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PITTSBURGH PLATE GLASS COMPANY

CHEMICAL DIVISION

LAKE CHARLES, LOUISIANA

HCl PLANT MANUAL

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Manual No. 19

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INTRODUCTION

USES AND PURPOSE OF MANUAL

This operating manual has been assembled with the following purposes in mind:

1. To aid the operators in becoming familiar with the HCl plant.
2. To serve as a ready source of reference for the operators throughout their tenure at the HCl plant.
3. To provide a set of basic procedures so that everyone is working under the same instructions.
4. To serve as a place where data, facts, information, etc. on the unit are centrally located and readily available.

Like any new operating manual, it is expected that changes will be warranted in this write-up as operating experience is gained. Please feel free to suggest these changes as it is intended that this manual be kept current and meaningful.

It should be remembered that this manual is the property of Pittsburgh Plate Glass, Chemical Division, Lake Charles, and may be recalled at any time. You are personally responsible for the safe keeping of this manual as well as the information therein. This is why the manual is numbered and charged to you.

GENERAL DESCRIPTION

The HCl process is broken down into two areas. There is a Dry HCl plant and a Wet HCl plant. Both plants use H_2 and Cl_2 as feedstock and both plants produce anhydrous HCl as an end product, but there is a difference in how each plant processes the HCl.

Anhydrous (dry) HCl is produced by burning H_2 and Cl_2 in a water-cooled combustion chamber. The reaction is:

$$H_2 + Cl_2 \rightarrow 2\ HCl$$

H_2 is fed in a slight excess so that all of the Cl_2 is reacted and the product HCl has 2% to 5% H_2 in it. The excess H_2 should be large enough so that there is no danger of having any Cl_2 in the product stream.

The Dry HCl plant gets its Cl_2 from the MC Cl_2 vaporizer and its H_2 from the H_2 compressors in the cell area. The two gases are fed into the bottom of a combustion chamger where they are burned, forming HCl. The HCl is removed from the top of the combustion chamber and goes through two stages of cooling. The first stage is well water, the second stage is chilled brine. There are two identical sets of burners and coolers. From the coolers the gas goes through an H_2SO_4 dryer and into the compressor suction. From here the gas is compressed to 50 psig, cooled and sent through 11,000' of 6" schedule 40 pipe to the customer.

The Wet HCl plant gets its Cl_2 from the compressors in liquefaction (cell gas) and its H_2 from the H_2 compressors in the cell area. Cell gas Cl_2 may be used in the wet process because the inert gas impurities are not carried through the process. H_2 and Cl_2 are fed to the bottom of a combustion chamber where they are burned forming HCl. The combustion chamber and the feed systems are the same as those in the dry system. The HCl is fed from the top of the chamber to a cooler absorber, where the gaseous HCl is absorbed in a weak acid (20%) solution making it strong acid (32%). The inerts are pulled through a tails tower by a steam jet ejector and discharged into the vent scrubber. There are 3 identical sets of burners and absorbers. One dry burner and cooler may be run as a burner absorber system, and there is one absorber that is used for vent streams. The strong acid is sent to storage and from there it is pumped to a stripper. In the stripper, strong acid is fed and gaseous HCl is cooled in 3 stages, the first stage is cooling tower water and the other two are chilled brine. There are two idential sets of strippers and coolers. After being cooled, the HCl goes through a H_2SO_4 dryer, is compressed, cooled and sent to EC.

In the near future VC will be tied into the HCl system. VC will then become the source of HCl in place of the burners. At this time this manual will be brought up to date.

To improve efficiencies in the MC plant, HCl from the TCE Reactor is fed into the suction of the EC HCl compressors. To replace this HCl, No. 4 compressor takes its suction gas from the stripper gas, compresses this high purity HCl, cools it and sends it to the MC reactor.

SAFETY FOR THE HCl AREA

Due to the nature of the operation and the chemicals involved, the HCl area is restricted to authorized personnel only.

Company vehicles will be permitted to travel on the main approach road through Area "B" and the access road to the control house during normal operations. Special permits will be required to enter any of the operating areas or chained-off areas. 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 affected 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.

"It has been said that all synthetic hydrogen chloride plants blow up sooner or later. This is probably true. Someone will be careless, or some unforeseen event will occur."

This is not an idle quotation. We should all remember that the hydrogen-air explosive limits range from 4% to 75% hydrogen by volume and for hydrogen-chlorine the explosive range is 5% to 95% hydrogen or chlorine by volume.

As long as the flame in the combustion chamber is maintained, the danger of an explosion is minimized.

Causes for flame failure can generally be ascribed to the following conditions:

1. Unequal or insufficient gas pressures into the burner nozzle.
   Feed gas surges.
2. Inaccurate flow control.

3. Loss of vacuum.

4. Condensate build-up.

5. Burner cap and inner pipe failure.

6. Inadequate cooling.

Our unit has a "Firetron" fire-eye which will monitor the flame continuously. On flame failure the hydrogen and chlorine valves should close instantaneously preventing any explosive mixture accumulation. This action is completely automatic -- depending only on the proper functioning of this flame failure device.

EMERGENCY HORNS

The HCl plant has only one emergency horn, and that horn is the Area "B" evacuation horn. Due to the fact that the HCl operator and operations are in near proximity and closely associated with the EC-VC operations, it is well that HCl personnel be familiar with those plant sirens as well as the plant evacuation warbler. For this reason a description of both the horns is included in this manual.

There are two distinct emergency horns in the area, the plant or Area "B" evacuation horn and the EC operating area siren.

The Area "B" evacuation horn is a continuous warbling sound and may be activated from the EDC or EC-VC control rooms, or the guardhouse. The sounding of this horn will shut down all non-process equipment in area "B" and will cause all non-essential personnel to leave the area. Area "B" includes all areas west of Columbia-Southern Road. The Area "B" evacuation horn should be sounded in case of a major break in EC, or if there is some reason to expect a major break, or if there is a possibility that EC vapors will escape the operating area. Whenever the evacuation horn is sounded, the guards should be notified of the nature of the emergency if at all possible. If it is desired to evacuate the whole plant, the guards will have to be notified and they will sound the plant evacuation. The guards are the only people able to sound the all-clear.

The operating area siren is to evacuate all non-essential personnel from the operating area and to have all arcing devices in the operating area shut down. This siren is controlled by a switch on the panel board or by a switch located near the bottoms Dopp kettle. The area siren should be used in case of a minor spill or a possible spill.

It is well to keep in mind the extreme flammability of EC. Should a spill occur, keep it from spreading if at all possible and eliminate all sparking devices in the area. One of the best means to prevent spreading is the use of the fire water system, use it and use it quickly. The arcing devices can be eliminated by sounding the siren or evacuation alarm. Evaluate the situation quickly, and act quickly; it is much better to get someone wet or evacuate them than to have a fire or an explosion.

When you are in the operating area and the siren blows or you are in Area "B" and the warbler blows, see to it that all non-essential equipment is shut down (trucks, hysters, welders, etc.) and if you are non-operating personnel get out of the area. All operating personnel should go to their respective control rooms, if possible.

FIRE PROTECTION

Flammables are present in the HCl plant in only a few locations. For this reason the fire protection is minimal. All equipment and fixtures are explosion proof, but this is to protect against corrosion. It is possible to have some flammables in the vent as EC from the EC vent stream and H_2 from the absorbers is being continuously vented. The fire protection in the HCl plant is provided in two ways, CO_2 and dry chemicals. The CO_2 extinguishers are good for small fires or small electrical fires. The dry chemicals are good for all fires, but leave a harmful residue on electrical equipment. The only CO_2 extinguishers will be upstairs in the control room. There are 30# dry chemical units located throughout the unit with at least one extinguisher on each level.

