, but eight times the power is required. The operating personnel should be thoroughly familiar with these relationships.

3. Fuel Gas Supply System:

Start-Up Procedure

a. Close block valves and by-pass valves at each of the six TRC and PRC stations (one of each for each furnace).

b. Place the 90 to 30 psig PCV on manual and pressurize the 30 psig header. If the PCV does not seat off (or hold 30 psig pressure at no flow), close one of the block valves.

c. Open the appropriate pilot PCV and burner TCV block valves. These valves should also be started on manual control.

d. Fuel gas is now ready to be fed to the furnaces (see furnace start-up procedure for purging, etc. before start-up).

4. Furnaces: The procedures for the start-up and operation of the three furnaces will be very similar. Therefore, their operation will be treated in one section. Differences that exist in operations between the vaporizer and the cracking furnaces will be pointed out. The reader is referred to the Petrochem-Isoflow Furnaces OPERATING MANUAL, 1957 edition, for much useful general information on furnace operation and control.

GENERAL INFORMATION ON FURNACES

a. Definition of Terms

Brevity makes it advisable to use terms throughout this manual with which the operator may not be familiar. For this reason they are defined here.

Fluid Stream

The term "fluid stream" is used to designate the stream of fluid to be heated in the tubes of the furnace. The term "fluid" is defined as any substance, liquid or gas, or combination thereof possessing flow characteristics.

Pass

By a "pass" is meant the bank of consecutive tubes through which the fluid travels from the point it enters until it leaves the furnace. Thus, for example, in a two-pass furnace the fluid would divide into two streams at the inlet, flowing separately through their respective tube banks and recombining as they leave the furnace on the opposite side. A two-pass furnace with 32 tubes, for example, would have two coils of 16 tubes each, one half the total flow going through each coil. If the same furnace were four-pass there would four coils of 8 tubes each, etc.

Inlet Tube

The term "inlet tube" designates the first tube through which the fluid passes after entering the furnace. A two-pass furnace would have two inlet tubes, a four-pass furnace, four inlet tubes, etc.

Outlet Tube

By "outlet tube" is meant the last tube through which the fluid flows before leaving the furnace.

Radiant Section

By "radiant section" is meant that section of the furnace in which the surface of the tube is exposed to direct radiant heat from the burner flames. In this portion of the furnace by far the major portion of the heat absorbed by the tubes and, therefore, by the fluid, is transferred by means of radiation (75% of total duty).

Convection Section

The "convection section" of a furnace is that portion in which the tubes are mechanically screened from "seeing" the flame burst and which, therefore, depend upon convection transfer from the combustion gases sweeping over them for the major portion of their heat absorption (25% of total duty).

Bridge Wall Temperature

This temperature is measured at the point where the products of combustion enter the convection section in integral radiant-convection furnaces.

b. Draft Gauges

Location

On Petro-Chem Iso-Flow heaters customary practice is to connect the draft gauge to the following points:

1. The top of the radiant section.

2. The top of the convection section on integral radiant-convection types.

3. Both top and bottom of the convection section on separated radiant-convection types.

The furnaces are built with 4 draft taps at the proper locations for attachment of the draft gauge connections.

Method of Hook-Up

The most satisfactory method for connecting draft gauges to the furnace is to bring tubing (preferably copper) from the 1 1/2" couplings mentioned above to a point near the draft gauge and merely let the ends of the tubing hang free. A length of rubber tubing permanently attached to the draft gauge can then be temporarily coupled to any tube for the purpose of measuring the desired draft. The practice of putting valves in all tubes or pipes leading from the draft connections and bringing them into a common manifold permanently attached to the draft gauge is not recommended since cross leaks are prone to develop and thus give erroneous readings.

Drafts Expected

A draft gauge capable of recording in the range +0.2 to -1.0 inches of water is usually satisfactory for Petro-Chem heaters. All drafts on the natural draft Petro-Chem furnace should always be negative.

c. Snuffing Steam

Snuffing steam connections are supplied to the combustion chamber and header boxes of all Petro-Chem furnaces. The amount of steam needed for purging a heater depends entirely upon the operating conditions at the time steam purging is required. The concentration of steam in turn is dependent entirely upon the air admitted to the setting and is not affected by the amount of fuel burned or the amount of fuel present in the combustion chamber due to a burst tube.

The correct rate of steam introduced will extinguish a fire in a very short time. However, it will be necessary to continue some steam flow in order to maintain conditions and cool the setting to the point where it will not re-ignite.

The amount of steam required after the initial introduction to extinguish the fire can be reduced by partially closing dampers either in the stack or at the intake to the burners. There is a definite advantage to closing dampers at the bottom of the furnace. Closing a stack damper tends to force the fire back out through the burner block. A damper at the intake to a plenum chamber around the burners eliminates this possibility.

d. Preparation for Start-Up

(1) GENERAL INSPECTION: The first step to be taken is a careful physical inspection of the furnace. The major points to be checked are the following:

(a) Burner Alignment & Placement-- Verify the burner position against the suppliers prints. Make sure burner tips are placed correctly and that the connecting piping permits proper vertical alignment of the burner core and tip. Make sure that all air shutters and dampers function freely. In the case of directional burners be certain that all threaded joints which must turn as the burners are rotated have been graphited. It is important that the operators be able to make the necessary burner adjustments freely after the furnace is in operation.

(b) Instrumentation-- All flow controllers, recorders, thermocouples, and safety shut-down devices should be checked prior to start-up. Flow recorders should be properly zeroed. Thermocouple leads transmitting outlet temperatures are sometimes reversed thereby making proper furnace adjustments impossible. Leads should therefore be carefully checked. After start-up, removal of the thermocouple from the well for a few moments will indicate very quickly if the proper points are being read. High temperature or low flow shutdown devices should be tested prior to start-up. Flame failure devices should be checked by simulating the hazardous condition with the "Fireye" system.

(c) Sampling Points-- All 1 1/2" couplings not used for draft or thermocouple connections should be sealed off with a pipe plug.

(2) BLOWING OUT TUBES

Prior to lighting off, it is important to make certain that tubes are clear and unobstructed. Some water may remain in the tubes after the hydrostatic test, or other foreign matter may have accumulated. Compressed air should be forced through the tube coil at a high enough pressure and in sufficient quantity to assure satisfactory flow. In the case of multipass units, each pass must be blown independently. The inlet valves to the other passes should be closed and air forced through one pass at a time. Finally, nitrogen should be purged through the unit before start-up. All tubes must be thoroughly dry.

(3) BLOWING OUT BURNER PIPING

All burner piping should be thoroughly blown out with compressed air. On multiburner units fed from a single header each burner should be blown independently. Control valves for all burners except one should be closed and full pressure and flow applied to each burner in turn. Failure to remove mill scale and rust in this manner prior to start-up can result in severe operating difficulties over a period of several months. Particles of scale and rust interfere with the proper functioning of the atomizing tips and result in long flames, dripping, and coking. Repeated shut-downs are necessary until all the foreign material has finally worked itself out of the system.

(4) DRYING OUT REFRACTORY

In order to insure maximum life for the furnace refractory, it is necessary that it be thoroughly dried before the furnace is put in service. As a general rule the brickwork can be adequately dried by the following procedure: Run steam or any other available fluid through the tubes, using the lowest flow possible consistent with prevention of overheating of the tubes.* The purpose of this is to get high flue gas temperatures without firing so hard as to overheat the brickwork.

If EDC stands in the tubes without circulation even at low firing rates the tubes will fill with coke.

Table 6.1 lists recommended drying-out periods for furnaces having linings commonly used with Petro-Chem heaters.

TABLE 6.1 -RECOMMENDED DRYING-OUT PERIODS

Lining	Total Drying Out Time, Hrs.	Time of Temperature Cycle, Hrs.
9" 2600°F ins. firebrick, 7" block ins.	72	24
4 1/2"2300°F ins. firebrick, 7" block ins.	60	20
4 1/2"2000°F ins. firebrick, 2" block ins.	36	12
4 1/2"1600°F ins. firebrick	24	8

*NOTE: A small fire should be kindled in the furnace to warm the tubes and setting before introducing steam into cold tubes; this will prevent severe water hammer from condensate.

For the first cycle the furnace should have only a low fire, starting with sufficient flame to give a temperature of about 300°F at the top of the radiant section, raising gradually during the day to 500°F. On the second cycle the temperature on the thermocouple installed at the top of the radiant chamber can be raised to 750°F, and during the third cycle it should be maintained at approximately 1000°F. Normally the brickwork and insulation will then be dry enough to permit placing the furnace in operation. However, the most accurate indication of readiness of a furnace for operation is the shell temperature. When the fires are started in a new furnace the moisture at the outer surface of the brickwork evaporates into the combustion gases but much of the moisture held deeper in the brickwork is driven back into the insulation next to the shell. During this period the furnace shell remains cold. Then as the heat density in the combustion chamber is increased the brickwork heats through and the moisture from the insulation begins to evaporate. This causes the furnace shell to heat up due to the generation of steam in the adjacent insulation; but when this moisture has been thoroughly evaporated the shell temperature will again fall. If the operator keeps some progressive accounts of the shell temperature he will note this rise and fall during the drying out process and when the shell temperature has decreased to approximately 150°F or to a point where the hand can be held on it for 8 or 10 seconds the furnace can be considered ready for operation.

Definite requirements for drying out time vary with the moisture content of the brick and insulation which is in turn affected by the length of time the furnace may have been idle between completion of erection and beginning of operation. The longer a furnace is inoperative the more moisture is taken up by the brickwork and insulation due to absorption from the atmosphere, rainfall running down the stack, etc.

e. Furnace Start-Up

With the several steps outlined in the above sections completed, the actual furnace start-up can proceed. The following outline will give the proper sequence for this operation:

(1) START FLOW TO FURNACE

The circulation rate should be set as close to design as possible. In addition, the operator must be sure that circulation exists in all passes by checking his flow indicators or controllers. Flow distribution between the passes should be adjusted as closely as possible before the burners are ignited.

(2) PLACE FIRING CONTROL ON MANUAL OPERATION

All firing during start-up must be done on manual control. Upsets in various areas of a plant frequently occur during these periods and with the fuel feed system on automatic control any upset which causes the temperature of the fluid passing through the heater to drop suddenly will actuate the automatic fuel valve. The fuel valve will then open wide and permit severe overfiring. A similar condition will result if the charging rate is suddenly increased. Sometimes a furnace is lined out satisfactorily at flow rates considerably below design. If the feed rate is stepped up rapidly on automatic fire control overfiring will again be the result.

(3) LIGHT OFF BURNERS AND HOLD ON LOW FIRE

Light off the individual burners as described in the sections on burner operation. Trim the burners properly and hold on a low fire.

(4) CHECK OUTLET TEMPERATURE ON EACH PASS

Immediately after lighting off check the outlet temperature of each pass by noting the thermocouple readings. In some cases where inlet temperatures are low a more rapid and purely qualitative check can be made by placing the hand very briefly near an outlet flange to determine any tendency toward a temperature increase. If any outlet tubes remain cold, the fire must be immediately extinguished until the reason for the blocked pass is determined.

Experience has shown a wide variety of causes for flow obstructions. On gas heaters or steam superheaters with a low pressure drop, accumulations of condensate or water remaining from a hydrostatic test frequently block one of the passes. On new furnaces blinds are sometimes left on flanges. Frequently waste material, rags, etc., are carried along through the system and deposited at the inlet valve or in a return bend. Other sources of trouble are improperly marked plug cock shut-off valves, faulty flow controllers, vapor locks on inlet manifolds, etc.

(5) BRING FIRE UP GRADUALLY ONCE FLOW HAS BEEN ESTABLISHED

The circulation of the feed stock through the furnace should be brought up to design as rapidly as possible. However, to prevent overfiring and overheating of the fluid streams the firing rate should be brought up gradually. During this period heat must be supplied both to the charge stock and the cold setting. An attempt to reach design outlet temperatures too quickly can result in severe overfiring. The outlet temperatures of the passes should be watched carefully and the various fluid streams trimmed accordingly. If one pass overheats or vapor locks, the flow to this pass should be temporarily increased until normal flow is restored. As charging rate and temperature approach design conditions the pressure drop through the furnace will increase and the unit will tend to line out. Bringing up the firing rate too quickly does not permit making the necessary intermediate adjustments and may make it impossible to line out the furnace at full rate. Depending on the type of process and the furnace design involved, the time required to reach design outlet conditions will vary. The recommended increase in outlet temperature of the feed during start-up of a Petro-Chem furnace of standard design is 100°F per hour.

(6) WHEN OUTLET TEMPERATURES REACH NORMAL OPERATING LEVEL SWITCH TO AUTOMATIC CONTROL

When the furnace has been brought up to the expected operating level the swing to automatic control may be attempted. In some cases it is advisable to line out the furnace on hand control before switching, particularly on new units where the automatic control may not have been completely adjusted. On a routine start-up, however, where the instrumentation is reliable considerable time may be saved by making the swing from manual to automatic control as the outlet temperature approaches the desired level. Under such circumstances the automatic temperature controller may stabilize furnace outlets more quickly than would be the case on hand control.

f. Requirements of Good Furnace Operation

The normally accepted operating procedure of most refineries will result in satisfactory performance with Petro-Chem furnaces. However, there are certain important requirements, peculiar to the Petro-Chem furnace, which must be met.

Flame Condition

The ideal length for the flame pattern is between one-half to two-thirds of the distance of the radiating section. Under no circumstances should the flame be permitted to touch or lick the tubes. In the case of multi-burner installations the fires should be kept as uniform in length and size as possible.

Excess Air

Continuous checks will automatically be made of the flue gas to determine the excess air in the furnace. The furnaces are designed for 20% excess air. Apart from the benefits obtained from greater operating efficiency, the bridge wall temperature is reduced as well as the rate of oxidation of the tubes.

Overloading

Good operating practice must recognize that while excessive firing is at times necessary and the furnace design allows for a limited percentage of overload on a continuous basis there is nevertheless a definite limit beyond which it is both uneconomical and unsafe to go. Overload capacity varies with the size and type of heater as well as the individual design. PPG's furnaces are overdesigned for 20% additional load.

g. Operating Precautions

Pressure at Top of Furnace

Standard Petro-Chem furnaces are not designed to operate under pressure.

A negative pressure at the top of the convection section is utilized to pull in cold air from the atmosphere to cool the structural steel work. If the furnace is fired too hard or allowed to operate with too much excess air the large quantity of flue gases may cause a positive pressure to build up and thus blow hot gases out through the openings intended for the admission of cold air. This is particularly true with the separated radiant convection types and with those types equipped with an air preheater, since both have a greater constriction than would normally be offered by the stack. With such units, pressure on the furnace can be easily recognized by the burning of the paint from the header boxes at the top of the radiant section.

The possibility of building a positive pressure usually occurs during a start-up, when the furnace is being fired excessively, or the excess air for combustion has not been brought down to the normal operating requirements. Due to its vertical construction the Iso-Flow furnace has a high draft at the burner level and to control the excess air it is necessary to close the dampers much farther than an operator would expect on the basis of experience with other types of heaters.

Firing too hard, that is, burning an excessive amount of fuel in the furnace, can usually be attributed to the use of an automatic temperature controller to bring the furnace up to temperature. Upsets in various areas of a plant frequently occur during these periods and with the fuel feed system on automatic control any upset which causes the temperature of the fluid passing through the heater to drop suddenly will actuate the automatic controller and may allow it to open the fuel valve too wide, thus forcing an excess amount of combustion products through the furnace.

In order to protect the upper structural steel work, it is important that the operator watch draft conditions at the top of the furnace. Any tendency for a pressure to build up at this level should be cut to a minimum by keeping secondary air damper doors closed as far as possible, consistent with good flame conditions. The furnace should always be brought up to temperature by hand control.

In order to assist the operator in maintaining satisfactory draft conditions in the heater, draft gages are installed as described earlier. The draft at the top of the radiant section should be logged each shift and become part of the permanent operating data of the furnace.