CONTROL BUILDING

The control building is pressurized to prevent accumulation of any vapors inside. Since it is a pressurized building, non-explosion proof electrical equipment canbe used and smoking is permitted inside. The positive pressure is maintained by a fan which draws its intake air across an activated carbon filter. Should a major break occur, the filter would be unable to eliminate all contaminants, therefore the fan should be shut down. To prevent any vapors from entering the building when the fan is off, instrument air bleeds should be opened. (Do not bleed the air system down by taking too much.) To prevent dust from accumulating in the control room, filter bags are in the suction of the air conditioner. For any problems with the air conditioner, notify the supervisor.

ELECTRICAL EQUIPMENT

The characteristic of HCl is such that the equipment used in the area is classified as Class I, Group D, but the area is classifed as non-hazardous. The higher classified equipment is used to protect against the corrosive atmosphere present in the plant. The methods 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.

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. To simplify this procedure, circuit breakers for lights in the process area and control laboratory have been grouped in the lighting panels. Globes and guards must be replaced after relamping.

GROUNDING

Grounds for motors and other electrical devices are contained in the conduit supplying the device and connected to the device frame internally. 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 or agitation, a system of jumpers for pipe flanges has been installed to provide metallic continuity of the piping systems that contain flammable materials. All vessels are grounded at 2 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 and the resulting spark.

The nearness of the radio transmitting station north of the process area presents a problem in that metal objects will act as receivers of radio frequency energy. It is not practically possible to prevent this effect. It is known that the energy picked up will be amplified if the height of the object is a multiple of the transmitter wave length.

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. Particular attention should be paid to this problem if the crane height is greater than 90'.

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 EC plant.

TOOLS

Special spark-proof tools are not required unless there are EC or VC vapors present, or a possibility that EC or VC vapors will become present. Check with operations prior to starting each job to determine the type of tools needed.

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 Ethyl Chloride Unit.

To: John Jones Date: 17 Nov 65

Location: Dopp Kettle Equipment: Truck

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

Remarks: He will make 2 trips, will check before the second trip.

Approved: Robert P Lynch

To be filled in for truck pass

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

John Jones
Employee's Signature

WELDING OR BURNING PERMIT

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

pipe rack, West of product cooler
(Location)

It is good for: Date 17 Nov 65 Time 9 15 AM ~~PM~~

To: Date 17 Nov 65 Time 1 00 ~~AM~~ PM

Special Comments: John will check with operations before resuming, after dinner.

Signed: Robert P Lynch
(Area Production Supervisor)

To be filled in for weld Burning, Blasting.

GENERAL FIRE AND EXPLOSION RULES

1. Personnel entering the organics area will deposit lighters, matches, regular flashlights, etc. at the gate to this area. Safe flashlights have a label showing MSA approved for flammable areas.

2. Anyone entering an operating area should first check with operating personnel.

3. Smoking will be permitted only in the main control building (except the laboratory) where permanent lighters are provided.

4. A vehicle permit signed by an operating supervisor will be required for any vehicle to go into the chained-off roads. Vehicles may drive to the control room to obtain passes, or do business there.

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

   (a) Welding machine .
   (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.
   (h) Sandblasting equipment.

6. Only explsion-proof flashlights will be permitted.

7. In case of an emergency warning (siren or plant howler), all vehicles or equipment that are in the area on permits will be shut off immediately, and the occupants will evacuate the area immediately on foot.

8. Do not dump ethyl chloride or other flammables into openings such as sewers or other underground cavities where harmful vapors could be evolved.

9. Do not leave an open sample or container of a flammable material setting around to give off vapors.

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

11. Do not permit air to enter any of the process equipment that contains flammable material.

12. Fire protection equipment is different. Know it well! Report all damges immediately. Do not use the fire hoses for any other purpose.

13. It is intended that all personnel will obtain periodic refresher courses on fire-fighting techniques.

GENERAL SAFETY RULES

1. Pumps and Equipment -- any pump or pieces of equipment that are removed from the process stream must be thoroughly cleaned and inspected by a foreman before they are permitted to leave the area for the main shop or other work areas.

2. Regular plant utility hoses are not to be used for solvents because they will become weakened and unsafe to use with pressure. Use the special hose provided.

3. The laboratory hood fans are to operate continuously. Do not attempt to run analyses without the fan being in service.

4. Use Full-Face, Chemox or Scott Air-Pak masks for protection against HCl vapors.

5. Do not permit chlorine to be heated above 300^{o} F. as it will rapidly corrode most metals at higher temperatures.

6. Clothing that has been wet with HCl should be removed immediately and the body thoroughly washed with soap and water.

7. Clearing 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 declaring them suitable for maintenance.

Clearing Procedure:

(a) The tank or vessel will be emptied of its contents and all valves will be closed and tagged.

(b) The vapor contents of the tank will be purged with an inert gas.

(c) Blinds will be inserted in all connecting lines.

(d) Purge the equipment with plenty of air.

(e) The equipment will then be checked with an explosion meter before work is begun. When a man is to enter the tank, it will first be checked for sufficient 0_2. The apparatus for testing for sufficient oxygen is either a flame or a special metering device. These tests can be run only by a supervisor.

(f) Safety belts and safety lines will be required in top exit tanks.

8. If the emergency warning sounds, all personnel not needed for control purposes should walk upwind or crosswind if in fumes to a safe location and remain there until the all-clear sounds. Those personnel required for operation should remain on the job, while taking safety precautions necessary to remain in the area.

9. Tagging -- Same as used throughout the plant. See General Section of Production Department Manual.

SPECIAL SAFETY EQUIPMENT

1. Stretchers	(1)	(a)	Located inside control room
2. Chemox Masks	(3)	(a)	Two in control room
		(b)	One at main gate
3. Full Face Masks	(10)	(a)	Three located in control room
		(b)	One located in day tank area
		(c)	Two in shipping building
		(d)	Two at the main gate
		(e)	Two at the clock area
4. Scott Air-Pak	(6)	(a)	Two in control room
		(b)	One in supervisor's office
		(c)	One in HCl area
		(d)	One in TE catalyst building
		(e)	One in EC catalyst building
5. Cylinder Type with connecting regulator, hose & mask	(1)	(a)	In EC control room

The following is a run-down on the type situations for which each of the masks will be used:

(a) Scott Air-Pak - This unit is good for any concentration of gas and can be used for periods up to thirty (30) minutes. The unit can be put on in a few seconds,and because of this its primary use is for major gas breaks requiring quick response to get valves closed or injured men out of contaminated areas. The point to remember with this unit is that it has a life of only 30 minutes and when using it one should not remain in a contamined area for a period of more than 20 minutes. NOTE: THE SCOTT AIR-PAKS IN THE EDC AREA ONLY HAVE A 15-MINUTE LIFE.

(b) Chemox - This unit is good for any concentration of gas and can be used for periods up to one hour. It is a unit which chemically generates breathing oxygen;and because of this, several minutes are required to get this unit operating properly. The primary advantage of this unit is its long life. Because of this, the unit should be used in cases where one is required to enter and remain in a contaminated area for more than 45 minutes.

(c) Full Face All-Purpose - This unit is good for weak concentrations of gas. One can equip himself with this mask in a few seconds. It should be used only in weakly-contaminated area and for escape purposes.

(d) Cylinder Type with Connecting Regulator, Hose and Mask - These units are good in any concentration of gas. They are to be used in the event of gas being pulled into the control room. The important point about using these units is to get the units on before the room becomes excessively contaminated. Since the control rooms are pressurized, contaminating gases can enter only through the intake of the pressurizing unit. When contamination is detected, the pressurizing unit should be shut down and instrument air bleeds behind the panel board and in the laboratory should be opened.