Flame Impingement on Tubes

Flame impingement on tube surfaces will greatly decrease tube life and may result in a serious tube failure. The furnace should be checked for any signs of flame impingement at regular intervals and particularly after any change in load. In gas fired furnaces at high firing rates, the true flame pattern may not be visible to the naked eye. However, local hot spots on the furnace walls, especially if of varying intensity are indicative of impingement by the non-visible portion of the flame. Mis-alignment of the burners, insufficient combustion air, or enlargement and corrosion of the burner ports are frequently the cause of incorrect flame pattern.

Afterburning

Operation of the furnace with insufficient combustion air may result in loading the unit with carbon monoxide. As a result, afterburning may take place at the base of the stack where the cooling air is admitted or even at the top of the stack depending on the amount of CO present. The burning at the base of the stack will not be visible from the outside and the only evidence will be a rapid increase in stack temperature. Permanent damage may result due to overheating of stack metal and the upper structural steel.

The immediate remedy is introduction of more combustion air by opening of the burner dampers in the following sequence: (1) cut firing rate; (2) open burner dampers; (3) increase firing rate. If the additional air admitted is insufficient to halt burning, or if the dampers are already in the wide open position when the afterburning first occurs, a substantial temporary cutback in firing rate must be made. As soon as the afterburning has ceased and the furnace has cleared itself of carbon monoxide, the firing rate may be increased again. Corrective steps in the case of afterburning must be immediate and drastic to avoid serious damage. Whenever afterburning becomes a problem it is an indication that a program of more adequate combustion control and flue gas analysis is in order.

Keeping Peep-Holes Closed

Peep-hole door hinges are occasionally tight enough to prevent the doors closing completely by their own weight. Consequently the operator should take care to see that the peep-hole doors are pushed tightly closed at all times. If this precaution is not observed, considerable air leakage may occur with resultant lowering of furnace efficiency. Also a greater amount of air leaking in at one peep-hole than at another will tend to cool off one section of the furnace, thereby making if difficult to balance the temperatures in the various passes of a multipass furnace.

Low Flow--Loss of Flow

The operator must at all times be watchful of low flow or temporary loss of flow to the furnace. Check multipass furnaces to insure that flow is going through all passes. There are flow controllers for all passes because proper flow is critical.

Testing Tubes

When placing hydrostatic test on tube coil, it is necessary to expel all air from tubes. This is best done by circulating water at full main volumes through each pass until a full flow of water is noticed at each outlet. Allow water to run out of outlets to sewer for one-half hour, then shut off drain valves and bring up to test pressure with test pump.

Cleaning Extended Surface and Outside of Tubes

The tubes in the convection section of radiant-convection furnaces are equipped with extended surface studs welded to the tubes. With continued operation, particularly on fuel oil, this surface may become coated with carbon, sulphur, etc., so that its efficiency will be reduced. When this happens the convection surface can be cleaned in several ways.

The easiest and frequently the most satisfactory method is to pass cold EDC through the tubes after the furnace has been shut down and at the same time introduce steam into the combustion chamber. The steam will condense on the outside of the tubes and remove the deposits.

An alternate method when the furnace is shut down is to water-wash the extended surface from the inside of the furnace. This can be done by stationing an operator on the baffle sleeve cover plate, which is located at the top of the extended surface. The water hose should be equipped with a right-angle nozzle to direct the stream down along the extended surface, thus keeping the wetting of the surrounding area to a minimum. Start-up of the furnace should be done gradually to permit excess moisture to steam off. The drying-out procedure as outlined for new furnaces may be used.

If the deposit is loose in character, it can be removed to a considerable extent by entering the furnace through the stack access door and blowing down the convection surface with a steam lance in a similar manner to the water wash.

The furnace can also be designed to permit cleaning of the extended surface while it is in operation. The top tube sheets are then provided with openings to allow use of a steam lance while the furnace is running.

If the coating is so adherent in character that it does not respond to any of the foregoing treatment the tubes should be raised from the furnace and cleaned with a wire brush. Some radiant convection heaters are fitted with demountable top headers and special Y-type bottom headers of which only the plug projects through the tube sheet. This allows any tube hairpin to be hoisted from the stack monorail by merely unbolting two adjacent top headers. The only joint that is broken by this procedure is the concrete around the bottom header. This break should be patched before operating the furnace.

Always make an explosionmeter check at all burners before light-off to check for possible fuel valve leakage. If the test is positive, find and stop the leakage before light-off.

h. Gas Burner Operation

Once the individual burners have been lit off and are being controlled by the main gas valve, the condition of the flames should be checked.

(1) Open completely the gas valves to the individual burners. The main gas control valve should directly affect all the burners without any intermediate throttling action by the individual shut-off valves. Only in cases where unequal burner pressures result from a poor gas distribution header, should the individual gas valves be used to trim the burners.

(2) Close off the secondary air shutters until the desired excess air is obtained. For initial operation this should be checked by an Orsat analysis of the flue gas.

i. Gas Burner Problems

Once burners have been ignited and the furnace operation has lined out, very little difficulty should be encountered. However, listed below are several causes of burner trouble along with the necessary corrective steps:

PROBLEM: BURNERS GOING OUT

Cause No. 1: When aspirating type burners are operated at pressures considerably over design, sufficient primary air may be aspirated to lean out the gas-air mixture to a point where it will no longer ignite.

Solution: Close down on primary air damper.

Cause No. 2: Liquid in the gas line of both aspirating and raw gas burners may cause them to go out. This is particularly true at higher rates. As gas velocities go up, liquid may be entrained that has been accumulating for some time.

Solution: A knock-out drum properly drained and of adequate capacity should be installed in the fuel gas system ahead of the burners.

PROBLEM: FLASHBACK OF FLAME TO GAS MIXING ORIFICE

Cause No. 1: Operating at too low pressure. Flame propagation velocity exceeds gas velocity at ports.

Solution: On multi-burner installations shut off sufficient burners to raise the pressure level more nearly to design conditions.

Cause No. 2: High hydrogen concentration in fuel gas.

Solution: Close off primary air doors completely and seal with tape. This in effect results in a raw gas burner. However, for continued operation a permanent burner revision must be considered.

PROBLEM: INSUFFICIENT CAPACITY

Cause No. 1: Insufficient gas at burner.

Solution: Check gas pressure at the burner. Design pressure is given in PSIG at the burner not in the header or at some intermediate point upstream. If gas pressure is too low check piping and control valve for trash and obstructions.

Cause No. 2: Heating value of gas below design. Occasionally the fuel gas as fired has a BTU value considerably below design. This results in insufficient heat release despite the fact that the burner is operating at design pressure or above.

Solution: The gas limiting orifice on aspirating burners should be enlarged. The drilling should be increased by 1/64" at a time and the results noted. However, before any changes are made, the BTU value of the gas should be compared with the design and the heat load on the furnace should be checked. On raw gas burners check with manufacturer for burner port revision.

PROBLEM: ERRATIC FLAME PATTERN

Cause No. 1: Lack of combustion air. Insufficient combustion air will result in long, lazy irregular flames, with a tendency to wander. The flame will reach toward any available oxygen, consequently leakage of air around peep-hole doors or from other burners will cause the flame to deviate from its normal pattern.

Solution: Open air dampers until flame steadies out.

Cause No. 2: Excessive firing. High firing rates, particularly with gas-mixing orifices or burner ports enlarged above design will result in long irregular flames.

Solution: Check with manufacturer for information on allowable port or mixer drilling and gas pressure for overload condition. Do not make changes unless properly advised.

Cause No. 3: Obstructions in burner ports. When operating at high pressures, aspirating burners may pick up loose trash paper, insects, etc., with the primary air and lodge them in the burner ports.

Solution: Disassemble burner and clean ports. If condition seems likely to repeat, install screen over primary air intake. (This should not be done unless absolutely necessary since it also reduces amount of aspirated primary air.)

Cause No. 4: Improper alignment of burner and tips. (Particularly likely to give trouble with raw gas burners.)

Solution: Check burner for alignment, centering, and proper distance of tip inside muffle block.

PROBLEM: PULSATING FIRE, "BREATHING"

Cause: Lack of draft. As the available draft is exhausted in the furnace the flame begins to pulsate badly, finally reaching the point where it will alternately ignite and go out, sometimes with almost explosive force.

Solution: Reduce firing rate immediately. After pulsations have ceased, check furnace. Stack dampers should be checked if the furnace is so equipped. If no obstructions are found, furnace duty should be calculated to determine if excessive overload is responsible for lack of draft.

Difficulties may arise from a wide variety of causes and the foregoing is not intended as a complete list of possible trouble spots.

5. Quench Tower Start-Up:

Start-Up Procedure

a. Close all valves connecting the quench tower and cracking furnaces (ten vapor inlet lines).

b. Establish an operating level of EDC in the Dopp Kettles, quench tower, and quench liquor surge tank.

c. Start a cooling tower water flow through the primary quench condensers.

d. Open the valve on the vapor line from the Dopp Kettle to the quench tower and the manual block valves on the quench tower drain line.

e. Start a steam flow to the Dopp Kettle through the pressure control valve.

f. When EDC vapors start passing through the quench tower, as indicated by the temperature rise, start a quench liquor flow to the tower from the surge tank.

g. The quench liquor system is now in service, ready for the forward flow from the furnaces.

Check Points

a. Make certain there is a starting level of EDC in quench tower. Hold this level by recycling quench liquor to the quench tower. This level must submerge the gas inlet ports. Never run the quench tower dry. Care must be used in starting up so that dirty EDC does not back down into the furnace passes. This is prevented by letting the cracking furnace outlet pressure increase until it is higher than the quench tower pressure before opening the valves connecting the two.

b. Any large temperature increase at the top of the tower may indicate failure in the quench liquor supply system. The furnaces will have to be shut down if this flow is not restarted immediately.

c. In the pilot plant it was important to eliminate cooling of the furnace gases in the line leading to the quench column. Cooling resulted in carbon deposit formation. This will occur normally, however, at the inlet nozzles according to pilot plant experience. This means that the rod-out assemblies will have to be stroked to clean the inlet ports as pressure drop increases. Always pull out the plunger as far as it will go when rod-out is completed.

6. Dopp Kettles: At full production, both Dopp Kettles will be floating on-stream continuously receiving periodic dumps from the quench column and vaporizing EDC and VC back into the system. Since this is a scraper-type kettle agitating a carbonaceous, black, tarry mass, level indication could be some problem. However, a workable system has been provided via a pair of top-mounted sight ports, one lighted and one for view. The ports are cleaned internally with an EDC flush stream.

Start-up Procedure

a. Turn on all steam tracing for the liquid dump lines to the kettles.

b. Open valve in vapor line from top of kettles to the quench tower. Open valve in the vent by-pass between feed and vapor lines. This allows the tarry liquid to drain completely into each Dopp Kettle after the batch automatic valves close thus lessening the chance for line make-up. If it is found that steam-tracing is a detriment to such an empty line part time, the tracing will be left off. Perhaps the tracing will evaporate all remaining solvent leaving a coating of tars-carbons on the inside of the pipe.

c. Start flow of EDC seal flushing liquor to the agitator seals. This EDC comes from the lean oil stream. Whenever this flow is off, the agitator must by necessity be turned off so the seals do not run without coolant-lubricant. Regulate the pressure control valve on the inlet line to give desired EDC pressure at the seal faces of 95 psig. Regulate flow of EDC to the seals with the 1/2" manual valve provided so that the seal is running cool.

d. Set steam pressure regulator to give desired steam jacket pressure. Open valve in steam line to kettle to be used. Check steam trap for proper functioning. Vent the jacket to remove non-condensables, normally air.

e. As indicated by the quench tower bottoms temperature and level, the dark liquor should be manually or automatically withdrawn to the Dopp Kettles. To effect this operation, open the two Strahman ram-type plug valves in the draw lines passing to the kettles. Leave these valves open all the time except when the outlet gets plugged and needs "ramming" clean or the automatic valve is out for repairs. Open the manual block valves in the draw lines downstream from the level control valves; the automatic on-off control valves will remain shut if the selector switch is on "manual" or if the level is low and the selector is on "automatic". Use the selector switch provided to have either "manual" or "automatic-batch" dumps. On "manual", the operator must observe the sight glass and push the proper button for dumping at the proper time keeping it depressed until the level has decreased to the proper place. On "automatic", alternate batch dumps will be made to each kettle whenever a preset high level is reached in the quench tower. The valve will automatically close when the level reaches a pre-set low level in the quench tower. Therefore, the level will fluctuate up and down in a given frequency of dumps depending on the specific excess amount of quench liquor pouring into the tower.

f. Normal operation on "automatic" batch dumping will cause the level in the quench tower to fluctuate as mentioned above. If this frequency is too rapid, lower the flow of quench liquor slightly to see the effect; if conversely the frequency is too infrequent and the dump liquid consequently too concentrated in tars and carbon, raise the quench flow and watch the effect closely. Make slow changes here.

NOTE: The design of the kettles at full production rate requires both in operation. They will work at the end condition except when a fresh dump is made into the kettle and EDC is being evaporated. They will always contain a mass of hot tars being agitated around at a high 325°F temperature to provide a heat sink. As the tars build up to the top of the external heating jacket, they will be dumped out the bottom into a portable "buggy" for disposal. Even then, the kettles should not be emptied completely of tars.

g. To isolate either Dopp Kettle for some reason like maintenance, only the Strahman valves and the kettle vapor outlet line and vent need be closed.

h. Drain tars from the full Dopp Kettle to the portable "buggy" for disposal. Operator must wear gloves and face shield during this operation to protect his person in the event of a leak. The hot tars cause very painful burns. These dumps are made while the kettles are in operation in order to take advantage of the 70 psig internal pressure for dumping. A vent line is provided to vent the "buggy" to the vent header.

i. The sight glasses located on the tops of the kettles will coat with splashing tars. The tars can be flushed off with a clean stream of EDC, which can be turned on to the underneath side of each sight glass with a valve.

Check Points

a. Make certain the automatic dump control is functioning and the material is being withdrawn to the kettles. If purge liquor will not flow, the drawline will have to be cleaned out. In this case, isolate the Dopp Kettle to be worked on and use the clean-out flanges provided for getting to the pipelines.

b. Make sure EDC seal flush liquor is flowing at proper rate and pressure (15 psig above the internal pressure). Seals should be cool to the touch.

c. Make certain the real level in the bottom of the quench tower is being indicated on the sightglass.

d. Do not let unit cool off while it contains concentrated tars. All tars should be dumped out before steam is ever turned off.

7. Absorber:

Start-up Procedure

a. Set the absorber pressure controller at 50 psig. Open block valves around this PRC.

b. Determine where vent HCl stream is to be sent and line up the proper HCl transfer system. The HCl scrubber will always float on the line.

c. Pressurize the absorber to 50 psig with N_2.

d. Make certain operating levels are in intercooler tanks and in the bottoms of the absorber, stripper, and product still. Now the refrigeration unit and lean oil flow (Flywheel No. 2) can be started.

e. The intercooler pumps must be started in order for the control valves in the gravity overflow lines from the trays to open up to the intercooler tanks. Open valves in the draw tray lines to the respective intercooler tanks. Select the draw tray to be used at this time. Open the intercooler tank vent lines to the respective draw tray. All other valves in liquid draw lines and tank vent lines should be closed. Unblock the intercooler level control valves. Set level controllers at desired control point for the intercooler tanks. Start intercooler pumps.

f. The absorber is ready to accept vapor and liquid feed streams from the quench system.

g. When vapor feed to absorber commences see that the pressure control valve is holding the set point value. This is the main pressure controller for the front end of the plant.

h. Lean oil temperature to the absorber top tray should be regulated so that the EDC will not freeze on the tubes in the -40° lean oil cooler. Close control of this temperature will be obtained by automatic regulation of the suction damper in the 14" line to the refrigeration compressor. Fine control of the lean oil temperature may be obtained by manually adjusting the flow of hot liquid by-pass around the 34° lean oil cooler. If there is danger of a freeze-up, the by-pass allows a warming-up of the effluent stream.

i. If it is found during operations that the proper draw trays are not being used, the other available draw tray to each intercooler unit will be used. At any one time, only one tray should be open to each intercooler tank.