CHEMICALS IN THE AREA

In the course of discussion of the HClplant, many abbreviations are used. Since everyone is not necessarily familiar with a majority of the chemicals used in Area "B," a quick review is listed:

$CaCl_2$	Calcium Chloride
Cl_2	Chlorine
$FeCl_3$	Ferric Chloride
HCl	gas - Hydrogen Chloride liquid - (mixed with water) - Hydrochloric Acid Muriatic Acid
H_2SO_4	Sulfuric Acid
NaOH	Caustic, Sodium Hydroxide, Cell Liquor is about 10% NaOH
N_2	Nitrogen, Inert
O_2	Oxygen
H_2	Hydrogen
CH_4	Methane, Natural Gas
C_2H_4	Ethylene
C_2H_6	Ethane
EC	Ethyl Chloride
EDC	Ethylene Dichloride (there are two EDC's, 1,1 & 1,2.)
MC	Methyl Chloroform, 1,1,1-Trichloroethane
Per	Perchloroethylene, Tetrachloroethylene
TCE	1,1,2-Trichloroethane
Tri	Trichloroethylene
VC	Vinyl Chloride, Chloroethylene
VDC	Vinylidene Chloride, 1,1 dichloroethylene

There are many more chemicals in the area, and if you need to know the names or abbreviation, see the operating foreman.

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NAME: Caustic Soda (lye)

FORMULA: NaOH

MOLECULAR WEIGHT: 40.01

BOILING POINT: 2532° F.

VAPOR PRESSURE: Normally a solid, but can be mixed with water to form a solution.

FREEZING POINT: 604° F.

HAZARDOUS PROPERTIES: When mixed with water, caustic soda will react violently, splashing caustic solution on anyone nearby. Caustic soda in the form of solid, flake or liquid attacks any tissue upon contact. The degree of injury depends upon the extent and duration of contact, temperature of the materials and concentration of the materials.

TREATMENT: Flush the contacted area immediately with an abundance of water. Remove any clothing or equipment that has been saturated with caustic. After thoroughly flushing the contacted area of the body with water, report to First Aid for further treatment. Eyes should be irrigated at once with plenty of warm water for at least 15 minutes anytime caustic comes in contact with the eye.

NAME: Cell Liquor

FORMULA: Aqueous solution of NaOH

HAZARDOUS PROPERTIES: Cell liquor is an aqueous solution of sodium hydroxide (caustic) and salt and as such should be handled with the caution given any caustic solution. This material has a markedly corrosive action upon all body tissues, and skin contact may result in moderate to severe chemical burns if the exposed surface is not washed immediately. Eye contact is quite painful and can result in impairment of vision.

TREATMENT: Speed in removing cell liquor from contact with the body is important to avoid injury. Removal of all contaminated clothing and thorough washing of the exposed surface is essential. If the eyes are involved, they should be irrigated at once with plenty of warm water for 15 minutes. Call a physician.

NAME: Chlorine (Cl_2)

FORMULA: Cl_2

MOLECULAR WEIGHT: 70.91

BOILING POINT: -30^{o} F.

VAPOR PRESSURE @ 75^{o} F.: 92 psig

FREEZING POINT: -148^{o} F.

LIQUID DENSITY @ 77^{o} F.: 11.6#/gal., 1.391 gm/ml

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

HAZARDOUS PROPERTIES: Liquid chlorine is very dangerous to the eyes as is chlorine gas. High concentrations of chlorine gas can cause pneumonitis and edema of the lungs. Lung irritation is one of the most serious effects of chlorine.

TREATMENT: Remove patient from toxic area and loosen all constrictive clothing about the neck. Oxygen should be administered in all cases to prevent cyanosis and relieve the pain of deep respiratory effort. Notify a physician.

Chlorine is about $2\frac{1}{2}$ times as heavy as air; therefore, it has a tendency to collect in the low spots or stay near the ground.

NAME: Ethane

FORMULA: C_2H_6

MOLECULAR WEIGHT: 30.07

BOILING POINT: -128^{o} F.

FREEZING POINT: -277^{o} F.

RELATIVE VAPOR DENSITY (air-1.0) 1.04

AUTOIGNITION: 950^{o} F.

EXPLOSIVE LIMITS: 3-11%

ODOR: Odorless

HAZARDOUS PROPERTIES: EThane is a flammable gas. It is the main impurity in the ethylene, and may reach high concentrations in the vent streams. Ethane is a very dangerous explosion hazard upon exposure to heat or flame. It can react vigorously with oxidizing materials. Ethane is moderately toxic, but the slight effects disappear as soon as the patient is removed from the exposure. The main danger with C_2H_6 is asphyxiation. The ethane will displace the oxygen of the air causing the victim to suffocate.

TREATMENT: Remove the patient from the contaminated area, perform artificial respiration if breathing has stopped. Report to First Aid.

NAME: Ethyl Chloride

FORMULA: C_2H_5Cl

MOLECULAR WEIGHT: 64.52

BOILING POINT: 54° F. (gas under normal conditions)

VAPOR PRESSURE @ 75° F.: 1130 mm

FREEZING POINT: -228° F.

LIQUID DENSITY @ 68° F.: 0.893

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RELATIVE VAPOR DENSITY (air= 1.0) 2.22

FLASH POINT: Open Cup -45° F. Closed Cup -58°F.

AUTOIGNITION: ~~966~~° F. 966.0 F.

EXPLOSIVE LIMITS: 3.6 - 12.0%

MAXIMUM ALLOWABLE CONC.: 1000 ppm

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ODOR: Pungent

HAZARDOUS PROPERTIES: The liquid is harmful to the eyes, and if spilled on the skin will cause frostbite. The vapor gives some warning of its presence because it is irritating, but it is possible to tolerate exposure to it until one becomes unconscious. EC is the least toxic of all the chlorinated hydrocarbons. It can cause narcosis, but the effects are usually transient. Continued exposures may cause some kidney deterioration. Inhalation of EC vapor in concentrations of 1%(by volume) produces narcotic and anesthetic effects; concentrations of 4% or greater may produce deep or even fatal anesthesia.

Although EC is not extremely poisonous, any exposure is very dangerous, because of the extreme flammability of the material. When EC is burned, phosgene and HCl are formed, so never approach burning EC without a gas mask.

Any spill of EC will result in an explosive mixture being formed;and because of the high density of the EC gas, the mixture will tend to stay near the ground. It will take very little to explode EC vapors. Static electricity spark, friction spark or an arcing device are all dangerous when EC is spilled.

TREATMENT: Remove the injured person from the contaminated area. If breathing has stopped, perform artificial respiration. In any case make sure the person injured is reported to First Aid immediately. If any liquid enters the eye, wash the eye continuously with a large amount of water for at least 15 minutes. If at the end of 15 minutes eye damage is still apparent, continue washing until the doctor arrives or gives new instructions.

NAME: Ethylene

FORMULA: C_2H_4

MOLECULAR WEIGHT: 28.05

BOILING POINT: -155° F.

FREEZING POINT: -273° F.

RELATIVE VAPOR DENSITY: (air = 1.0) 0.98

AUTOIGNITION: 1009° F.

EXPLOSIVE LIMITS: 3-34%

ODOR: Sweet

HAZARDOUS PROPERTIES: Ethylene is a flammable gas. It is a very dangerous explosion hazard upon exposure to heat or flame. It can react vigorously with oxidizing materials. Ethylene is moderately toxic, but the slight effects disappear as soon as the patient is removed from the exposure. The main danger with C_2H_4 is asphyxiation. The ethylene will displace the oxygen of the air, causing the victim to suffocate. (See Methane treatment)

TREATMENT: Remove the patient from the area, perform artificial respiration if breathing has stopped. Report to First Aid.

NAME: Freon 11 (trichloromonafluoromethane)

FORMULA: CCl_3F

MOLECULAR WEIGHT: 137.38

BOILING POINT: 74.7^{o} F.

VAPOR PRESSURE @ 75^{o} F.: -14.7 psia

LIQUID DENSITY @ 68^{o} F.: 1.5

RELATIVE VAPOR DENSITY: (air = 1.0) 4.8

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 1000 ppm in air

HAZARDOUS PROPERTIES: Dangerous! When heated to decomposition, it emits highly toxic fumes of phosgene, flourides and chlorides. Never allow any open flames to come in contact with F-11 or any vessels containing it. Never rush into an area where F-11 is burning or might burn without a mask.

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NAME: Hydrogen

FORMULA: H_2

MOLECULAR WEIGHT: 2.02

BOILING POINT: -423° F.

FREEZING POINT: -434° F.

RELATIVE VAPOR DENSITY: (air = 1.0) 0.069

AUTOIGNITION TEMP: 1085° F.
EXPLOSIVE LIMITS: 4-74%

HAZARDOUS PROPERTIES: Hydrogen is a flammable gas. As may be seen from the explosive range, any concentration is highly dangerous when exposed to heat or flame. Hydrogen gas itself is only slightly toxic, but will displace the O_2 in the air, causing suffocation. Symptoms will be the same as Methane.

TREATMENT: Remove the patient from the contaminated area, perform artificial respiration if breathing has stopped. Report to First Aid.

SL 008974

NAME: Hydrogen Chloride

FORMULA: HCl

MOLECULAR WEIGHT: 36.47

BOILING POINT: -121^{o} F.

VAPOR PRESSURE @ 75^{o} F.: 36,000 mm

FREEZING POINT: -174^{o} F.

LIQUID DENSITY: Normally a gas

RELATIVE VAPOR DENSITY: 1.26 (air = 1.0)

FLASH POINT: None

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC: 10 ppm for 8 hour working day

DETECTABLE ODOR CONC: Unknown

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.

NAME: Hydrochloric Acid, Muriatic Acid, Wet HCl

FORMULA: HCl

MOLECULAR WEIGHT: 36.47

BOILING POINT: 166° F. (32% HCl)

VAPOR PRESSURE @ 75° F.: 40 mm Hg.

FREEZING POINT: 12° F.

LIQUID DENSITY @ 68° F.: 1.159

EXPLOSIVE LIMITS: None

MAXIMUM ALLOWABLE CONC.: 10 ppm for 8 hr.

DETECTABLE ODOR CONC.: 3 ppm

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.

NAME: Nitrogen

FORMULA: N_2

MOLECULAR WEIGHT: 28.02

PHYSICAL APPEARANCE: Colorless, odorless, inert gas

SPECIFIC GRAVITY: 1.0 with relation to air. (Air is 78% N_2)

HAZARDOUS PROPERTIES: Even though nitrogen is a very safe, inactive gas, it has some inherent dangers since it is used so universally throughout the plant. Its prime use is for padding and sweeping of equipment that has, or has had, flammables in it. The hazard involved is that a vessel may have insufficient oxygen or that nitrogen is used to purge the vessel instead of air, before man-entry.

Therefore, in the HCl plant, every vessel that is entered not only must first be checked for flammability, etc., it must also be checked for sufficient oxygen. Not only that, nitrogen lines, as well as other toxic lines, must be isolated from the vessel before entry and a clean air sweep provided.

TREATMENT: Remove person from the oxygen deficient area. Administer artificial respiration if necessary. See Methane for symptoms.

NAME: Sulfuric Acid

FORMULA: H_2SO_4

MOLECULAR WEIGHT: 98.08

PHYSICAL APPEARANCE: Colorless to cloudy liquid

HAZARDOUS PROPERTIES: Highly corrosive to most metals, particularly at concentrations below 75%. This reaction produces H_2 gas. At concentrations above 75%, H_2SO_4 may be handled in steel provided the temperature is never greater than 100° F.

Very reactive with water or organic materials with heat being evolved.

Contact with the body produces a rapid destruction of the tissue. The acid will continue to destroy the skin until it is washed off. The destruction of the skin will result in a painful and slow-healing burn.

PROTECTIVE EQUIPMENT: Use rubber gloves and face shields whenever working with H_2SO_4. Use a slicker suit whenever transferring acid, entering the shielded area around the HCl dryer, or where there is any danger of an acid spill.

TREATMENT: Flush the contacted area with an abundance of water. Remove any contaminated clothing or equipment. After thoroughly flushing the affected area, report to First Aid for further treatment. Treat for shock in case of severe burns. If any of the acid has been swallowed, do not induce vomiting; if the patient is conscious, wash his mouth with water and feed him as much water as he can drink; get medical help as quickly as possible.

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NAME: Vinyl Chloride (chloroethylene)

FORMULA: C_2H_3Cl

MOLECULAR WEIGHT: 62.50

BOILING POINT: 8^{o} F.

VAPOR PRESSURE @ 75^{o} F. 2700 mm (gas under normal conditions.)

FREEZING POINT: -244^{o} F.

LIQUID DENSITY @ 68^{o} F.: 0.0908

RELATIVE VAPOR DENSIRY: (air = 1.0) 2.15

FLASH POINT: Open Cut -107^{o}F. Closed Cup - 162^{o}F.

EXPLOSIVE LIMITS: 4-22%

MAXIMUM ALLOWABLE CONC.: 500 ppm for 8 hours

ODOR: Faintly sweet (smells like phenol when inhibited)

HAZARDOUS PROPERTIES: Vinyl chloride is very much like Ethyl Chloride. It is not very poisonous; it is extremely flammable and it has a narcotic effect. Continued exposures may cause some kidney deterioration. Inhalation of vapors greater than 500 ppm may produce a slight narcotic effect. At concentrations of 4% or greater, VC vapors may produce a deep or fatal anesthesia.

The main danger with VC is the extreme flammability of the vapors. VC when burning will form phosgene and HCl, so never approach a fire without a gas mask.

Any spill of VC will result in an explosive mixture being formed and because of the high density of the VC gas, the mixture will tend to stay near the ground. It will take very little to explode the VC vapors, static electricity spark, friction spark or an arcing device are all dangerous when VC is spilled.

TREATMENT: Remove the injured person from the contaminated area; if breathing has stopped, perform artificial respiration. In any case, make sure the person injured is reported to First Aid immediately. If any liquid enters the eye, wash the eye continuously with a large amount of water for at least 15 minutes; then get the person to First Aid.

DRY HCl PROCESS

Dry HCl is produced by the combustion of hydrogen and chlorine in large graphite combustion chambers. H_2 and Cl_2 are fed to the bottom of the chamber, with the Cl_2 flow kept proportional to the H_2 flow. The two gases burn in the combustion chamber forming HCl. The HCl leaves the top of the chamber, flows through a 6" Karbate line, to the Primary Cooler. The gas entering the Primary Cooler generally runs about 400° F., but it is dependent on the rate. The Primary Cooler is cooled by well water and should cool the gases to about 100° F. The cooling water leaves the Primary Cooler and flows uniformly down the outside surface of the combustion chamber. The HCl gas comes out the bottom of the Primary Cooler into a rubber-lined pipe which carries it to the top of the Secondary Cooler. The Secondary Cooler is cooled by refrigerated brine at 0° F. The HCl gas leaves the bottom of the Secondary Cooler at about 40° F., goes through an entrainment separator and into the bottom of a H_2SO_4 dryer. Sulfuric acid is pumped from the bottom to the top of the tower where it contacts the HCl gas by filtering down through a packed section. The HCl gas leaves the top of the H_2SO_4 dryer and flows to #5 compressor. No. 5 compressor compresses the gas from a slight vacuum to about 55 psig. After compression, the gas is cooled by two parallel aftercoolers to about 100° F. The aftercoolers are cooled with cooling tower water. From the aftercoolers the HCl is sent through one of two meter runs to the underground pipeline that goes to the consumer. The pressure on the customer line is controlled by bleeding the excess HCl through a PCV to #2 Absorber Cooler. Additional HCl may be added to the system by bleeding HCl gas from the Wet System (#1, 2, 3 compressor suction line) to the Dry System (suction line to #5 compressor).