Check Points

a. See that proper control over the lean oil temperature is obtained. This temperature must be maintained at -29^{o}F as it enters the absorber. EDC freezes at -32.2^{o}F. Check the field-indicated temperature and the temperature recorded on the control board for agreement. They must agree or be checked.

b. Be sure the draw trays are taking the full absorber downflow stream. If not there may be plugging or vapor lock in the draw line. Flow indicators measure the flow to the intercoolers, but will represent more than the overflow if the manual by-pass valves are open back to the intercooler tanks for recirculation.

c. The HCl vent transfer system from the absorber must be connected up properly with the correct valves open. Otherwise excessive and detrimental back pressures may be built up on the absorber.

d. Check the absorber level control valve in the field for proper functioning. This controller is not in the control room.

8. HCl Stripper: Careful operation of the stripper is important, since whatever HCl gets through the stripper bottoms will end up in the vinyl product and will have to be neutralized with flake NaOH. The reboiler steam flow will be controlled on the basis of control chemical analyses made on the stripper bottoms stream for HCl.

Start-up Procedure

a. See that proper start-up level of EDC is in reboiler.

b. Select the tray that will be used to receive the excess quench liquor from the quench liquor tank and close all alternate feed line valves.

c. Open block valves around the level control valve in the feed line to the stripper from the absorber.

d. The York refrigeration unit and Flywheel No. 2 may now be started. Turn on the stripper feed pump. Open the block valves on the liquid overflow line to the product still feed tank and the equalization line from it to the stripper.

e. Start-up stripper reboiler. Open block valves around the steam flow control valve. Open the 100 psig steam to the flow control valve, then set it at a steam flow to give desired stripper boil-up rate. Check the steam trap for proper operation.

f. Stripper is now ready to receive the EDC-VC-HCl stream from the bottom of the absorber.

g. Make fine adjustments with the steam flow controller set point so that the stripper bottoms will analyze less than 10 ppm in HCl content. Remember, the temperature is already fixed by pressure and composition of liquid which must pass through this point. Therefore, boil-up rate is the only variable available to do the HCl stripping effectively.

Check Points

a. Maintain proper level in the reboiler sight glass. This should be done automatically due to the overflow arrangement.

b. Very careful handling of the flow controller must be exercised to establish the proper boil-up rate so that the stripper bottoms stream will be essentially free of HCl. No more than 10 ppm HCl should be in the bottoms liquor. The operator can prevent a loss of flake caustic handling if the stripper is operated correctly.

c. Make sure that the material equivalent to the EDC and VC in the furnace discharge plus the EDC lean oil is being sent through the stripper reboiler and on to the vinyl still. This stream cannot be temperature controlled, since concentration and pressure have already been set. The concentration at this point should be 12-15 wt. % VC.

d. Check the steam trap at the reboiler for proper functioning.

9. Product Still: This still is designed to operate critically at both the top and bottom of the column. This is, EDC and other minor heavy constituents must be kept out of the still product, and in like manner VC must be kept out of the bottoms. The production of pure vinyl product is the controlling limitation, so it should be met first. However, it should be pointed out that in general all VC appearing in the still bottoms will be lost from the system either by (1) being sent to the absorber and vented with the HCl or (2) being sent with the recycle EDC to the chlorination step and there converted to 1,1,2-trichloroethane which represents a loss to the system.

Start-up Procedure

a. Set the pressure controller at 75 psig. Turn on 100 psig N_2 supply and open the block valves around the pressure control valves. The still will now pressurize up to the 75 psig set point.

b. Make sure recycle EDC chlorine is available up to the chlorine flow control valve.

c. See that cooling water is on the still condenser.

d. Open valve in feed line to proper tray. This initially will be tray 30. Close valves in alternate tray feed lines (trays 22, 26 and 34).

e. Start-up charge of EDC should be in reboiler. Drains should be closed. A start-up level should also be in the reflux drum.

f. The recycle EDC level control valve, should be blocked off.

g. Follow the reboiler start-up procedure.

h. The VC in the column will pass overhead to the condenser and reflux drum. If there is no VC inventory in the still at start-up, then pump some to it from storage. Otherwise, the column will have EDC from bottom to top and it will not be possible to use the automatic temperature controller.

i. When there is a level build-up in the reflux tank, start reflux to the still. To do this turn on the reflux pump and open the block valves around the reflux FCV. Set the FRC so that some level is maintained in the tank. Increase the reflux flow to the desired set point as soon as possible. This will take some time for at least two reasons. First, the still is cold and it has to be warmed up. Secondly, the first overhead product will contain a lot of EDC and some time will be required to work the EDC and/or other impurities out of the reflux tank. The still cannot be put on full reflux at once or it will flood. All impurities must be removed from this reflux tank or the first material produced will have to be reworked later on.

j. Leave the still on total reflux until the top tray temperature, at 75 psig is 100^{o}F and the reflux receiver is over half full.

k. The still is now ready for the York unit and Flywheel No. 2 to be started.

l. After VC is being sent to the product still and the reflux tank level starts increasing, open up the proper valves so that VC product can be piped to storage via the following route: (1) from the level control valve through the product cooler to one of the flake caustic neutralizers; (2) from the flake caustic neutralizer to be used to one of the eight monomer day tanks. Be sure to pass through both phase separators.

m. As product VC fills the reflux receiver past half full, open the isolation valves around the level control valve and slowly bring up the set point on the level control valve to the desired level control point. Until the flake caustic neutralizer on line is filled completely with VC, vent the top of the neutralizer through the line provided to the vapor line to the still condenser.

n. The EDC that does not crack in the furnaces (the recycle EDC) will begin to build up in the vinyl still reboiler. To lower and control this level at the proper value, adjust the set point on the controller and open block valves around the control valve. Open up any other valves in the line between the product still reboiler and the heavies still feed tank. The recycle EDC stream will now begin to flow.

o. Open up block valves around the chlorine FCV and adjust the chlorine flow to the proper setting for the recycle EDC chlorination.

p. Check to see that the product still controller is giving the approximate temperature desired in the vinyl reboiler. Refine the set point value by obtaining analyses on the still bottoms. Raise the set point (higher temperature) if too much VC is in the reboiler liquor. The VC should be 0.5 wt. % or less at this point.

q. Check the pressure controller to see that the still pressure is at its control point.

r. Have F-12 system adjusted on the vent condenser if the proper temperatures are not being obtained. Troubleshoot with the process inlet and outlet temperatures. Also, the liquid refrigerant temperature and the F-12 vapor pressure in the exchanger shell will be helpful in checking out a poorly functioning system.

s. The proper still feed tray location will be determined after operations have commenced. Sample analytical traverses will be obtained from the trays so that the feed composition can be matched to a particular tray.

Check Points

a. See that the reboiler steam trap is working.

b. Adjust the temperature controller set point so that the bottoms VC concentration is as low as practicable without causing heavies to appear in the VC overhead product. Remember, keep EDC out of the overhead VC product as a first priority.

c. The vent condenser must be in operation to keep the VC losses at a minimum.

10. VC Neutralization, Product Cooler: Product VC from the still will contain some HCl. It is necessary to remove this by neutralization with flake NaOH. This is where it pays to run the stripper bottoms as free of HCl as possible.

Start-up Procedure

a. See that cooling water is on the jacket of the product cooler.

b. Select one of the two dried flake caustic product neutralizers for service. Be sure an adequate charge of NaOH remains in the neutralizer selected. Isolate the other one with the valves provided. Open up valves around the neutralizer to be used so that liquid flow will be from the cooler through the phase separator (which should be about 1/2 full of water) to the bottom of the neutralizer, then out the top of the neutralizer to the down-stream phase separator and on to the storage tank area.

c. The vapor vent line from the top of the neutralizer to the stil[illegible] should be opened.

d. Be sure the drain valve at the bottom of the neutralizer is closed.

e. The product cooler phase separators, and the on-line neutralizer are ready for feed.

Check Points

a. The VC passing through the downstream phase separator must be perfectly clear. If entrained solids are present, switch to the other neutralizer. Drain the VC liquid from the offending neutralizer. Recharge the neutralizer with fresh NaOH and fiber glass packing.

b. Closely follow the water analyses of the effluent VC from the flake neutralizers. These analyses will be used to determine when a neutralizer is no longer able to retain the water of neutralization. The analyses will also show when the neutralizer is losing its effectiveness to neutralize the HCl present in the VC product.

c. Some water may have to be added to the upstream phase separator to open up a blocked neutralizer.

11. Chlorination of Recycle EDC: More than the two-minute minimum retention timeoof recycle EDC with chlorine at a temperature of 180^{o}F has been allowed for the chlorination of unsaturates, especially chloroprene. IT WAS FOUND THAT CHLOROPRENE IN VERY SMALL AMOUNTS IN THE CRACKING FURNACE FEED HAD A DEFINITE, DELETERIOUS, EFFECT ON THE CONVERSION. IT MUST BE REMOVED FROM FEED TO THE FURNACES.

Start-up Procedure

a. Bring gaseous chlorine to the flow metering station. This will come from the chlorine vaporizer in the Tri-Ethane plant.

b. Open up the block valves around the flow control valve.

c. When recycle EDC is flowing, add chlorine by adjusting the automatic controller to the proper flow rate. Use analyses of the chlorinated recycle EDC stream to determine whether further adjustments are required in the chlorine flow.

Check Points

a. If furnace conversion ever falls off necessitating a higher cracking temperature, SUSPECT CHLOROPRENE.

12. Heavies Still: This still is designed to remove the heavies from the recycle EDC. It will also remove heavies from the make-up EDC from the EDC plant until the second cracking furnace is installed. Then a new heavies still will be installed in the EDC plant to remove the heavy impurities from the make-up EDC. The purified EDC make-up stream will then be added to the heavies still reflux tank.

Start-up Procedure

a. Make certain cooling water is on the still condenser and that 200 psig steam pressure is available at the temperature control station.

b. Open the proper feed tray valve. For initial start-up operations open the valve to tray 27. The exact feed valve to use will be determined by operating experience and analyses.

c. Open manual valves on each side of still reflux control valve and on back through the reflux pump to the reflux drum. Leave the reflux pump discharge valve closed.

d. Open manual valves in the still feed line between the feed tank and the still. Leave the discharge valve on the still feed pump closed.

e. Check the still reboiler level. The initial start-up level for the reboiler is at the top of the sight glass.

f. The start-up level should be in the still reflux drum. A higher level can be used if the unit was recently shut down.

g. Turn off the nitrogen pad that has been held on the unit since it was cleaned for start-up (or after a shutdown was made).

h. The still bottoms discharge line should be blocked off.

i. Turn on steam to the reboiler. Follow the reboiler start-up procedure. As the reboiler temperature starts to rise, the still pressure will come up. When a slight positive pressure is obtained, open the still vent line to bleed off the inerts.

j. As the reboiler temperature comes up, the level will drop. If the level goes below the normal operating level, add some reflux to the still from the still reflux drum. Watch the reboiler level closely, as it can easily change during start-up.

k. Slowly raise the steam flow until it is approximately at the desired operating value.

l. As the still vapor line comes up to 183°F and a level rise is indicated in the still reflux drum, start the still reflux flow. Begin the flow low and increase it to hold a constant level in the reflux drum. Increase the reflux until the proper flow for a 1:1 reflux ratio is obtained. Base the reflux ratio on the still output. Regulate the reboiler steam flow to hold a constant level in the reboiler at the set reflux rate by remote-manual opening or closing of the temperature control valve.

m. Close the still vent after the temperatures are established and open the nitrogen pad to the still condenser. All inerts should be vented from the still.

n. The still is now on total reflux with no feed or bottoms withdrawal.

o. Put the steam controller on automatic if enough heavies are present for automatic control.

p. Start feed to the still from the feed tank. Slowly increase the feed to the still until the still feed is equivalent to the vaporizer feed.

q. Increase the set-point on the temperature controller to the desired reboiler temperature. This must be done slowly as the reboiler can be boiled dry if a sufficient quantity of heavies is not present.

r. When the desired reboiler temperature is reached and the level begins to rise above the set level, begin bottoms withdrawal by opening the block valves around the level control valve and turning on the still bottoms pump.

s. The still bottoms should be transferred to the still bottoms storage tank in the EDC plant.

t. At this time the EDC make-up stream should be adjusted to hold the heavies still feed tank level constant.

Check Points

a. Make certain cooling water flow is on the condenser.

b. When the still is in operation a N_2 pad should be on the units to keep constant pressure.

c. The reflux flow should be adjusted to give a 1:1 reflux ratio.

d. The reboiler level should be below the vapor inlet from the reboiler.

e. The still production rate will be twice the EDC recycle flow. This fact should be remembered when flows around the still are being set.

Trouble Shooting

There can be many operating difficulties associated with distillation columns, particularly when they enter service for the first time. Such problems include flooding, entrainment and similar occurrences that interfere with proper fractionation. How can the operator recognize and correct these situations? Temperatures, pressures, and product purity are the diagnostic tools for the difficulties described below:

You must have vapor pressure-temperature data on the materials being fractionated when you are operating distillation columns. Pressures (read on process gages) can serve as a temporary guide to performance when key temperature control is inoperable or not dependable. Grabbing samples from various trays for check analyses is another conventional technique for determining performance.

Operators should check the temperature profile across the column to be certain that it is consistent with the anticipated pattern. Excessively high temperatures in upper parts of the column may indicate vapor bypassing, due to excessive velocities or inadequate liquid tray-loading. Insufficient liquid on trays can be caused by inadequate weir height or missing or leaky valves.

Note that inconsistent temperatures may not always indicate process upsets. Checking thermocouples or seeing that thermowells are properly installed can sometimes eliminate what at first appears to be a process probelm. Be certain that thermocouple immersion liquids are provided where required and see that insulation is sufficient to stop heat leaks around thermocouples or thermometer bulbs.

Column flooding is most frequently confirmed by differential pressure readings. When much higher than normal Δp's prevail, particularly with fluctuation or surging, it is very likely that there is flooding. Typical techniques for "dumping" flooded columns are: withdrawing or curtailing feed, dropping reboil heat, or temporarily increasing pressure.

Usual cause of flooding is excessive liquid downflow at high vapor loading. Plugged trays can also cause this condition. Too cold a feed can also result in flooding and poor column operation. Finally, don't overlook the possibility that the bottoms takeoff line from a still may be plugged, causing the liquid level to rise above the reboiler vapor inlet to the column.

Entrainment of liquid can be traced to excessive vapor velocities through the valves or the column proper. This can be reduced by cutting back reboil heat. Engineers should recheck liquid and vapor velocities to be certain that design considerations have not been overlooked. In general, the columns have been sized at 40-60% of loading conditions.

Foaming-over is another problem in distillation. This is ascribed primarily to properties to the materials being handled under the turbulent conditions in the column. Column design (tray spacing) should consider this potential difficulty. Defoaming agents such as silicones have eliminated the problem in many cases. Experience with EDC stills indicates that foaming will be little or no problem.

Packed columns are particularly vulnerable to certain of these operating difficulties. If packing is not properly loaded into the tower and provision made for even liquid distribution, poor separating efficiencies, if not flooding, may result.

13. HCl Transfer, Absorption: It is intended that HCl will be distributed to an outside consumer (via the carbon filters and No. 3 HCl compressor) and to the Ethyl Chloride and OHC plants (via a manual loading valve and No. 5 HCl compressor). The HCl scrubber will be floating on the line at all times to catch upsets and mis-match of HCl consumption and production.

Start-up Procedure

a. Open the block valves on each side of the absorber pressure control valve.

b. Close the block valves to the carbon filters and open all block valves to the HCl scrubber (HCl, water, and cell liquor). Also close the block valves to the manual loading station which goes to No. 1 and No. 2 HCl compressors.

c. When a sustained HCl flow has been established, open the block valves to No. 3 compressor and slowly open the pressure control valve on manual control until a sufficient amount of HCl is passing through the compressor. This will have to be coordinated with the rate of conversion in the cracking furnaces and the subsequent rate of rise of HCl flow from the absorber.

d. Put the pressure control valve to No. 3 HCl compressor on automatic control.

e. Check the HCl gas stream from the carbon filters to ascertain whether one or two filters are needed.

f. As the HCl flow increases, an increasing amount of gas will be passing to the scrubber. Open the block valves to the manual loading station and then slowly open this control valve until no HCl is being scrubbed. This valve will have to be manually adjusted from time to time to avoid scrubbing HCl gas.

g. The block valves to the back-pressure control valve leading to the scrubber should remain open at all times. This valve will open whenever the pressure downstream of the absorber pressure control valve exceeds a preset value.