The dry system consists of 2 burners, 2 primary coolers, 2 secondary coolers and 2 entrainment separators. From the entrainment separators, the HCL from both burners goes through a common system. No. 1 burner is used for producing dry HCl only, but #2 burner may produce wet or dry HCl. For this reason the Primary Cooler on #2 burner is an Absorber Cooler. The Absorber Cooler may run as either an absorber, or by cutting the weak acid feed off and changing a few valves, the absorber will serve as a primary cooler. All condensate from the dry system is fed through sealpots to the sewer.

VAPORIZED CHLORINE SYSTEM

A. Equipment

1. Chlorine Vaporizer-62A-70-48 - The chlorine vaporizer is located in Tri-Ethane and is a Type G with a capacity of 11,000#/hr. of chlorine when 5 psig steam is used.

2. Chlorine Surge Drum- 62A-60-419 - The chlorine surge drum is 36" OD x 5'0" tan to tan. The design pressure is 150 psi at 300°F. The rupture disc is set to burst at 85 psig and the relief valve is set for 115 psig.

B. Operation The chlorine vaporizer is operated by the Tri-Ethane(R) operator because it is used to vaporize chlorine for the TCE reactor. Cardinal rules for a vaporizer are: never put steam on a closed-up vaporizer and never make large changes to any controls on or around a vaporizer. The vaporizer floats against the Cl_2 supply line and its pressure is controlled by the liquefaction operator. Cl_2 is pumped from #7 or #8 Cl_2 scale tank with the majority of the Cl_2 being recirculated back to the tank it is being pumped from. By adjusting the valve in the recirculation line, the pressure of the Cl_2 coming to Per-Tri, EDC, MC and HCl is set. The liquefaction lead operator is the controller of the valve,and he must be notified any time rates are changed on vaporized Cl_2. Failure to do so will result in surging and either high or low pressure.

The PCV for the vaporized Cl_2 to HCl is located in the MC plant, north of the vaporizer and east of the MC PCV. The control of this valve comes from the HCl board and it should be set at 25 psig. Whenever the block valves around the PCV are open, a close watch on the pressure should be maintained, as any leakage of the valve will cause the Cl_2 Surge Drum to overpressure and burst the rupture disc. The only way to prevent this is to bleed the leaking Cl_2 into the burner through the FCV bypass. It is best to remember that most valves in Cl_2 service will leak through. Care should be exercised in shutting down the plant, regardless of whether the shutdown is automatic or manual, to see that the PCV is blocked off immediately.

In between the rupture disc and SRV is a bleed. This bleed must be always open; if it is not, it is possible to over pressurize the Cl_2 Surge Drum. When Cl_2 is leaking out this opening, the rupture disc should be changed. Once per shift this opening should be checked to assure that no corrosion products are plugging the opening.

Burner #2 may be run on gaseous Cl_2, but this should never be done when the burner product is going into the dry HCl system. The impurities in the cell gas would cause the HCl to be out of spec.

The Cl_2 to each burner is flow controlled by a ratio controller that will keep the Cl_2 flow proportional to the H_2 flow. In case of a system failure, air to the Cl_2 FCV will be cut off and the valve should close. The Cl_2 flows through a loop just before entering the burner nozzle. The purpose of the loop is to prevent acid from draining from the bottom of the burner back to the FCV. The drain on the burner side of the loop should be checked after a burner shutdown and while the burner is down for acid.

H_2 SYSTEM

A. Equipment

1. Hydrogen Surge Drum - 62A-60-420 - The H_2 Surge Drum is 36" OD by 5'0" tan to tan. The design pressure of the vessel is full vacuum to 75 psi. The rupture disc is set for 75 psig.

2. H_2 Cooler - 62A-71-517 - The hydrogen cooler is a 6 5/8" OD exchanger with 26 8' tubes 3/4" OD 16 gauge. The material of construction is steel for everything.

B. Operation - The hydrogen line to the HCl plant is a 4" line that comes from the top of the H_2 scrubber in the cell area. The line has several low spots in it that have float traps to remove moisture. These traps should be checked regulrly, especially during cold weather. The H_2 system has very little extra capacity since the maximum pressure available is about 22 psig. The booster compressor (to other H_2 consumers) is set to cut off at about 10 psig. So any failures in the H_2 system will result in a rapid pressure loss to 10 psig, then the only consumer will be HCl so the pressure loss below 10 psig will determine how much to cut back the burner rates.

The H_2 line runs down the main racks and enters the plant south of the acid storage tanks. The H_2 system has a PCV and two meter runs at this point. The PCV should be set to give H_2 pressure to the burners of about 20 psig. This pressure as well as the Cl_2 pressure will affect the ratio between the two gases, so care should be taken in changing the pressures on the systems. The larger meter run should be used whenever more than two burners at full rates are operating or the total hydrogen flow is greater than 500 SCFM. From the meter run, the H_2 flows through a surge drum and a cooler to the individual burners. The purpose of the cooler is to keep the H_2 at a fairly stable temperature for metering at each burner.

The hydrogen flow to each burner is controlled by the burner pressure. The burner pressure should be set to keep from -2" to +2" of H_2O pressure. The set pressure is maintained by increasing or decreasing the H_2 flow. The H_2 flow is measured and sent to a ratio controller. The ratio controller keeps the Cl_2 flow to the burner in a preset ratio to the H_2 flow. The normal ratio is about 1.1 H_2 to Cl_2, but his will vary according to the pressures and temperatures of the gases. The set ratio is the ratio that gives 3% to 5% excess H_2 in the product HCl.

Located in each H_2 system is a positive shutoff Maxon valve. This valve will shut during any system failure.

SHUTDOWN SYSTEM

The shutdown system (Dwg. 62A-7703) for the Dry HCl plant is designed to shut down burner #1 and/or burner #2. When the shutdown system is activated, it will close the Maxon valve on the H_2 line, close the Cl_2 FCV, shut down the compressor, and close the compressor recirculation valve.

The Maxon valve is a positive shutoff valve located in the H_2 feed system to each burner. It is possible to bypass this valve and it is bypassed during start-up. AT NO OTHER TIME SHOULD THIS VALVE BE BYPASSED. The most dangerous thing to happen around an HCl plant is to fill the system with H_2 and human reflexes are not quick enough to close off a valve that is wide open. The Maxon valve is spring loaded to close and is kept open by an engaging solenoid.

The Cl_2 FCV is designed to fail closed with a loss of air supply. The shutdown system has a solenoid in the air supply that closes for system failure. Most valves in Cl_2 service gunk up, so in order to assure that no Cl_2 is going through the burner, the block valves will have to be closed.

The compressor recirculation valve will fail closed with loss of air supply. There is a solenoid in the air supply to this valve; and with the loss of both burners, the solenoid will close. Switch 5 will bypass this feature, and it is generally closed. By running with switch 5 closed, loss of both burners will not cause the recirculation valve to close; but should the compressor fail, the solenoid would cause the valve to close. Caution should be used in running with both switch 5 and switch 6 closed as this would allow the recirculation valve to stay open with compressor failure and this would result in blowing the customer line pressure back through the dryer, coolers and burners.