Check Points

a. Check the scrubber effuent stream passing to the scrubber to make certain enough cell liquor and water are being fed to the scrubber.

b. Keep all block valves on the cell liquor and water lines open so that these two flows will start automatically at the proper signal. The cell liquor flow control valve and pump are actuated by an HCl flow to the scrubber, while the temperature of the scrubber effuent to the sewer determines the amount of water flow through the water temperature control valve.

14. Product Storage and Transfer: Eight storage tanks have been provided as day tanks for VC storage. As each of these tanks is filled, it will be analytically cleared and pumped to one of the three spherical tanks. All eight day tanks are piped up identically.

Start-up Procedure

a. Make sure that everything is operable on tanks, i.e., gauges, relief valves, level indicators.

b. Air in tanks must have been purged out with nitrogen.

c. Fill tanks to 90% of capacity only.

d. Use product storage transfer pumps to transfer the VC from one tank to another, to circulate a tank's contents, or to transfer the VC in a day tank to a spherical tank.

e. Make certain the proper valving is used in making a transfer.

f. If a tank does not meet the monomer specifications, transfer the batch back as feed to the vinyl still via the rework pump and rework line. The batch will have to be worked off slowly so as not to flood the still.

Check Points

a. Check for leaks from the system on a continuing basis since much monomer can escape in a short period.

15. York Refrigeration Unit

Start-up Procedure

It is assumed that the unit has been charged with Freon-12. All exchangers will have a normal operating level and be completely valved off.

a. Start the pump-out compressor. If the low stage suction pressure is too high, the compressor motor will not be capable of accelerating the compressor to design speed. A pressure switch will prevent the motor from starting if the suction pressure is above 44 psig. All of the compressor suction and discharge valves must be closed to pump out the casing. The compressor must be started with the suction valve closed, but it must be throttled open immediately on starting to prevent shutdown on low suction pressure.

Start-up under this condition must be done with the "start-up normal" switch for the 2nd, 3rd, and 4th stage switches in the "start-up" position to keep the side suction line butterfly valves closed until the compressor is up to full speed. Then the switches can be put in the "normal" position. Some "hot" start-ups may also require manual throttling of the side connection hand valves to prevent motor overloading.

b. Energize the control system and compressor oil heaters at least four hours prior to start-up. Set the thermostat at 160°F. This boils the F-12 from the oil to prevent foaming during operation.

c. Make sure cooling water is on the F-12 condenser, gear oil cooler and compressor oil cooler.

d. Open the cylinder-operated valves in the F-12 vapor line from each refrigerated exchanger to the K.O. drums.

e. Check the five drain valves on the bottom of the compressor casing to assure that all liquid has been eliminated.

f. Turn auxiliary oil pump switch to "auto" position.

g. Start the compressor. Manually throttle the suction damper open immediately after pushing the button. Put the switches for the 2nd, 3rd, and 4th stages in the "normal" position.

Start opening the block valves for the level control valves which supply liquid F-12 to the heat exchangers.

h. Check to see that compressor oil pressure is being maintained and that the oil is not foaming excessively.

i. Reduce the system temperature by manually adjusting the suction pressures (all stages). When the system pressures start lining out and the unit is not surging, put the pressure controllers on automatic control.

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RECURRING RESTART PROTECTION

NEMA STANDARD

2 starts cold or ambient

or

1 start @ rated temperature

Any subsequent starts require that motor returns to normal rated temperature before they can be made. This is accomplished by an electrical timer that must ime out after the attempted starts. The timer on the G.E. starter is adjustable from 3 to 100 minutes. It came from the factory set at 60 minutes, which G. E. engineering in Houston suggested for our motor.

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C. Special Plant Procedures

1. Initial Start-up: As in any new plant, the initial start-up will differ from a routine shut-down/start-up in many ways. The following items are pointed out as being especially associated with new start-ups:

a. The system must be cleaned, dried and purged to rid it of water and oxygen. It is particularly helpful to circulate EDC through the system and operate the vinyl still reboiler so that the water can be azeotroped overhead to the reflux receiver, where it can be phased off and discarded with some improvising.

b. A new or freshly decoked cracking tube in a furnace seems to be quite active in converting EDC to VC. This activity, however, will subside shortly and stabilize at a given conversion as the tube becomes finely coated with a layer of carbon. The temperature to produce 50% conversion lies in the range 950-97[illegible].

C. Particular attention must be given to keep water from entering the system at all times. Water that leaks into the system will collect in the vinyl reflux receiver. Never leave permanent a tie-in of steam or water to the process side.

2. Decoking Procedure for Furnaces: In the pilot plant it was necessary on occasion to decoke the furnace tube when carbon build-up caused excessive tube pressure drops. With good steady operation below 60% conversion, though, coking of the cracking tubes should be of minor concern. The Ptero-Chem recommended procedure for tube decoking is given below.

a. Type of Deposits

Deposits can be of a powdery type, scarcely adherent to the pipe internal walls, or of a compact type, highly adherent to the pipe walls. They may build up within either the vaporization furnace during heating of the product, part of which, not cracked in the cracking furnaces, is recycled, or within the cracking furnaces owing to the process in course.

Product overheating may likewise contribute to build up deposits, which, when increasing in volume, will result in more or less serious pressure drops.

b. Decoking Intervals

The tubes decoking operation must be carried out at variable intervals depending upon the flow nature, purity, rate, outlet temperature, and particularly upon the furnace operation system. In our case, the frequency of the decoking operations might be such as to require cleaning of the cracking furnaces every two hundred hours at full load operation, whereas the decoking intervals might be far longer for the vaporization furnace.

It must, however, be considered that the above data are merely indicative and subject to broad variations, as a furnace not overloaded and correctly operated may be operated for as long as a year without decoking.

c. Conditions Requiring Decoking

In order to establish when decoking has to be carried out, the furnaces are fitted with the below listed instruments(besides those normally required for the operation of furnaces):

Vaporization Furnace

(1) One indicator of pressure differential between the incoming and the outcoming flow.

Cracking Furnaces

(for each furnace)

(1) One flow recorder-regulator for each pass.

(2) One outlet temperature indicator for each pass.

(3) One recorder of pressure differential between the incoming and the outcoming flow.

(4) One tube metal temperature for each pass.

The decoking operations can be started under the following conditions:

For the vaporization furnace: when the pressure drop in the coil exceeds by approximately 20% the normal pressure drop under clean pipe conditions.

For the cracking furnaces: both when the pressure drop reading shows such a value as to indicate the metal temperature is reaching the maximum allowed temperature, and when the flow differential between the 4 passes rises to an abnormal value, that might be indicatively fixed at approximately 30% above normal. Also, the tube metal temperatures should be a primary indication.

Of course, the above data are given just as an indication, and they can be changed according to practical experience.

d. Operating Principles of the Suggested Decoking Process

It is felt a convenient decoking method for the dichloroethane vaporizer and cracking furnaces is by thermal means. This method, speedy and scarcely expensive, is based upon the alternate circulation of steam and air within the process pipes, externally heated by the furnace burners. Thus, the chemical reactions of water-steam and air-oxygen with the hot coke takes place at a controlled temperature. To this chemical action the mechanical deposit scaling action is added as well as the dragging action of steam(spalling).

e. Decoking Method

Each complete pass (convection and radiant areas) of the cracking furnaces shall be decoked separately. When one of the four passes of the above furnaces has to be decoked, it will be possible, for instance, to decoke one of the passes of one furnace while maintaining in the other passes of the same furnace a steam flow such as to avoid overheating of the pipe metal.

After it is established at what frequency decoking is required, it may be desirable to decoke all passes at the same time. However, it is suspected that such close control will be required for this,that it will be discouraged unless decoking frequency has become a problem in meeting production demands.

Temperature points are provided for checking the temperature of the outcoming decoking fluid. These are also the process temperature points already mentioned.

f. Piping System for the Decoking Process

In order to reduce the time required for the decoking of a furnace, it is advisable to prepare beforehand the steam and air supply system.

This system is particularly interesting owing to the fact that it enables supplying steam in the two directions of circulation to the passes to be decoked and decoking air in a forward direction.

g. Description of the Decoking Process

(1) After the furnace has been shut down and purged, connect the air/steam supply system to the pass to be decoked, and put in operation the air and steam flow indicators, the gauges and the cooling water system. There are many Figure 8 blinds which must be manuevered properly. Also, the steam inlet elbows to the furnaces must be put in place.

After the furnace is shut down and purged with N_2 and isolated from the rest of the system:

a) Install removable spools for steam-air entrance into the convection coils of each pass.

b) Close the Figure 8 blinds downstream of the EDC flow control valves so that steam will not back down into the valves and so no EDC by chance can leak through. Of course, close the block valves around these two control valves.

THIS PERMITS THE INJECTION OF STEAM OR STEAM AND AIR INTO THE FRONT END OF EITHER OF THE FURNACE PASSES WITH FLOW METERING FOR AIR AND FOR STEAM.

c) Install the removable spool pieces in the pass outlet pipes which carry the decoking products to the coke knock-out drum.

d) Close the Figure 8 blinds on the outlet of each pass which carries the process stream forward to the Quench Tower so that no steam will enter this system. Open the manual valves in the lines going into the header entering the coke knock-out drum.

YOU ARE NOW SET UP TO KEEP WATER OUT OF PROCESS PIPING EXCEPT THE FURNACE PASSES AND TO CARRY DECOKING PRODUCTS TO THE COKE KNOCK-OUT DRUM WHILE FLOWING FORWARD.

e) The quench water entering the knock-out drum should be turned on. Also, turn on water at each funnel sampling point so that when the outlet decoking gas is sampled it will be immediately quenched into the funnel and drained away allowing a visual check on the progress of the decoking spalling.

NOTE: All of the Figure '8' blinds and removable spool pieces must be put back as they were prior to decoking after the decoking is completed. No decoking connection can be left permanently attached to the process piping because of danger of steam leaking into the system.

If to complete the spalling, it becomes necessary to reverse the steam flow through the furnace passes, these things must be done:

(a) Make sure steam is available at the respective pass outlet.

(b) Two operators are required for this operation of switching.

(c) When the forward flow is coming through, open the reversal steam flow to the desired rate. It will simply be purging into the coke knock-out drum with the forward flow products.

(d) One operator is stationed at the header entering the coke KO drum and the other is near the forward flow stations.

(e) To reverse the flow, the operator near the header going to the KO drum must close the valve in the line from the pass outlet to the coke KO drum while the other operator opens the valve from the same pass inlet to the coke KO drum. The forward flow of steam will probably not have to be turned off since it will simply flow to the coke KO drum with the reversal steam flow coming out the front end of the furnace to the drum. It must be determined first that the step (c) flow acts properly as well as the forward flow feed when reversal is tried - i.e., they simply by-pass their job and go direct to the coke KO drum.

CAUTION ON REVERSAL: Make sure the steel convection tubes are not subjected to temperatures above 690°F.

(2) Insulate tubes not to be decoked by conveying through them such a steam flow as to have the temperature not exceeding 900°F during the whole process.

(3) Keep a burner operating at low rate and raise the smoke temperature up to approximately 300°F within one hour time.

(4) Increase heating gradually, always at a rate of approximately 300°F per hour, until a smoke temperature of approximately 1350°F (at the top of the radiating section) is reached.

(5) Increase the steam flow proportionately, so as to have its outlet temperature not exceeding 1000°F.

(6) Keep the smoke temperature at 1350°F during the steam spalling-decoking. During this period the steam flow in passes being decoked shall be as follows:

- for the vaporization furnace ....approx.

- for the cracking furnace ....approx.

(7) In principle, a large part of the coke deposits shall be removed, and in order to improve the removal and detachment of these particles the below listed recommendations are given:

- quickly invest the direction of circulation in the coil; watch that the design temperatures of the convection sections are not exceeded (690°F) by this reversal of flow;

- quickly reduce and increase the steam flow;

- reduce and raise the smoke temperature by alternately reducing and increasing the burner rate;

- add a small air quantity over few minute periods.

(8) During the steam spalling-decoking operations examine the nature of the coke deposits removed from the coil, and if they are too greasy reduce the steam flow to avoid erosion.

(9) The decoking operations progress can be checked by looking at the below listed details. Use is made of sample points and funnel drains at the furnaces to see a quenched pass sample.

- appearance of the effluent at the initial and final decoking stages (milky gray);

- appearance of the effluent during the removal of fine particles (light gray to black).

- appearance of the effluent during air blowing in (reddish).

- the more or less considerable quantity of coke particles.

(10) When coke particles are no longer seen at the coil outlet sample tap, and it is ascertained that the possible fine powder collected is not caused by a too high steam speed, the steam flow shall be reduced.

(11) Reduce heating until a smoke temperature of approximately 1200°F is reached, and adjust as follow: the steam flow to the tube pass being decoked;

- vaporization furnace ....approx.

- cracking furnace, each pass ....approx.

(12) Gradually introduce some air to reach a steam/air weight ratio of approximately 9:1.

(13) Carefully check the temperature of the pipe metal and the appearance of same: on some pipes hot spots, sometimes movable, will be noted, indicating that coke deposits are burning. If this operation is carried out by night, the position of the hot spots will be more noticeable.

(14) Don't let the pipe metal temperature exceed the below listed values:

- for carbon steel ....approx. 690°F vaporizing furnace, and cracking furnace convection sections.

- for 18/8 stainless steel ....approx. 800°F cracking furnace radiant sections.

(15) On the other hand the furnace temperature must be kept sufficiently low to avoid pipes becoming red with the exception of the hot spots where coke is burning.

(16) The pipe temperature check might be done, for pipes that are visible, by means of an optical pyrometer.

(17) By means of the Orsat apparatus check the CO_2 contents in the effluent and keep it at 19% by setting the temperature in order to maintain an even combustion (maximum outlet temperature 650°F).

(18) When no CO_2 is contained in the effluent and when no hot spots are anylonger noted in the pipes, the following checks are to be made:

- shut off the extinguishment water and place a burning brand at the effluent outlet point. If the brand is extinguished this means that decoking is not yet complete, whereas if the brand becomes even more incandescent decoking can be considered as completed.

- in the latter case shut off the air supply and raise the steam flow to the same level as in the initial stage, in order to remove the residual ashes.

- stop testing while maintaining the same steam flow in order to cool the furnace. When a temperature of approximately 480°F is reached, clean the tube by N_2 purge and then carry out a N_2 pressure test.

- dismantle the air/steam decoking system and, if needed, clean the other passes as above described. Always disconnect the steam line from the furnaces after decoking is finished.

g. Major Precautions

(1) Avoid overheating tubes. Watch closely for local hot spots. Do not exceed 1300°F metal temperature. Use optical pyrometer is available.

(2) Avoid excessive velocities through tubes. Coke particles are very abrasive and can cause serious erosion of return bends.

(3) If heater has a separated convection section, maintain steam flow at all times through convection section to keep outlet temperature below 900°F.

(4) In reversing steam flow through the furnaces, make sure that the steam temperature does not exceed 690°F as it passes through the carbon steel convection passes. Keep the velocity high enough to keep below 690°F.

(5) As the color is more pronounced at night, some operators perfer to conduct burning in the dark.

(6) Furnace temperature must be kept down so that tubes generally do not show red. The only hot spots on tubes should be where coke is burning.

3. Furnace Efficiency

The efficiency of the furnace is controlled by the amount of excess air used in combustion. Generally the furnace should be operated with a minimum of excess air as long as the flames do not reach excessive length or impinge on the tubes or cone. These furnaces are designed for 20% excess air.

Visual examination of the flames in a furnace is not a satisfactory means of arriving at excess air and the Orsat should be depended upon to give this information.

Due to the fact that the liquid in the tubes flows progressively around the Iso-Flow Furnace it is difficult to obtain a true average flue gas reading before the cooling air is introduced at the base of the stack. For calculating efficiencies and stack loss the temperature of the flue gas should be taken in the stack above the flare and the flue gas samples should be taken at this same location. In addition, it is important that the thermocouple and the gas sampling probe each be extended the same distance into the stack.

For obtaining a check of excess air at the burners a sample should be taken from the upper observation door.

Operation at 20% excess air rather than 30-40% used generally will require closer attention from the operators.

In an attempt to secure maximum furnace efficiency by running with a minimum of excess air it must be remembered that for each 0.1% CO present in the flue gases, efficiency drops off by 1.0%. Hence, firing with small amount of CO present in the stack gases is more detrimental than firing with slightly increased excess air. Furthermore, there is a considerable danger of the CO content "snowballing" due to the decrease in efficiency and the attendant limiting of combustion air. The furnace may then become loaded with dangerous quantities of carbon monoxide.

In all instances where flue gas samples are taken at low excess air (below 15% or when oxygen content is less than 2.5%) a complete test must be run to include a reading of CO as well as the CO_2 and O_2 readings normally taken.

DETERMINATION OF FURNACE EFFICIENCY FOR OIL AND GASEOUS FUELS

1. Measure percent CO_2 and O_2 by Orsat analysis. Use stainless steel sampling tube to prevent error from oxidation. Under no circumstances should copper tubing be used in the gas sampling tube.

2. Take stack temperature (preferably with high velocity couple).

   These two measurements should be made at the same location at the same time. In Iso-Flow Furnaces it is recommended that they be taken through the connection provided for this purpose in the [illegible]. [illegible] taken [illegible] extend both the thermocouple and gas sample [illegible] distance into the stack.

3. Measure combustion air temperature.

4. Measure quantity of fuel.

5. Measure gross calorific value of fuel.

6. Determine stack losses by calculation. (H/C ratio of average refinery gas varies from .24 to .31 and of fuel oil from .09 to .15).

4. Automatic Burner Damper Control:

Flue gas samples will continuously be sent to a Bailey Analyzer where the percent oxygen and percent combustibles are determined. The heat of combustion and the resulting increase in the temperature of a filament are proportional to the amount of oxygen or combustibles in the gas sample. This signal is then transmitted to a controller on the panel board. The controller then sends a signal to a control drive which controls the air damper position. If the set-point on the controller and the signal from the transmitter to the controller are

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not the same, then the controller signals the control drive to reposition the damper as necessary for the desired percentage oxygen in the flue gas.

Two switches are provided for operation of the air damper control drive. One is for automatic (supply) and one for manual control. Following is a description of the position of these switches for various operations:

Manual Operation :

a) Supply valve in closed position.

b) By-pass valve in open position.

c) Hand lock lever pulled up tight when hand lever is not being operated.

d) With the hand lock lever released, position the Drive by manual operation of the hand lever. Pull the hand lock lever up tight to hold the Drive in any position.

Transfer from Manual to Automatic:

a) Adjust the loading pressure to the positioner so that the balance beam is centered between the upper and lower stops.

b) Turn by-pass valve to"Closed-Auto"

c) Release hand lock lever.

d) Slowly turn positioner supply valve to"Auto-Open".

e) The Drive is not set for automatic operation

Automatic Operation:

a) Supply valve in "Auto-Open" position.

b) By-pass valve in "Closed" position.

c) Hand lock lever released.

d) The Drive piston is now positioned automatically.

VII - SHUTDOWN PROCEDURES

A. Overall Shutdown Procedure (Furnaces, Flywheel #1, Flywheel #2)

1. Notify EDC and the HCl-consuming plants of the intended shutdown.

2. Shutdown the Dopp Kettle agitator and seal liquid. The agitator must be off before this liquid is stopped.

3. Lower the furnace exit temperature on automatic to 900°F and hold for 15 minutes, then drop 100°F more and hold for 15 minutes. Put the fuel temperature control valves for each cracking furnace on manual control. Open the by-pass around each feed flow control valve for each cracking furnace pass and establish the same flow as on automatic. Shut off burners and pilots on cracking furnaces.

4. Put the vaporizer feed FCV on by-pass control to provide an EDC flow after the time-delayed shutdown of the FCV. Shut off the burners and pilots.

5. Add N_2 to the quench tower and absorber to keep the flywheels OK on pressure.

6. Lower the quench tower level to the bottom of the sightglass by dumping into the Dopp Kettles.

7. Turn off the furnace feed pumps and start adding N_2 into the vaporizer simultaneously.

8. Close all cracking furnaces pass outlet valves and shut the N_2 off.

9. Decrease the quench liquor flow until the need for it has ceased. Then shut it off, turn off the quench liquor pump, and close the block valve around the quench liquor FCV.

10. Shut off steam to the stripper reboiler and product still reboiler.

11. Shut off the York refrigeration unit.

12. Shut the Flywheel #2 pumps down; these are the product still feed pump, the lean EDC pump, and the stripper feed pump.

13. Turn off the intercooler pumps. This shuts the tray overflow valves

14. Turn off recycle EDC chlorination when recycle EDC flow falls off. Close block valves around the FCV.

15. Close block valves around the recycle EDC LCV, the product vinyl take-off to neutralizers LCV, upper intercooler return LCV, the lower intercooler return LCV, the absorber bottoms LCV, the product still feed FCV, lean oil FCV, and the vinyl still reflux FCV.

16. Maintain a positive pressure on all the columns (20-40 PSIG) by carefully bleeding in N_2, where needed, manually. Do not let equipment go on vacuum.

17. Close off block valves around the absorber PCV and the FCV on the liquid line from the quench liquor surge tank to the stripper.

18. Keep positive N_2 pressure (20-40 PSIG) on the furnace-quench-absorber system by adding N_2 as required.

19. If this is a short shut-down, leave cooling water circulating through heat exchangers, and leave steam on Dopp kettles. If a long-term downtime is foreseen, shut off cooling water flow to exchangers and dump tars out of Dopp kettles into the tar "buggy." Shut down Dopp kettles.

20. Check to see that the HCl Scrubber has been shut down. Close block valves around all 3 PRV's on the HCl header.

21. Close valves in VC transfer line being used to the storage area.

22. Close block valves around main fuel gas PCV (90-30 PSIG).

23. Isolate the EDC safety drier in use from the system if a long-term shut-down is expected. Shutdown the heavies still and stop the make-up stream.

24. Expansion chambers in VC lines are provided where needed so that when equipment or lines are isolated between two valves, liquid expansion when the temperature rises will not cause ruptures. Those for VC will need periodic filling with nitrogen as the pad is dissolved in the VC and carried away.

25. For long-term shut-downs, shut down all utilities in the following order:

a) Refrigeration machine
b) Steam supply
c) Cooling tower water
d) Instrument air
e) Electrical system

B. Detailed Equipment Shut-Down Procedures

1. <u>Fuel Gas Supply System:</u>

a) Close manual valves in fuel gas lines to furnace burners and pilots.

b) Close block valves around all three temperature control valves.

c) Close block valves arount the 90-30 PSIG pressure reducing station.

2. Vaporizer and Cracking Furnaces:

a) Lower the furnace exit temperature on automatic [illegible] and hold for 15 minutes. Next, lower this temperature [illegible] hold for 15 minutes. Put the fuel temperature on [illegible] manual control. Open the [illegible] by-pass valves and close block valves for each cracking furnace pass inlet [illegible] same EDC flows through the by-pass.

b) Close the manual block valves in [illegible] furnace burner. This will allow the [illegible] If not, close the main burner Maxon valves and then [illegible] on the gas to the pilots.

c) Put the vaporizer feed [illegible] on [illegible] allow the EDC flow to continue after the [illegible] FCV.

d) Shut off the gas flow to the burners and pilots.

e) After the quench tower level is lowered below the [illegible] nozzles, shut off the furnace feed pumps.

f) Simultaneously close the block valves on the EDC feed [illegible] open the N_2 purge lines into the vaporizer pass inlets [illegible] steps together so that there will be no flow interruption.

3. Quench Tower:

a) Start lowering the quench tower level as soon as [illegible] have been shut off. This can be done by decreasing [illegible] liquor flow.

b) Close all cracking furnace pass outlet valves [illegible] through them for several minutes.

c) When no more vapors are passing through the [illegible] off the quench liquor pump, and the [illegible]. Close [illegible] each.

d) Work off the quench tower bottoms liquor [illegible] Dopp [illegible] It may be necessary to recycle some quench liquor [illegible] aid the flushing of tars/carbon material to the Dopp [illegible] dumping to the kettles should be possible even if [illegible] off.

4. Dopp Kettles:

The Dopp kettle agitators depend on EDC flush [illegible] double mechanical seals from Flywheel #2. Therefore, any time Flywheel #2 is shut down, the Dopp agitators must also [illegible]

a) Shut off agitators whenever Flywheel #2 is [illegible]

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b) Shut-off the Strahman valves at the quench tower an [illegible] line empty into kettles.

c) Leave steam on kettles and vapor line open [illegible]

d) Before steam is ever turned off the kettles, drain [illegible] out into the tar "buggy" for disposal. Flush with [illegible]

e) Turn off steam and close vapor lines to quench [illegible]

NOTE: To take kettle off the line for maintenance people to enter [illegible] vessel, the kettle must be flushed with EDC to wash out tars and purge [illegible] nitrogen before opening up. Purge with air before entering!

5. Primary Quench Condenser:

a) Leave cooling water on unless long-term shut-down is [illegible] If this is the case, however, shut it off.

6. Secondary Quench Condenser:

a) This refrigerated condenser is shut down when the York re[illegible]eration unit is turned off. See earlier part of this write-up [illegible] timing on refrigeration shut-down.

b) To shut off F-12 liquid supply to exchanger, close the [illegible] block valves.

c) Drain F-12 from exchanger shell to refrigeration system [illegible] for some reason work is to be done on the shell.

d) If necessary, isolate exchanger from compressor [illegible] closing the cylinder-operated valve in the discharge [illegible] K. O. drum.

7. Quench Liquor Surge Tank:

a) When level rise ceases, indicating no forward flow of [illegible] VC, close block valves around the [illegible] on the feed line [illegible] stripper.

b) Leave the quench liquor pump on until its shut-down [illegible] by quench tower operations.

8. Absorber:

a) Turn off pump the stripper feed to cease the absorber's contribution to the lean EDC flow. Shut these pumps down only [illegible] forward flow of EDC and VC have ceased. See coverage [illegible] earlier section. This should be done immediately after [illegible] unit has been shut down.

b) Isolate the absorber PCV with block valves (absorber vent line

c) Turn off upper and lower intercooler pumps when lean oil flow is stopped. This shuts automatic valves in the gravity overflow lines to the intercooler tanks.

d) Close block valves around the intercooler surge tank [illegible]

e) Close manual valves in tray sump overflow lines.

f) Leave the intercooler tank vent lines <u>open</u>. These are closed only for special reasons, such as maintenance.

g) Turn off F-12 valve in line upstream of the upper intercooler LCV. To isolate exchanger from compressor suction, close the cylinder-operated valve in vapor outlet line to the K.O. drum. This will not normally be necessary.

h) Turn off F-12 valve in line upstream of the lower intercooler LCV. To isolate exchanger from compressor suction, close the cylinder-operated valve in vapor outlet line to the K.O. drum. This will not normally be necessary.

i) Close manual valve in line that supplies liquid F-12 to the absorber vent condenser. This exchanger also has a cylinder-operated valve in its F-12 vapor vent line for isolation.

10. <u>HCl Stripper</u>:

a) When the York unit has been shut down, shut off steam to stripper reboiler and isolate the steam FCV.

b) Turn off the product still feed pump when the rest of the lean oil circulation system is shut down.

11. <u>Product Vinyl Still</u>:

a) When formward flow of EDC and VC ceases, shut off the recycle EDC chlorination FCV and isolate it.

b) Close block valves around the recycle EDC LCV.

c) When the York unit has been shut down, shut off steam to still reboiler by closing block valves around the steam [illegible].

d) Shut off reflux flow to still by closing block valves around the reflux FCV after lowering set point of controller to zero to shut the FCV itself first.

e) Close block valves around product flow to neutralizers [illegible]. Turn off reflux pump.

f) Turn off lean oil pump when [illegible] turned off.

g) Close block valves [illegible] CAUTION: Be sure no -40°F [illegible] exchangers [illegible] EDC lean oil is turned [illegible] perhaps. Keep lean oil circulating as long as [illegible] operation.

h) Turn off cooling water to [illegible] shut-downs.

i) Refrigeration vent condenser [illegible] valve in line [illegible] Close cylinder-operated vapor [illegible] condenser shell from compressor [illegible]

j) Close block valves [illegible] pressure on the vinyl still. [illegible] ized with N_2 as required to keep some pressure [illegible] Should it be desired to use automatic [illegible] on the PCV to 20-40 PSIG and leave the block valves open [illegible] the PCV.

12. Lean Oil Exchangers:

a) Cooling water to the 90° lean oil cooler should [illegible] only for long-term shut-downs.

b) [illegible] the 40° lean oil cooler may be turned [illegible] manual valve in line [illegible] cylinder-operated vapor [illegible] exchanger shell from compressor [illegible]

c) Freon-12 to the -40° lean oil cooler may be [illegible] closing the manual valve in the [illegible] supply [illegible] cylinder-operated valve [illegible] of the exchanger from the compressor [illegible]

13. Recycle EDC Cooler:

a) Turn off cooling water to unit only on long-term [illegible]

14. Product Cooler:

a) Turn off cooling water to exchanger only on long-term [illegible]

15. Flake Caustic Neutralizers:

a) Process Shut-down

1) Close inlet and outlet valves to neutralizer [illegible]

2. Close inlet valves to storage tank in use at time of shut-down.

b) Regeneration Cycle

1. Switch VC flow to neutralizer containing fresh NaOH charge.

2. Isolate spent neutralizer from system.

3. Force the VC in the spent neutralizer to the inlet of the other neutralizer by adding N_2 pressure to the top.

4. Vent neutralizer to still vent header. Purge with nitrogen to make neutralizer safe to work with.

5. Unbolt and remove the top flange cover on neutralizer and take out the fiber glass packing. Unbolt unpacking manhole flange on side just above support plate.

6. While wearing protective clothes, including face shield, apron, and gloves, manually unload the flake caustic through the manhole.

7. Flush any remaining spent NaOH to sewer with process water. Be very careful during this operation because caustic soda has a very high heat of solution - - thus the water in the caustic bed will become very hot and might make caustic solution splatter on the operator. Face shield and gloves are required for the wash-out operation.

8. Dry wet neutralizer with steam and then air or nitrogen. Recharge neutralizer with proper amount of flake caustic. Top the top of the bed with fresh fiber glass. Close up the neutralizer. Make sure it is dry.

9. Purge neutralizer with nitrogen to remove air. Close off purge valves and vent valves.

10. Neutralizer is now ready for service.

16. <u>HCl Scrubber:</u>

a) When the absorber PCV is closed, flow to scrubber will cease.

b) Close block valves around all distribution header PCV's [illegible].

c) Block off water and cell liquor automatic valves to scrubber.

17. <u>York Centrifugal Refrigeration System:</u> Please refer to the detailed operating procedures prepared by York for this system. The operator must be thoroughly familiar with the shut-down procedures in order to prevent mistakes which could cause severe damage to the compressor and/or auxiliary equipment.

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a) Push "stop" button on the control panel. The oil heater circuit should continue to be energized when the compressor is stopped.

b) Close the block valves on the liquid F-12 LCV's for each exchanger. The LCV's should have closed automatically.

c) Close the valves on the F-12 vapor lines from each exchanger.

d) Isolate the compressor.

18. Heavies Still:

a) When the level in the feed tank is worked down to half full, shut off the still feed. Close block valves around the FCV. Shut down still feed pump.

b) When the bottoms level control valve closes, turn off steam to the still reboiler. Turn off the bottoms withdrawal at this time.

c) Gradually reduce the reflux flow by lowering set point on the FRC. Maintain a constant level in the reflux drum.

d) When the reflux flow is essentially off, close the reflux flow control valve and close the manual block valves around the automatic valve. Shut down the still reflux pump.

e) The nitrogen pad should be on the still condenser and the vent of the system to prevent a vacuum from forming.

f) Shut off cooling water to the still condenser after column cools down, but only for long-term shut-downs.