The compressor will be shut down anytime both burners fail unless switch 7 is closed. Under normal conditions switch 7 will always be closed.

The shutdown system is activated by: a flame failure, low burner pressure, high burner pressure, loss of cooling water, or loss of the compressor. A failure of any of the first four items will cause the affected burner to shut down, and failure of the last item will cause both burners to shut down. The shutdown system can be bypassed by timers, and individual parts of it may be bypassed with switches. The reason for the bypass switches and timers is that under different circumstances different items are of importance. The timers are for equipment checking and starting up. Periodically the burner shutdown system should be checked to see what shutdown relays are bypassed and these checked to see if it is necessary for these to be bypassed under the conditions of operation at that time.

A flame failure is detected by a "Firetron" photo-conductive cell, which continuously monitors the flame. The fire-eye is located at one of the sight ports on the burner bottom. High and low burner pressure are monitored, recorded and used to control the H_2 flow. Cooling water for #1 burner and primary cooler is monitored from the well water going into the cooler. In this line there is a no-flow switch which will close if the flow drops to less than 50 GPM. The cooling water flow is monitored in two spots for #2 burner. Cooling tower water flowing into Cooler Absorber #1 is monitored through a no-flow switch on the inlet as well as is the well water flow to the top of burner #2. Both of these switches must have at least 50 GPM and failure of either one will activate the shutdown system. The compressor shutdown is located in the electrical system to the compressor motor.

In case of an emergency shutdown in the HCl plant, the alarm on the panelboard will indicate the first one to fail. It will be the only one to flash. When the board is acknowledged the others will flash. When it is acknowledged again, all alarms will clear. The sequential alarm system applies to flame, loss of cooling water, high or low burner pressures, or loss of the compressor.

The timers that are on each burner system bypass flame failure and high or low burner pressure. These timers may be set for up to 15 minutes and are generally set for 7 minutes. Once they are set they cannot be reset again until time has run out. The system override timer will bypass all safety shutdown relays including compressor failure. The system timer may be set for 60 minutes but is generally set for 25 minutes. Switch 1 when closed will prevent high or low burner pressure from shutting down burner #1. Switch 2 when open is an isolation switch so that #1 burner shutdown system may be worked on and a ground in it will not shut down burner #2. (When switch 2 is open, burner #1 must be shut down.) Switch 3 bypasses high and low pressure shutdown for burner #2. Switch 4 is an isolation switch for burner #2 shutdown system. Switch 5 when closed will allow the HCl recirculation valve to operate with both burners down. Switch 6 when closed will allow the burners to operate with the compressor down. Care must be used with switch 6, as with it closed the recirculation valve will continue to operate with the compressor down. ~~Switch 7 when closed will allow the compressor to run with both burners down.~~ ~~Switch 7~~ is normally closed.

BURNER SYSTEM

A. Equipment

1. HCl Burner - 62A-71-535 & 536 - The HCl burners (combustion chambers) are 33" chambers. They are constructed of 3" thick graphite rings with each ring 3'3" OD and 5' 8 5/8" high. There are 4 full-sized rings and a top ring that is 3' 8 5/8" high. The rings are stacked on each other and all rest on a 4" thick "Karbate" base. When the sections are cemented together and set on the base, the over-all height is 24' 3 1/8". The sections are cemented together with National Carbon C6 cement and heat cured. The outside of the chambers have a thin washcoat of impervious material to prevent water from being absorbed through the burner walls. The top ring has a 4" thick graphite plate resting on it, and on top of this a water distributor. When the distributor is filled with water, the weight of the water, distributor and top will holdthe top on the burner until a pressure of about 20" of H_2O is reached. The top has a guide bar so the top resets itself properly whenever it is lifted. The burner has a hole in the bottom plate for the burner nozzle assembly, 2-4" nozzles with quartz sight glasses located near the bottom, and a 3" and a 6" nozzle near the top. The 3" nozzle is for burner pressure and the 6" nozzle is the gas outlet.

2. Burner Nozzle Assembly - The burner nozzle assembly is a National Carbon size 8"Karbate" impervious graphite with silica-coated caps. The diameter of the holes in the caps is to be at least 13/16" and they should be drilled to this diameter if they arrive with smaller holes. The hydrogen feeds in the outermost ring and Cl_2 in the center.

B. Operation - Chlorine and hydrogen are fed separately through the burner nozzle assembly. The two gases are mixed as they are ejected from the nozzle into the burner. Once a flame is started the two gases will burn when they are mixed. Located on one of the bottom sight glasses is a fire eye. The purpose of the fire-eye is to continuously monitor the flame and anytime the flame disappears the fire eye will activate the shutdown system for that burner.

The burner must have some of the heat generated by the reaction dissipated or the graphite walls will overheat, resulting in oxidation, cracking and leakage. For this reason there is a no-flow switch in the well water line going to each burner. Loss of well water flow will activate the shutdown system for that burner. The no-flow alarm on the well water is alarmed through the no-flow light and alarm on the CTW flow to the absorber. Should the CTW or the well water fail, it should be fairly obvious which one failed. If the switches fail each one may be checked. The well water to each burner is distributed at the top of the burner through a water distributor. The water distributor causes the water to flow down the sides of the burner in an even manner. Plexiglass is around the burner to prevent the wind from blowing the water layer away and leaving the graphite with no cooling film. Care should be taken in adjusting the well water flow to the burner to see that enough water is used to provide a water layer over the outside of the burner from top to bottom. This will require from 100 GPM to 200GPM, depending on the burner rate. The water is collected at the bottom of the burner in a rubber-lined pan and sent to the sewer. The bottom plate has grooves on its bottom to allow some water to flow beneath it. If the grooves are allowed to plug up, the rubber lining will have no protection and will be destroyed. Another problem with the cooling system will be algae. If the burner becomes coated with algae, the cooling water will have little effect. As the algae appears and gets thick enough to retard the heat transfer, it must be removed by (a) heavy chlorination of #8 deep well water, (b) bubbling a few TPD of HCl in the distribution crown (there is an HCl ring sparger for this purpose), (c) put Pittabs in the distribution crown, (d) shut burner down and expose it to sunlight, (e) physically scraping the burner. The best method is the HCl wash when excess HCl is available.

After the H_2 and Cl_2 burn, the HCl rises in the burner and leaves at the top through a 6" Karbate line. This line must be water-cooled also and there are spray nozzles to keep it wet. The maximum recommended temperature for "Karbate" is 338^{o} F. This temperature refers to the body temp, not the gas inside the pipe; i.e., a gas temp of 440^{o} F. and water on the outside of the pipe will give a "Karbate" temperature of about 310^{o} F. The "Karbate" risers have no water on them as it was felt that enough cooling will take place in the vertical run, and the gases will not cause the "Karbate" risers t o overheat. These risers should be checked fairly reguarly, especially at high rates.

Near the top of the burner is a pressure transmitter. This pressure is used to control the burner rates. The ideal operating pressure is -2" of H_2O, but the burner will operate anywhere in the range of -2" to +2" of H_2O. When the burner pressure falls below the preset rate, the H_2 flow will be increased and since the Cl_2 flow is kept proportional to the H_2 flow, the Cl_2 flow is increased. The net result is an increase in HCl production. High and low pressures may be used to shut down the burner also.

The burner nozzle assembly has a hole in the bottom of it. When the burner is operating, this hole should have a plug in it. Whenever the burner is down, this plug should be removed and air allowed to flow through the hole, the burner and the jets for at least 5 minutes.