C. Emergency Shut-Down of Equipment

In the event that trouble arises in the VC plant that cannot be handled by normal operating procedures, it may be necessary to make an emergency shut-down of one or more pieces of equipment. Emergency situations may involve fire, explosion, vessel or line rupture, instrument air failure, electrical failure, water failure, steam failure, etc. Each emergency will dictate its own procedure to be followed and it should be handles accordingly. Following is an explanation of some situations that may arise and a general outline of what should be attended to:

1. Furnaces: If an explosion, uncontrolled fire or tube rupture occurs at the furnaces, a rapid furnace shut-down should be effected. To do this punch "Total Shutdown" button; turn on snuffing steam to the offending furnace(s) using manual loading stations in the control room or by manually opening the valves in the field; lower set-point on vaporizer EDC feed controller to zero to shut this valve; then try to get a nitrogen purge started through the furnace tubes. In the case of a tube

rupture, the vaporizer FCV will close with no time delay; [illegible] it will remain open, and the valve will have to be shut by [illegible] the set-point indicator to effect an immediate valve closure. [illegible] tube rupture, follow the steps additionally [illegible]

If an uncontrolled fire (normal burner operation in furna[illegible] "controlled fire") occurs and is supported by the fuel ga[illegible] source of fuel gas can be turned off by closing the main fuel ga[illegible] at the panel.

A tube rupture or broken fitting in the furnace process p[illegible] will, of course, allow system pressure to be lost, and as a [illegible] vapor and possibly liquid in the quench and purification par[illegible] plant will want to "dump" back to the lower pressure part [illegible] When it appears this is the case, close the valve on the [illegible] the secondary quench condenser. Also, the quench liquor pump [illegible] turned off and the discharge valve closed. [illegible] from the panel.

FURNACE TUBE RUPTURE - FIRE (Detailed Emergency Shut-Down)

Tube rupture in one of the three furnaces will be the most likely cause of fire in the plant. Certainly it is the most susceptible spot. [illegible] how EDC will act when spilled out into the furnace setting is not known, [illegible] it is a combustible so we can expect a fire. Fortunately the amount of air available in the firebox is limited to that entering through the secondary [illegible] ports of the burners.

DETECTION: a. Visual (observation of stack smoke)

b. Automatic (with automatic shut-down)

(1) Low Pass Outlet Pressure

(2) High Bridgewall Temperature (possibly)

THINGS TO DO WHEN TUBE RUPTURES:

a. Notify plant fire department

b. Open snuffing steam to firebox of ruptured tube.

c. Shut down all furnaces if not already shut down by automatic detection system by pushing all three "Total Shutdown" [illegible] on panel.

d. Close vapor line from secondary quench condenser to [illegible]

e. Shut down quench liquor pump from panel board - p[illegible]

f. Follow through with plant shut-down.

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2. Quench Tower: The quench tower is quite important to the VC process because it prevents tars and carbonaceous matter from passing forward into the purification end of the plant. Therefore, there should be concern whenever anything occurs to stop the flow of quench liquor to the tower. If this flow is lost permanently, the furnaces should be shut down as quickly and as orderly as possible by the operator.

3. Primary and Secondary Quench Condensers: Loss of cooling medium to either of these partial condensers will result in loss of the quench liquor. The primary condenser normally provides most of the quench liquor condensate for the surge tank. However, if it is lost, the secondary condenser will try to pick up the full partial condensation and may therefore become inoperable due to flooding. In either case it is best to shut down the furnaces so that the faulty condenser can be repaired. If the secondary condenser is lost alone, this will [illegible] shut-down if it can be brought back on soon, since its duty is small in comparison to the other Freon exchangers.

4. Absorber: Several situations can be visualized which might be used as a basis for shutting down the absorber. If the absorber PRC loses control over the control valve, the valve may either close or open. If the valve fails open the absorber will vent down to the pressure of the distribution header. The absorber will not operate efficiently here but it can be done if repairs to the control system will not take long. Operate on by-pass manual control in the meantime if valve and/or controller are out.

If the control system fails shut, then the absorber should be immediately vented by using the by-pass around the PCV. If the situation persists, the furnaces should be shut down. Otherwise the relief valves will open and vent the system down.

Loss of refrigerant to the vent condenser will not materially affect the absorber operations per se. EDC and VC losses to the HCl vent stream will be higher, however.

Loss of either intercooler system is serious, and if the trouble can't be repaired quickly the furnaces should be shut down to reduce the heat load on the absorber. It may be possible to operate on one intercooler for short periods of time, but VC-EDC losses will be increased.

Loss of cooling medium to any one of the lean oil coolers (there are three direct coolers and an intercooler in this loop) will result in higher tray temperatures in the absorber. EDC and VC losses out the top of the absorber will consequently be higher. The failing cooler should be put back on line as soon as possible. If this can't be done, the furnaces should be cut back in rate or shut down completely.

5. Stripper: Loss of steam to the stripper reboiler will mean an immediate increase in the amount of HCl passing to the vinyl still. If the steam supply to the stripper cannot be restored very quickly, the furnaces will have to be shut down.

High HCl content in the vinyl still product could easily overl[illegible] the flake caustic neutralizers, resulting in off-grade product being made.

6. Vinyl Still: Loss of steam to the vinyl still reboiler [illegible] in an immediate rise in the amount of vinyl chloride in the still bottoms. If steam cannot be restored reasonably soon, the furnaces should be shut down. Turn off reflux to the still to prevent further losses of vinyl chloride out the bottom of the still. Try to keep the recycle of high vinyl chloride-content EDC to the heavies still feed tank at a minimum.

Loss of cooling water to the vinyl condenser is a serious problem and if not remedied immediately will result in heavy venting through the PCV. Shut down reboiler to reduce heat input to still. Leave reflux on until column has cooled a little, then turn reflux [illegible] down furnaces to stop input of VC to system

Loss of refrigeration to the still vent condenser is not serious, but will mean higher VC losses from the still. Repair difficulty as soon as possible.

7. Recycle EDC Chlorination: It is important to continuously chlorinate the recycle EDC stream to remove chloroprene. If the [illegible] system fails in any way, open up the by-pass valve to the [illegible] so the chlorination can continue. Repair chlorine system as soon as possible.

8. Loss of Refrigeration: If the refrigeration system fails, the furnaces must be shut down immediately. Shut down stripper and vinyl still reboilers to lessen heat input into the system. Shut down Flywheel #[illegible].

9. Loss of Cooling Water: If the cooling water system fail[illegible] input to the system must be turned off immediately. In particular, furnaces and refrigeration system should be shut down right [illegible] off the stripper and vinyl column reboilers as soon as possible [illegible] remainder of the plant should then be shut down as orderly as p[illegible]

If the cooling tower fan should fail, it is still possible [illegible] the plant. The cooling water temperature will rise and a correspon[illegible] rise in condenser and cooler temperatures will result. The system will operate poorly as best under this condition, and if not remedied so[illegible] the plant should be shut down.

10. Loss of Steam Supply: If steam supply is lost the plant should be shut down. There are several good reasons for this statement: (1) [illegible] snuffing steam safety protection in the furnaces will be lost, (2) the HCl concentration will immediately increase in the feed to the vinyl still, (3) the vinyl still cannot be operated at all without reboiler steam.

11. Loss of Electricity: The loss of electrical power will necessitate a rapid shut-down of the plant. Some instrument air may be available for a brief period, but manual block valves, should be closed where necessary.

12. Loss of Instrument Air: The loss of instrument air will also necessitate a rapid plant shutdown. The entire plant should shut down automatically in the fail-safe position, but check to make sure. Block each control valve station. Immediately put a no purge through the furnace tubes.

13. Loss of Purge Nitrogen: Check before shutting down to ascertain if the return of the normal supply will be soon. If not, shut the plant down. Make sure no foreign material (organics in particular) gets into the N_2 header.

VIII. ANALYTICAL

A. Sample Points

The sample points have been numbered and are described [illegible] Please refer to the flow sheets given [illegible] of the sample taps. Some of the sample taps will not be used [illegible] are included in case a sample is desired at a later date.

In describing a sample, always use the sample point [illegible] as its description. This information should always be recorded [illegible] tag. The complete description requested [illegible] of a sample mix-up.

B. Control Samples

1. Sampling Schedule: The schedule [illegible] Table 8.2. This schedule will be revised as needed [illegible] experience gained in operating the plant. [illegible] obtain as much information as possible [illegible]

When there is trouble in the plant, extra analyses [illegible] quired. Do not hesitate to take and run the required analyses, because the answers so obtained may save a lot of useless effort later on, or will help the operator make the right process correction sooner.

2. Sampling Technique: The glass sample bottles may be either [illegible] or clear glass. They must be clean and oven-dried. This will [illegible] care of by the laboratory. Each bottle should be sealed with a cap. If the bottle has been exposed to the atmosphere, do not use the bottle. Bottle caps must have polyethylene liners, or equivalent.

To take a sample, first wipe the sample tap with [illegible] collected moisture and then purge the tap into a purge bottle [illegible] that use them). Purge at least a sufficient quantity of material [illegible] replace stagnant liquid in the sample tap fittings and dead line portions. [illegible] move the bottle cap and completely fill the bottle. [illegible] as little time as possible between opening the bottle and resealing [illegible]

Some of the samples will have to be taken in stainless steel sample bombs. Bombs have been purchased in sufficient quantity to use each one in one service only. Each bomb will be tagged with the name of the sample it is to be used for. The bombs are equipped with a standleg to maintain a vapor space. Always fill the bombs in a vertical position. In order to obtain a true sample a high pressure liquid stream will be circulated through the bomb to some low pressure process stream, i.e., a pump discharge to a pump suction. Any time a bomb is filled it should be checked (tilting or shaking) to be sure that it has some vapor space in it. If there is none, carefully drain a small amount of sample from the bomb.

3. Analytical Methods: A copy of each of the analytical methods used in the control tests is included in the Analytical Manual for the plant. Table 8.2 gives the sample points and the analyses that will be [illegible] on the control analyses.

C. Laboratory Samples

1. Sampling Schedule: The main laborator will [illegible] sampling and testing during the initial start-up period. Then a regular operation lab schedule will be prepared for sampling purposes. It will be necessary, usually, for the midnight operator to take these samples and [illegible] them to the laboratory. At the same time, the operator will [illegible] lab all used control containers and will [illegible] the next day's [illegible] of clean, dry, sample containers.

2. Sampling Procedures: [illegible] carefully to avoid water contamination, and to prevent [illegible] leakage [illegible] from the bomb. The process streams contain [illegible] little water [illegible] trace of water from an external source will [illegible] course, will give an incorrect determination.

Most of the sample techniques have been described above. In addition, furnace gas samples will be taken into special glass traps filled with ether. The traps will be immersed in a mixture of dry ice and methylene chloride. The glass trap has two fittings, an inlet and an outlet. When not in use but in the process of cooling down, a piece of flexible tubing will connect both openings. When a furnace gas sample is ready to be taken, crack the sample tap to purge it, then connect the flexible tubing to the tap and the inlet fitting on the trap and slowly bubble the furnace gas mixture into the chilled ether. Keep the trap in the dry ice bath. Sample bubbling must be slow enough that no bubbles escape out the top of the ether bath. When a sufficient amount of sample has been taken, close the sample tap and reconnect the flexible tubing between the inlet and outlet of the trap. [illegible] dry ice bath directly to laboratory for analysis.

Be sure to attach a numbered sample tag firmly [illegible] to the sample. On the sample tag place the description of the sample [illegible] with date, time and the sample point number.

3. Who Takes The Lab Samples? It is important that a systematic approach be followed in taking the plant analytical samples. This requires the assignment of specific shifts to obtain the required samples. In general all laboratory samples will be taken by the 11:30-7:30 operator at 6:30 A.M. The furnace gas samples will be taken on the day shift. The samples [illegible] storage tanks will be taken whenever a tank is filled.

SL 009944

TABLE 8.1
Sample Points for VC Plant

Sample Point No.	Container	Description	Location
V-1	B	Furnace Feed	After Filters
V-2	C	Furnace Outlet Pass #1	Furnace Discharge (Cracking)
V-3	C	Furnace Outlet Pass #2	Furnace Discharge (Cracking)
V-4	C	Furnace Outlet Pass #3	Furnace Discharge (Cracking)
V-5	C	Furnace Outlet Pass #4	Furnace Discharge (Cracking)
V-6	B	Quench Tower Bottoms	Discharge Line to Dopp Kettle
V-7	W	Dopp Kettle Bottoms	Kettle Discharge Line
V-8	C	Quench Tower Overhead	Inlet to Primary Quench Condenser
V-9	S	Primary Quench Condensate	Liquid Outlet from Primary Quench Condenser
V-10	C	Primary Quench Condenser Off-Gas	Vapor Outlet from Primary Quench Condenser
V-11	S	Quench Liquor before Drier	Discharge Quench Liquor Pumps
V-12	S	Quench Liquor After Drier	Quench Liquor FCV
V-13	S	Secondary Quench Condensate	Liquid Outlet from Secondary Quench Condenser
V-14	C	Secondary Quench Condensate Off-Gas	Vapor Outlet from Secondary Quench Condenser
V-15	S	Upper Intercooler Liquid	Discharge Upper Intercooler Pump
V-16	S	Upper Intercooler Liquid After Driers	Upper Intercooler Surge Tank LCV
V-17	S	Upper Intercooler Before Surge Tank	Liquid Inlet Line to Upper Intercooler Surge Tank
V-18	S	Absorber Condenser Condensate	Liquid Out of Absorber Vent Condenser
V-19	S	Lower Intercooler Liquid	Discharge Lower Intercooler Pump
V-20	S	Lower Intercooler Liquid After Drier	Lower Intercooler Surge Tank LCV
V-21	S	Absorber Bottoms	Discharge of Stripper Feed Pump
V-22	S/C	Absorber Overhead Gas	Vapor Inlet to Absorber Vent Condenser
V-23	S/C	Stripper Overhead Gas	Stripper Vapor Line
V-24	B	Lean Oil/VC Still Bottoms	Outlet of 900 lean oil Cooler
V-25	S	Stripper Bottoms	Stripper Bottoms Drain Line
V-26	S	VC Still Feed	Discharge of VC Still Feed Pumps
V-27	B	Recycle EDC Before Cl_2	After VC Still LCV
V-28	B	Recycle EDC After Cl_2	Outlet of Retention Tank
V-29	B	Heavies Still Feed	Suction to Heavies Still Feed Pumps

SL 009945

TABLE 8.1 (Cont'd)
Sample Points for VC Plant

Sample Point No.	Container	Description	Location
V-30	B	Make-Up EDC	LCV on Inlet to Feed Tank
V-31	S	VC Still Reflux	Discharge of Reflux Pumps
V-32	S	VC Still Vent Gas	Still LCV
V-33	S	VC Product After Phase Separator	Discharge of Phase Separator before Neutralizer
V-34	S	VC Neutralized Product	After Product Filters
V-35	B	Heavies Still Bottoms	Suction Line to Heavies Still Bottoms Pump
V-36	B	Heavies to EDC Plant	Discharge of Bottoms Pumps
V-37	B	Heavies Still Reflux	Reflux Pump Suction Line
V-38	S	VC Day Tank #1	Discharge of Product Transfer Pumps
V-39	S	VC Day Tank #2	Discharge of Product Transfer Pumps
V-40	S	VC Day Tank #3	Discharge of Product Transfer Pumps
V-41	S	VC Day Tank #4	Discharge of Product Transfer Pumps
V-42	S	VC Sphere #1	Discharge of Loading Pumps
V-		Freon	Freon Receiver

C=Chilled Ether
B=Brown Bottle
S=Stainless Bomb

- PRELIMINARY VC ANALYTICAL SCHEDULE -

SAMPLE POINT	DESCRIPTION	TYPE SAMPLE	SAMPLE CONTAINER	TYPE ANALYSIS	SAMPLE FREQUENCY	SAMPLE POINT PRESS. / TEMP.	ANALYSIS REPORT	SAMPLE TAG NOMENCLATURE	TYPICAL ANALYSIS
V-1	FURNACE FEED	LIQUID	BRN BOTTLE	DRY WET	2/SHIFT	275 PSIG/100°F	GC* HCL, FE, H_2O CL_2	V- No. FURN. FD.	99.9+% EDC ?/?/<15 PPM 40 PPM
V-2	#1 CRACKING FURNACE #1 PASS OUTLET	GAS/LIQ.	COLD TRAP	DRY	2 / DAY FROM 1 OF FOUR PASSES	75 PSIG/950°F	GC	V- No. #1 CRACKER # PASS	61.5% EDC w/ 39.5% VC
V-3	#2 PASS OUTLET	"	"	"	"	"	"	#2 " PASS	"
V-4	#3 PASS OUTLET	"	"	"	"	"	"	#3 " PASS	"
V-5	#4 PASS OUTLET	"	"	"	"	"	"	#4 " PASS	"
V-6	QUENCH TOWER BOTTOMS	LIQUID	W.M.** BOTTLE	DRY WET	1 / DAY	75 PSIG/ 250°F	GC TARS	V- No. D.K. FEED	~99% EDC ~.1%
V-7	DOPP KETTLE BOTTOMS	LIQUID	W M BOTTLE	DRY WET	AS REQUESTED	78 PSIG/ 260°F	GC TARS	V- No. D.K. BTMS	
V-12	QUENCH LIQUOR	LIQUID	BOMB	DRY WET	1 / SHIFT	70 PSIG/	GC HCL, H_2O Fe (ONCE/DAY)	V- No. Q. LIQUOR	85% EDC ? /<15 PPM
V-14	VAPOR FEED TO ABSORBER	GAS	BOMB	DRY WET	AS REQUESTED	65 PSIG/	GC HCL	V- No. ABS. Q. GAS FEED	
V-22	ABSORBER VENT HCL	GAS	BOMB		1 / DAY	60 PSIG/	GC	V- No. HCL [illegible]	
V-11	PRIMARY QUENCH CONDENSER VENT	GAS	BOMB	DRY WET	AS REQUESTED	65 PSIG/	GC HCL, H_2O	V- No P.Q. [illegible] VENT	
V-10	PRIMARY QUENCH CONDENSER LIQUOR	LIQUID	BOMB	DRY WET	AS REQUESTED	65 PSIG/	GC HCL, H_2O	V- No. P.Q. COND. LIQ.	

* ANALYSIS TO [illegible] CHLOR[illegible]

** WIDE MOUTH BOTTLE

SL 009947

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION LAKE CHARLES, LOUISIANA

TITLE	DRAWN BY	DATE	SCALE	DWG.
VC PLANT - PROCESS SAMPLE SCHEDULE	~	~	~	NO. TABLE 8.2a
	CHECKED BY ~	DATE ~	CHARGE 65A	
	APPROVED BY [signature]	DATE 7/8/66	BILL OF MATERIAL ~	SHEET 1 OF 3

SAMPLE POINT	DESCRIPTION	TYPE SAMPLE	SAMPLE CONTAINER	TYPE ANALYSIS	SAMPLE FREQUENCY	SAMPLE POINT PRESS / TEMP	ANALYSIS REPORT	SAMPLE TAG NOMENCLATURE	TYPICAL ANALYSIS
V-13	SECONDARY QUENCH CONDENSER LIQUOR	LIQUID	BOMB	DRY WET	AS REQUESTED	65 PSIG/	GC HCL, H_2O	V-No. S.Q. COND. LIQ.	
V-21	ABSORBER BOTTOMS	LIQUID	BOMB	DRY WET	1 / SHIFT	65 PSIG/	GC HCL, FE, H_2O	V-No ABS. BTMS	
V-20	LOWER INTERCOOLER LIQUID	LIQUID	BOMB	DRY WET	1 / SHIFT	75 PSIG/	GC HCL, FE, H_2O	V-No. L. I. LIQ.	
V-16	UPPER INTERCOOLER LIQUID	LIQUID	BOMB	DRY WET	1 / SHIFT	75 PSIG/	GC HCL, FE, H_2O	V-No U. I. LIQ.	
V-24	STRIPPER BOTTOMS	LIQUID	BOMB	DRY WET	1 / SHIFT (HCl - EVERY TWO HOURS)	75 PSIG/	GC HCL, FE, H_2O	V-No. STR. BTMS	
V-18	ABSORBER CONDENSER LIQUID	LIQUID	BOMB	DRY WET	AS REQUESTED	60 PSIG/	GC HCL, H_2O	V-No. ABS. COND. LIQ.	
V-23	STRIPPER O'HD. VAPOR	GAS	BOMB	DRY WET	AS REQUESTED	65 PSIG/	GC HCL, H_2O	V-No STR. O'HD. VAPOR	
V-26	V.C. STILL FEED	LIQUID	BOMB	DRY WET	AS REQUESTED	85 PSIG/	GC HCL, FE, H_2O	V-No. VC STILL FEED	
V-33	V.C. PRODUCT BEFORE NEUTRALIZATION	LIQUID	BOMB	DRY WET	1 / SHIFT		GC HCL, FE, H_2O	V-No. VCM CRUDE	
V-34	V.C. PRODUCT TO STORAGE	LIQUID	BOMB	DRY WET	1 / SHIFT (GC) 2 / SHIFT (HCl, Fe, H_2O)		GC* HCL, FE, H_2O	V-No. VCM PRODUCT	
V-26	V.C. STILL BOTTOMS (LEAN OIL)	LIQUID	BRN BOTTLE	DRY WET	1 / SHIFT		GC* HCL, FE, H_2O	V-No. VC STILL BTMS	
V-27	RECYCLE EDC AFTER CHLORINATION	LIQUID	BRN BOTTLE	DRY WET	2 / SHIFT		GC* Cl_2, HCl	V-No. RECYCLE EDC AFTER Cl_2	

* ANALYSIS TO INCLUDE CHLOROPRENE

SL 009948

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION LAKE CHARLES, LOUISIANA

TITLE VC PLANT - PROCESS SAMPLE SCHEDULE	DRAWN BY ~	DATE ~	SCALE ~	DWG. NO. TABLE 8.2 b
	CHECKED BY ~	DATE ~	CHARGE 65A	
	APPROVED BY [illegible]	DATE 7/8/66	BILL OF MATERIAL ~	SHEET 2 OF 3

SAMPLE POINT	DESCRIPTION	TYPE SAMPLE	SAMPLE CONTAINER	TYPE ANALYSIS	SAMPLE FREQUENCY	SAMPLE POINT PRESS / TEMP	ANALYSIS REPORT	SAMPLE TAG NOMENCLATURE	TYPICAL ANALYSIS
V-29	HEAVIES STILL FEED	LIQUID	BRN BOTTLE	DRY WET	1/SHIFT		GC * Cl; HCL, FE, H_2O	V - NO. HVS. STILL FD.	
V-30	EDC MAKEUP FEED	LIQUID	BRN BOTTLE	DRY WET	1/SHIFT		GC HCL, FE, H_2O	V- NO. EDC MAKEUP	
V-37	HEAVIES STILL PRODUCT	LIQUID	BRN BOTTLE	DRY WET	1/DAY		GC * HCL, FE, H_2O	V-NO. HVS. STILL PROD.	
V-35	HEAVIES STILL BOTTOMS	LIQUID	BRN BOTTLE	DRY WET	1/SHIFT		GC HCL, FE, H_2O TARS	V-NO. HVS. STILL BTMS	
V-38	VC DAY TANK #1	LIQUID	BOMB	DRY WET	1/DAY (1 OF 4 TANKS NORMALLY)	60 PSIG/	GC * HCL, FE, H_2O SPEC. TESTS	V-NO. VC DAY TK #1	
V-39	VC DAY TANK #2	"	"	"	"	"	"	"	
V-40	VC DAY TANK #3	"	"	"	"	"	"	"	
V-41	VC DAY TANK #4	"	"	"	"	"	"	"	
V-42	VC SPHERE #1	LIQUID	BOMB	DRY WET	1 / DAY	60 PSIG/	GC * HCL, FE, H_2O SPEC. TESTS	V-NO. #1 VC SPHERE	
	VC TANK CAR	LIQUID	BOMB	DRY WET	AS REQUESTED		AS *** REQUESTED	VC TK CAR #	

* ANALYSIS TO INCLUDE CHLOROPRENE

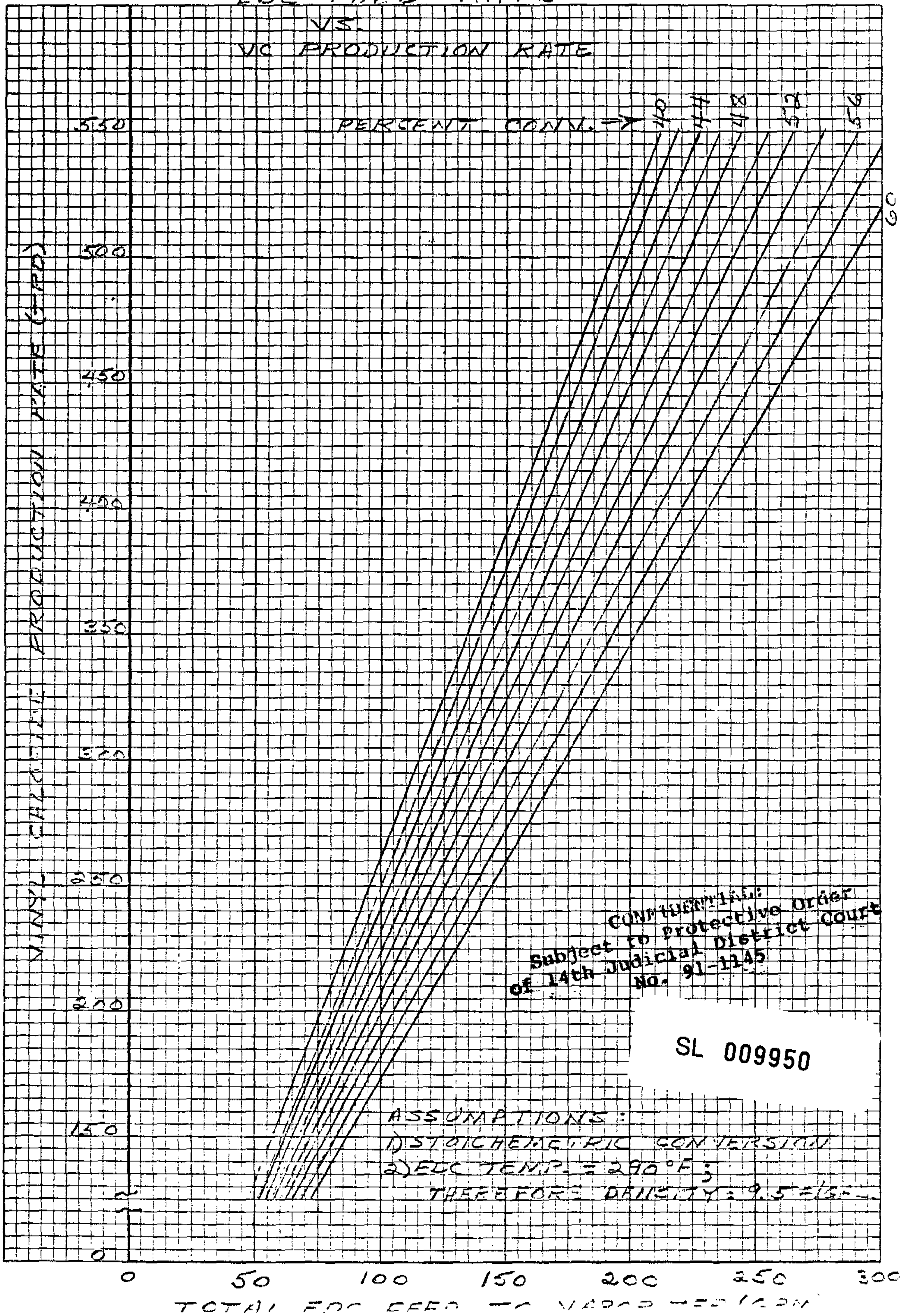
*** ANALYSIS TO INCLUDE PHENOL WHEN REQUESTED

SL 009949

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION LAKE CHARLES, LOUISIANA

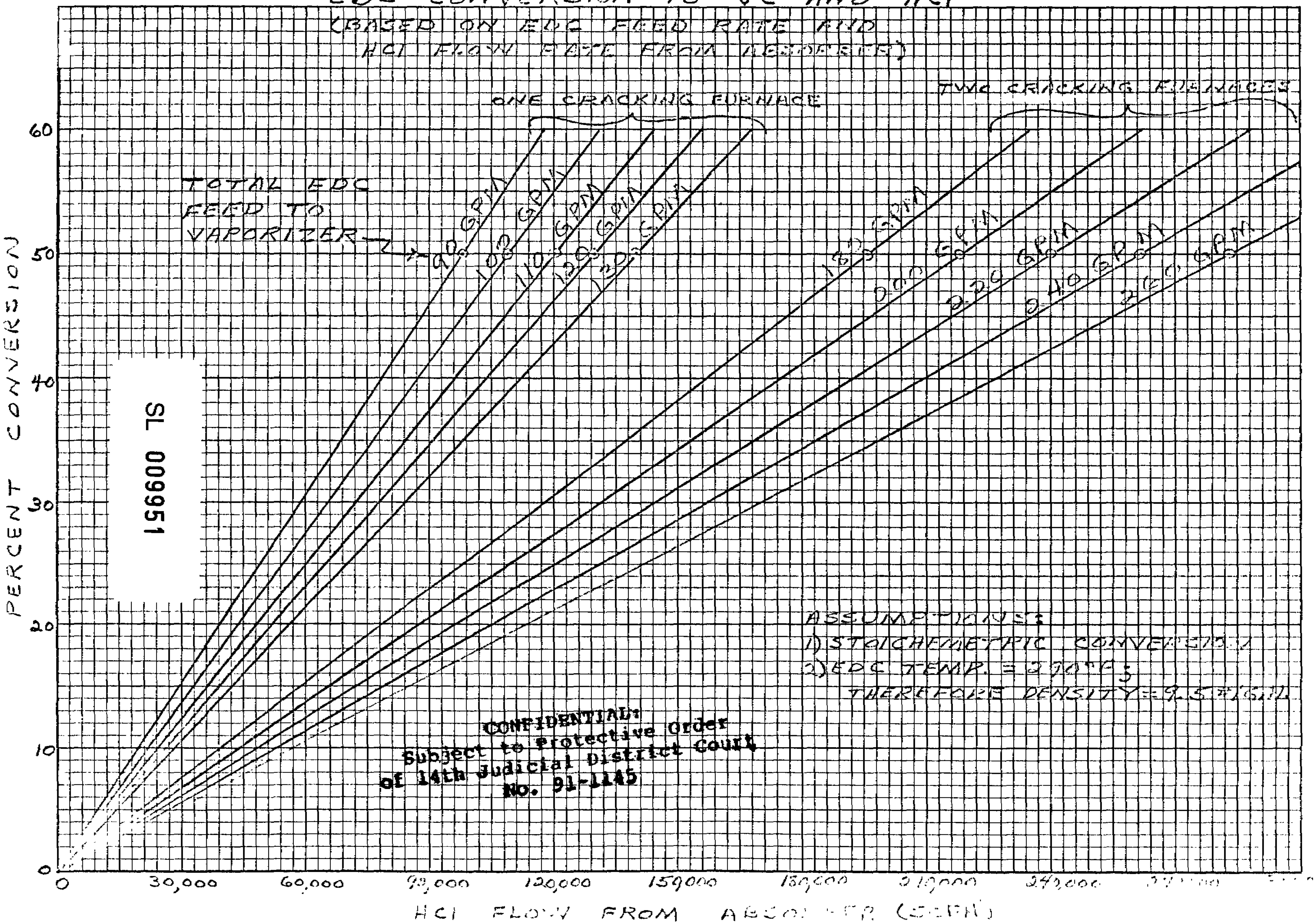
TITLE VC PLANT - PROCESS SAMPLE SCHEDULE	DRAWN BY ~	DATE ~	SCALE ~	DWG.
	CHECKED BY ~	DATE ~	CHARGE 65A	NO. TABLE 8.2c
	APPROVED BY [illegible]	DATE 7/1/66	BILL OF MATERIAL ~	SHEET 3 OF 3