The nozzle assembly also has a U-tube in it. This tube is to drain the condensate formed in the burner to the sewer. There should always be some water in the U-tube to form a seal. Generally some additional water must be added to keep the tube full. Caustion should be used around this condensate as it is 36% muriatic acid.

The dry system has two identical burners, numbers 1 and 2.

PRIMARY COOLERS

A. Equipment

1. Primary Cooler #2 (62A-71-537) is a 14" OD shell with 42 "Karbate" tubes 7/8 ID x 12'0" long

2. Primary Cooler #2 (Cooler-absorber #1, 62A-71-818) is a 14" OD shell with 42 "Karbate" tubes 7/8 ID x 16'0" long. At the top of each tube is a graphite weir that is used when the cooler is being used as as absorber. At the bottom of the tubes is a seal pot to separate the HCl gas from the muriatic acid.

B. Operation

The primary coolers are used as vertical coolers with the cooling water flowing up the shell side and HCl gas flowing down the tube side. There is some difference between #1 and #2 Primary Coolers because #1 is used for cooling HCl, while #2 is used as a cooler or as an absorber. Care must be taken to see that Teflon weirs are never installed in cooler #2 as they will melt when the cooler is being used as a primary cooler.

The water system used for cooling is different on each cooler. The water for #1 Primary Cooler is well water and is discharged from the cooler to the top of the burner where it is used to keep the burner walls wetted. The no-flow switch is located on the inlet line to the cooler and loss of water will activate the shutdown system. The flow required will be enough water to keep the HCl gas leaving at 100° F. The water flow is generally between 100 GPM and 200 GPM Enough water should always be used to have enough water to satisfy burner requirements. Water on this exchanger as well as all other "Karbate" exchangers should be throttled on the inlet side. All "Karbate" exchangers have the globe valve located in the inlet side.

Cooler-absorber #1 is cooled with cooling tower water. The flow rate required will be about 200 GPM and the HCl gas out will run 110° F. Since loss of cooling would damage the exchanger, the CTW has a no-flow switch in it. Whenever cooling water is lost, the shutdown system for that burner is activated. The well water going to the burner has its own no-flow switch but is alarmed and tied into the shutdown system through the CTW no-flow.

Moisture that is in the HCl gas will condense as the gas is cooled. This liquid is collected at the bottom of the cooler and sent to the sewer through a seal pot. Do not attempt to run this condensate to the strong acid storage.

The HCl gas leaves the bottom of the Primary Coolers and flows through a rubber-lined pipe to the top of the secondary cooler. When more than one burner isbeing used to provide dry HCl, it is impossible to determine the excess H_2 by the product stream analyzer. For this reason routine samples must be run on each burner. There is a nozzle in the rubber-lined pipe for this purpose. There are water aspirators located nearby to draw the sample. It is possible to analyze #2 burner through the wet HCl analyzer. This analyzer is manifolded from the tops of Cooler-Absorbers #1, 3, 4, and 5, but only one can be analyzed at a time.

On #1 Cooler-Absorber, there is an air trap on the top tube sheet. This trap is to make sure that cooling water is kept against the tube sheet. Any gases generated or trapped will bleed out through the trap but the water will not.

SECONDARY COOLERS

A. Equipment

1. The Secondary Coolers (62A-71-540) are a 14" OD shell with 42 "Karbate" finned tubes 7/8" ID x 12'0" long.

2. Mist Eliminator - The mist eliminators are 4" with "Karbate" internals.

B. Operation

The secondary coolers are used as vertical coolers with chilled brine flowing up the shell side and HCl gas flowing down the tube side. Too-rapid cooling of HCl will cause a fog to form and this results in high moisture HCl. To prvent this from happening, the HCl gas leaving should never be cooler than 35^{o} F. Some variation of this temp will result because the gases entering the cooler will be at different temperatures. Whenever high moisture is indicated by high H_2SO_4 usage, start raising the exit gas temperature. The exit gas temperature is controlled by throttling the brine into the cooler.

From the bottom of the cooler the gases flow through an entrainment separator and into a rubber-lined pipe. From this pipe on,the gases from #1 burner and #2 burner are common and go to the guard dryer. All condensate from the secondary coolers and the entrainment separator is drained to the sewer through a seal pot.

H_2SO_4 DRYING SYSTEM

A. Equipment

1. The H_2SO_4 dryer (62A-73-43)is a 2' 10 5/8" OD vessle 20' high. The dryer has 6' of 1½" Intalox saddles. The demister section has 1½' of 1½" saddles and a 6" Teflon demister. The vessel is protected from pressure by a floating head which is sealed with cell putty. The material of construction is steel. The vessel has one sparger and no distributor.

2. H_2SO_4 storage is a 3' diameter by 4'0" vessel that will hold 211 gallons with no outage. The vessel is constructed of 36" pipe.

3. $H2SO_4$ Pumps #3 & 4 (62A-55-443 & 443) are Worthington 1½ CNG-62 with a 6½" nickel impellers. The wet end of the pumps are constructed of Worthite. The seals used in the pumps are John Crane type 20. The pumps should deliver 25 GPM at 50' head. The motors are 3 HP, 1750 RPM.

B. Operation

The HCl flows from the individual entrainment separator into a rubber-lined pipe. The HCl flows from the rubber-lined pipe into the bottom of the

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H_2SO_4 dryer. The gas then flows up through the packing, through the demister, out the top of the dryer into a steel line that goes to the compressor. The bottom 6' of the dryer is used as an acid reservoir. The acid is pumped from the bottom of the dryer, through an acid heater and into the dryer, above the 6' section but below the 1½' section. The bottom of the acid dryer is steam traced and there is a heater on the recirculation line (double-pipe heat exchanger) which has hot water running to it to keep the acid from freezing. The acid temperature should be kept between 70^{o} F. and 95^{o} F. Below 70^{o} F. the acid will freeze and above 95^{o} F. the acid is extremely corrosive to steel. The acid is changed whenever its strength gets below 90%.

Hot water for the heater is made by bleeding steam into the well water. Adding steam directly to the heat exchanger causes a "hot spot" and therefore rapid deterioration of the steel exchangers. The exchanger is a field - constructed double pipe heat exchanger.

HCl COMPRESSOR SYSTEM

A. Equipment

1. HCl Compressor 62A-56-127 is an Ingersoll-Rand ES-1-NL-2 with a 19" diameter and a 13" stroke. The compressor running at 275 RPM is to compress 55 TPD of HCl from 13.7 psia to 64.3 psia. This will require a 150 HP motor. The design pressure of the compressor is 70 psia. The compressor had a capacity of 51 TPD at 275 RPM and the conditions of operation. For this reason the compressor has a new sheave to give an RPM of 291 and this gives a capacity of 55 TPD.

2. HCl Aftercooler 62A-71-542 & 559 - There are two Brown Fintube size 317-000-420 with 180.9 $ft.^2$ per unit

B. Operation

The pressure(vacuum) of the compressor suction drum controls the rate at which the HCl plant operates. The suction pressure is kept constant by recirculating HCl from the discharge line into the suction line. There is a suction header and a discharge header that were field fabricated from extra strong steel pipe. The headers serve to eliminate vibration from the compressor as well as to give some surge time for control. The discharge pressure of the compressor is controlled by customer demand and by a PCV that sends excess HCl to the scrubber or to #2 absorber. The compressor discharge temperature should not be allowed to operate continuously above 340° F.