EDC FEED RATE VS. VC PRODUCTION RATE



NO. 340R-10 DIETZGEN GRAPH PAPER   EUGENE DIETZGEN CO

FIG. 9.2
EDC CONVERSION TO VC AND HCl
(BASED ON EDC FEED RATE AND HCl FLOW RATE FROM ABSORBER)



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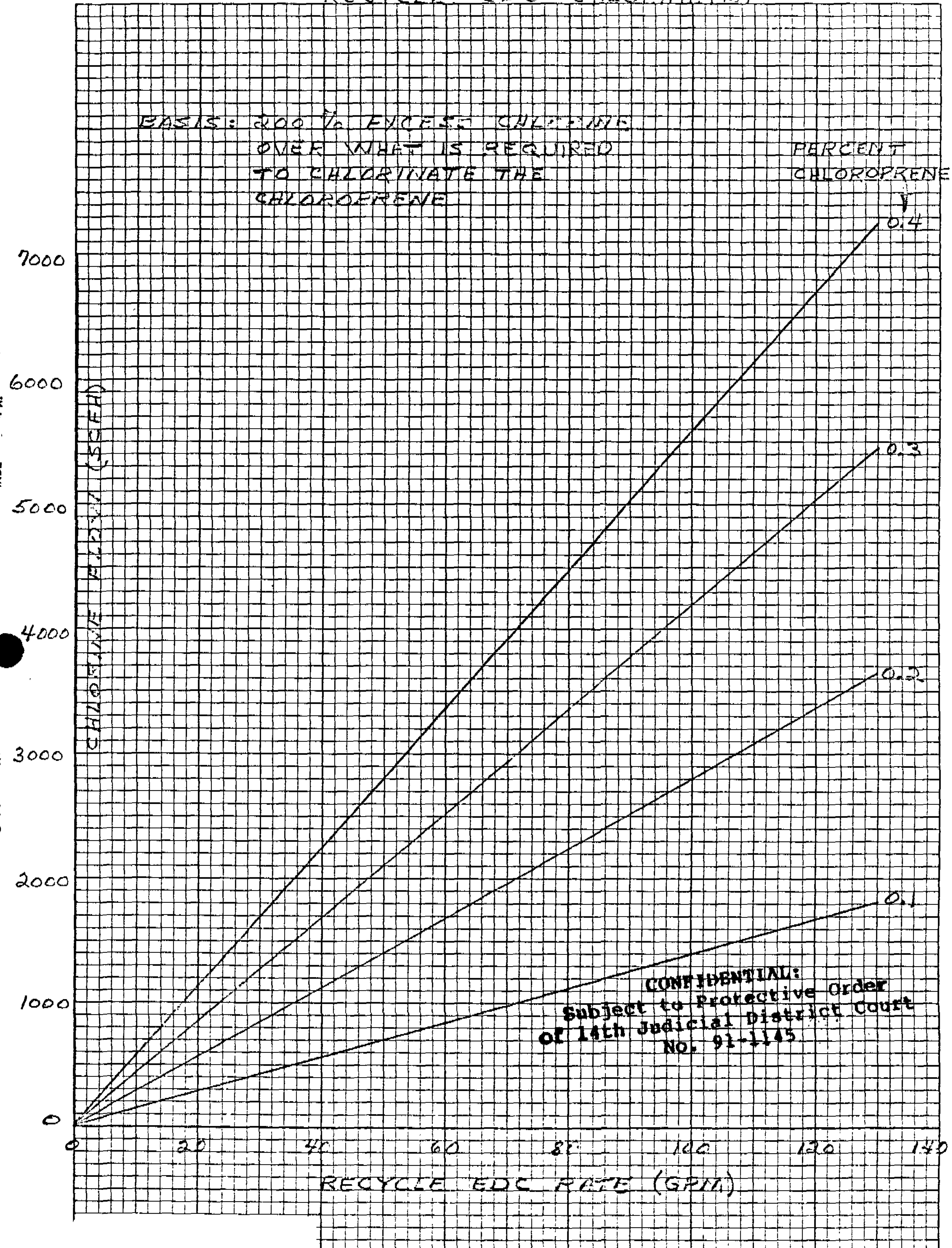
RECYCLE EDC CHLORINATION



SL 009953

TABLE 9.1

DESIGN DATA
FOR
DISTILLATION COLUMNS

	HEAVIES STILL	PRODUCT STILL	STRIPPER	ABSORBER
TOP PRESSURE (PSIG)	2	75	55	50
BOTTOM PRESSURE (PSIG)	9	81	59	55
% FLOODING AT FULL RATE				
ABOVE FEED TRAY	70	65	35	64
BELOW FEED TRAY	66	64	63	--
MINIMUM EFFICIENT OPERATING RATE (%)	39	40	30	30
REFLUX RATIO	1:1	1.35:1	--	--

VINYL CHLORIDE PLANT

Vessel - Quench Liquor Tank (65A-60-694) and Product Still Feed Tank (65A-60-697)
Length - 24.0' Tangent to Tangent
I.D. - 11' 10 3/8"

Level Ft.	Level In.	Volume Gals.
0	1	27
	2	63
	3	110
	4	167
	5	232
	6	305
	7	384
	8	469
	9	560
	10	657
	11	758
1	0	865
	1	976
	2	1,091
	3	1,211
	4	1,335
	5	1,462
	6	1,594
	7	1,729
	8	1,867
	9	2,009
	10	1,154
	11	2,302
2	0	2,453
	1	2,608
	2	2,764
	3	2,924
	4	3,086
	5	3,251
	6	3,419
	7	3,588
	8	3,760
	9	3,935
	10	4,111
	11	4,289
3	0	4,470
	1	4,652
	2	4,837
	3	5,023
	4	5,211
	5	5,400
	6	5,591
	7	5,784
	8	5,978
	9	6,174
	10	6,371
	11	6,569
4	0	6,769
	1	6,969
	2	7,171
	3	7,374
	4	7,578
	5	7,783
	6	7,989
	7	8,196
	8	8,404
	9	8,612
	10	8,821
	11	9,031
5	0	9,241
	1	9,452
	2	9,664
	3	9,876
	4	10,088
	5	10,301
	6	10,514
	7	10,727
	8	10,940
	9	11,154
	10	11,367
	11	11,581
6	0	11,785
	1	11,999
	2	12,213
	3	12,426
	4	12,639
	5	12,852
	6	13,065
	7	13,278
	8	13,490
	9	13,701
	10	13,912
	11	14,123
7	0	14,333
	1	14,542
	2	14,751
	3	14,959
	4	15,166
	5	15,372
	6	15,578
	7	15,782
	8	15,986
	9	15,188
	10	16,389
	11	16,589
8	0	16,788
	1	16,985
	2	17,182
	3	17,376
	4	17,570
	5	17,761
	6	17,952
	7	18,140
	8	18,327
	9	18,512
	10	18,695
	11	18,876
9	0	19,055
	1	19,233
	2	19,408
	3	19,580
	4	19,751
	5	19,919
	6	20,085
	7	20,248
	8	20,409
	9	20,567
	10	20,722
	11	20,874
10	0	21,024
	1	21,170
	2	21,313
	3	21,453
	4	21,589
	5	21,722
	6	21,851
	7	21,976
	8	22,097
	9	22,215
	10	22,327
	11	22,435
11	0	22,539
	1	22,637
	2	22,730
	3	22,818
	4	22,899
	5	22,974
	6	23,042
	7	23,103
	8	23,154
	9	23,195
	10	23,221
	10 3/8	23,230

VINYL CHLORIDE PLANT

Vessel - Upper and Lower Intercooler Surge Tanks (65A-60-696,695)
Length - 14.0' Tangent to Tangent
I.D. - 5'11"

Level Ft.	Level In.	Volume Gals.
0	1	9
	2	24
	3	44
	4	68
	5	95
	6	125
	7	157
	8	192
	9	229
	10	269
	11	310
1	0	352
	1	397
	2	443
	3	490
	4	539
	5	589
	6	640
	7	693
	8	746
	9	800
	10	855
	11	911
2	0	968
	1	1,025
	2	1,083
	3	1,141
	4	1,200
	5	1,260
	6	1,319
	7	1,379
	8	1,440
	9	1,500
	10	1,561
	11	1,621

Level Ft.	Level In.	Volume Gals.
3	0	1,681
	1	1,742
	2	1,802
	3	1,863
	4	1,923
	5	1,983
	6	2,043
	7	2,102
	8	2,161
	9	2,219
	10	2,277
	11	2,335
4	0	2,391
	1	2,447
	2	2,402
	3	2,556
	4	2,610
	5	2,662
	6	2,713
	7	2,763
	8	2,812
	9	2,859
	10	2,906
	11	2,950
5	0	2,993
	1	3,034
	2	3,073
	3	3,110
	4	3,145
	5	3,178
	6	3,208
	7	3,235
	8	3,258
	9	3,278
	10	3,293
	11	3,301

VINYL CHLORIDE PLANT

Vessel - Product Still Reflux Tank (65A-60-698)
Length - 16.0' Tangent to Tangent
I.D. - 6' 4 7/8"

Level Ft.	Level In.	Volume Gals.
0	1	11
	2	29
	3	52
	4	80
	5	112
	6	148
	7	186
	8	228
	9	272
	10	318
	11	367
1	0	418
	1	470
	2	525
	3	581
	4	640
	5	699
	6	760
	7	822
	8	886
	9	951
	10	1,017
	11	1,084
2	0	1,152
	1	1,220
	2	1,290
	3	1,360
	4	1,431
	5	1,503
	6	1,575
	7	1,648
	8	1,721
	9	1,795
	10	1,869
	11	1,943
3	0	2,017
	1	2,091
	2	2,166
3	3	2,239
	4	2,314
	5	2,388
	6	2,462
	7	2,536
	8	2,610
	9	2,684
	10	2,757
	11	2,829
4	0	2,902
	1	2,973
	2	3,044
	3	3,114
	4	3,184
	5	3,253
	6	3,320
	7	3,387
	8	3,453
	9	3,518
	10	3,581
	11	3,643
5	0	3,704
	1	3,764
	2	3,821
	3	3,878
	4	3,932
	5	3,984
	6	4,035
	7	4,083
	8	4,130
	9	4,173
	10	4,214
	11	4,253
6	0	4,288
	1	4,319
	2	4,347
	3	4,370
	4	4,387
	4 7/8	4,395

VINYL CHLORIDE PLANT

CONFIDENTIAL:
Subject to Protective Order
of 14th Judicial District Court
No. 91-1145

Vessel - Heavies Still Feed Tank (65A-60-711)
Length - 24.0' Tangent to Tangent
I.D. - 11' 10 5/8"

Level Ft.	Level In.	Volume Gals.	Level Ft.	Level In.	Volume Gals.	Level Ft.	Level In.	Volume Gals.
0	1	27	4	0	6,772	8	0	16,804
	2	63		1	6,973		1	17,002
	3	110		2	7,175		2	17,199
	4	167		3	7,379		3	17,394
	5	232		4	7,583		4	17,588
	6	305		5	7,788		5	17,780
	7	384		6	7,994		6	17,971
	8	469		7	8,201		7	18,160
	9	560		8	8,409		8	18,347
	10	657		9	8,617		9	18,533
	11	759		10	8,827		10	18,716
1	0	865		11	9,037		11	18,898
	1	976	5	0	9,247	9	0	19,078
	2	1,092		1	9,458		1	19,256
	3	1,212		2	9,670		2	19,432
	4	1,335		3	9,882		3	19,605
	5	1,463		4	10,094		4	19,776
	6	1,595		5	10,307		5	19,945
	7	1,730		6	10,520		6	20,112
	8	1,868		7	10,734		7	20,276
	9	2,010		8	10,948		8	20,437
	10	2,155		9	11,161		9	20,596
	11	2,303		10	11,375		10	20,752
2	0	2,455		11	11,589		11	20,905
	1	2,609	6	0	11,794	10	0	21,055
	2	2,766		1	12,008		1	21,202
	3	2,926		2	12,221		2	21,346
	4	3,088		3	12,435		3	21,487
	5	3,253		4	12,649		4	21,624
	6	3,420		5	12,862		5	21,758
	7	3,590		6	13,075		6	21,888
	8	3,762		7	13,288		7	22,014
	9	3,937		8	13,500		8	22,136
	10	4,113		9	13,712		9	22,254
	11	4,292		10	13,924		10	22,368
3	0	4,472		11	14,134		11	22,478
	1	4,655	7	0	14,345	11	0	22,582
	2	4,839		1	14,554		1	22,682
	3	5,025		2	14,763		2	22,777
	4	5,213		3	14,972		3	22,866
	5	5,403		4	15,179		4	22,949
	6	5,594		5	15,386		5	23,026
	7	5,787		6	15,592		6	23,095
	8	5,981		7	15,796		7	23,158
	9	6,177		8	16,000		8	23,211
	10	6,374		9	16,203		9	23,255
	11	6,573		10	16,405		10	23,286
				11	16,605		10 5/8	23,297

CONFIDENTIAL:
Subject to Protective Order
of 14th Judicial District Court
No. 91-1145

VINYL CHLORIDE PLANT

Vessel - Heavies Still Reflux Tank (65A-60-708)
Length - 24.0' Tangent to Tangent
I.D. - 11' 10 3/4"

SL 009958

Level Ft.	In.	Volume Gals.
0	1	23
	2	60
	3	108
	4	165
	5	231
	6	303
	7	382
	8	467
	9	558
	10	654
	11	755
1	0	861
	1	971
	2	1,085
	3	1,204
	4	1,326
	5	1,453
	6	1,583
	7	1,717
	8	1,853
	9	1,994
	10	2,137
	11	2,284
2	0	2,433
	1	2,586
	2	2,741
	3	2,899
	4	3,059
	5	3,223
	6	3,388
	7	3,556
	8	3,726
	9	3,899
	10	4,074
	11	4,251
3	0	4,430
	1	4,611
	2	4,794
	3	4,978
	4	5,165
	5	5,354
	6	5,544
	7	5,736
	8	5,929
	9	6,124
	10	6,320
	11	6,518

Level Ft.	In.	Volume Gals.
4	0	6,718
	1	6,918
	2	7,120
	3	7,324
	4	7,528
	5	7,734
	6	7,941
	7	8,148
	8	8,357
	9	8,567
	10	8,778
	11	8,990
5	0	9,202
	1	9,415
	2	9,630
	3	9,844
	4	10,060
	5	10,276
	6	10,493
	7	10,710
	8	10,927
	9	11,146
	10	11,364
	11	11,583
6	0	11,809
	1	12,028
	2	12,247
	3	12,465
	4	12,682
	5	12,899
	6	13,116
	7	13,332
	8	13,547
	9	13,762
	10	13,976
	11	14,189
7	0	14,401
	1	14,612
	2	14,823
	3	15,033
	4	15,241
	5	15,449
	6	15,655
	7	15,861
	8	16,065
	9	16,268
	10	16,469
	11	16,670

Level Ft.	In.	Volume Gals.
8	0	16,869
	1	17,066
	2	17,262
	3	17,457
	4	17,650
	5	17,842
	6	18,031
	7	18,219
	8	18,405
	9	18,590
	10	18,772
	11	18,953
9	0	19,131
	1	19,308
	2	19,482
	3	19,654
	4	19,824
	5	19,991
	6	20,156
	7	20,319
	8	20,478
	9	20,636
	10	20,790
	11	20,942
10	0	21,091
	1	21,236
	2	21,379
	3	21,519
	4	21,655
	5	21,787
	6	21,917
	7	22,042
	8	22,164
	9	22,281
	10	22,395
	11	22,504
11	0	22,608
	1	22,708
	2	22,803
	3	22,892
	4	22,976
	5	23,053
	6	23,124
	7	23,187
	8	23,243
	9	23,288
	10	23,322
	10 3/4	23,336