The compressor suction header pressure will vary according to the rate desired; i.e., 15" H_2O vacuum will give a rate of about 28 TPD while 30" H_2O vacuum will give a rate of 54 TPD. The compressor recirculation valve gets its impulse from the suction header and it will bleed enough HCl back from the compressor discharge to maintain the preset pressure. The suction drum pressure should never be allowed to get over 14.2 psia (10" H_2O vacuum) as this will overlad the compressor motor. Conversely, if the compressor is allowed to go on a high vacuum, air can be sucked into the system and it can form explosive mixtures either for us (in large enough quantities), or for the customer (in his vent from the plant).

The compressor discharge is controlled by a PCV in a line that will send the excess HCl to the scrubber or to #2 absorber. A compressor will discharge to any pressure set until it causes pipe failure, compressor frame failure, motor overload, or a relief valve to go. It is for this reason that the relief valve on the compressor as well as any PCV's in the compressor discharge should be checked. Once every shift the PCV in the compressor discharge is to be stroked.

It is possible when the customer demand is constant to adjust the plant rates so no excess HCl is produced. This is possible because the customer line is 11,000 ft. long, 6" schedule 40 pipe and this acts as a surge drum. Line pressure should not be allowed to vary too much. When line pressure is varying or the customer intends to change rates, a small amount of HCl should be allowed to bleed through the PCV to #2 absorber. The PCV is designed so the small valve opens before the large valve opens to give a smooth and dependable performance. The meter run for the customer is arranged so that the small orifice may be used when one burner is being used and the large orifice used when two burners are in service.

All entrained material in the HCl to the compressor will be caught in a strainer located in the compressor suction line just above the compressor. When the pressure drop across the strainer becomes too great, it will have to be changed out. The strainer can be bypassed for a short period of time. There is a strainer in the line just before the meter run also.

The fintube exchangers are designed to give a gas temperature of 110° F. for the meter run. The two Brown Fintubes are designed to run in parallel and to run on cooling tower water.

When starting up, shutting down, or running the compressor with no HCl available, the compressor is run on dry air. The air is fed into the compressor at its suction (below the HCl block valve) and is allowed to recirculate and discharge to the vent scrubber. Enough air should be used to prevent the compressor from running a hot discharge (250° F.). The discharge pressure should never be allowed to go below 25 psig as this causes unnecessary wear on the wear shoe. When the compressor is shut down, a small purge of air should be left on the compressor to prevent any moisture from entering.

<u>NEVER START A COMPRESSOR WITH A CLOSED DISCHARGE LINE</u>. Open the discharge system through the scrubber, set the pressure at 25 psig, allow recirculation, leave the suction valve closed, open the discharge to suction bypass, put air into the suction line and start the compressor. After the compressor is up to speed, close the discharge to suction bypass slowly. Adjust the air flow to give the proper discharge temperature after the system is lined out.

The first distance piece on the compressor is vented to the suction and therefore requires no attention other than to be sure it is open. The second distance piece is to have an air sweep leaving the top and bottom. Enough air should be used to sweep through both valves and have a 3 psig pressure on the chamber.

HCl SCRUBBER

A. Equipment

1. Scrubber 62A-60-421 - The HCl scrubber is a 3' OD by 10' rubber-lined vessel. The scrubber has a water distributor and a caustic distributor at the top and it is packed with 3' of 1½" Intalox saddles.

2. Jets - The two steam jets are constructed of Haveg 41 and are size 3 FHA-14 designed to handle 300#;hr. at 26 mm $H_g{}^o$ absolute.

B. Operation

The vent scrubber is used in start-up and under upset conditions in operations. Under normal circumstances the excess HCl produced over customer demands will be sent through the customer line PCV to #2 absorber. This extra material may be sent to the scrubber if it is desired. The gaseous feed to the scrubber is fed near the bottom and passes up through the packed section where it contacts water and cell liquor, the inert gases leave the top and are vented above the process platforms. The well water or the cell liquor is fed into the top of the scrubber where it flows through a distributor , through the packed section and out the bottom through a seal loop to the sewer.

The water flow to the scrubber flows through a rotometer and through a valve network. The valve network was used at one time to open the flow whenever the PCV to the scrubber opened. This is no longer true, and the water should be routed to bypass the solenoid.

The cell liquor flow is adjusted by watching the pressure drop in the line when the valve to the scrubber is opened. BEFORE USING ANY CELL LIQUOR THE "TRI-ETHANE(R)" OPERATOR IS TO BE NOTIFIED. The TE operator will notify the caustic lead operator if more than one pump is required. When the cell liquor line is opened to the scrubber, some contact should be maintained with the TE operator, because if HCl takes too much cell liquor the VDC section will not be able to operate. The cell liquor is needed whenever Cl_2 is going to the scrubber or when more HCl is going to the scrubber than the water can handle.

During the start-up of any burner, a large amount of water and cell liquor will be required. The two Haveg jets will be operating so the additional load of steam condensation will be added to the scrubber. The two jets will be used to sweep the burners before starting up the burner, to maintain burner pressure when starting up, or to sweep a burner after a shutdown. The jets will handle a load of about 12 TPD and still give burner control. Any wear in the jets will cause a large loss of capacity.

START-UP PROCEDURE - Assuming Both Burners Are Down

The auxiliary equipment should be running and completely lined out; i.e., refrigeration unit, brine circulation,jets, scrubber with water and cell liquor, vaporizer, and pumps and tower, water on the primary cooler and the burner, and the compressor running on air (unless one burner is in production).

Call the cell bridge and notify them you are going to start taking more H_2.

Line up the following valves:

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Cl_2 - PCV and FCV - closed and blocked

H_2 - PCV and FCV - closed and blocked
(The PCV's are only closed if no other burners are in service)

Discharge of the Secondary Cooler - closed

Discharge of the Acid Tower to compressor suction - closed
(If both burners are down)

Ball-valve to jets open.

Check the H_2 FCV with the manual control, be sure it is seated (visual check), block off the impulse to it and open the impulse to the air valve. (This valve will bleed air into the jet suction to give pressure control.) Set the gain on the burner pressure up (.35 $\longrightarrow$ .5), put it on automatic and set it to control -5" of H_2O.

HCl UNIT START-UP PROCEDURES

Start up Chlorine Flow

First put the Cl_2 PCV into service by having a man on Cl_2 FCV bypass bleed excess pressure into burner. With the PCV on manual and closed, open block valves around PCV. If the valve leaks through, adjust pressure to 25 psig with FCV bypass. Adjust to a chlorine flow of 30 on chart with the bypass. Set PCV on Automatic and make sure it is controlling.

Check the stack to see if Cl_2 is being vented. If so, use more cell liquor.

Purge the H_2 flame arrestor with N_2

It should be enough flow to put the burner on a slight pressure when flowing. Do this 2 or 3 times for about 15 to 20 seconds each.

When Cl_2 has been purging for 5 minutes, light the lance. Open the appropriate valves only (1 block and the ½"). Use only H_2, get small H_2 flow, point the lance at shell, throw a match at the end. Adjust flame until a good flame is present. DO NOT POINT on Epoxied base of Burner.

With a man at the observation nozzle and water flowing into the U-tube, insert the lance. Be sure that the flame is visible (lance may have to be moved up or down). Allow the burner pressure to settle out. If you can't see it at all, it is out; get H_2 flow off immediately. Wait 5 minutes before trying to start up again.

With a man at the observation nozzle, have an operator slowly crack the 1" H_2 FCV bypass. The burner will light with a thump and a pressure fluctuation; continue to slowly open the H_2 bypass until the H_2 flow is 25 on the chart. The only reason to not bring the H_2 flow up is malfunctions; i.e., flame failure or some indication on board, flame failure is by observation, not alarm. In the event of anything unusual, get H_2 flow off immediately.

Have the operator increase the Cl_2 bypass flow to 35 then H_2 to 30, Cl_2 to 40, H_2, etc. until chlorine flow is 55 or 60 and H_2 is 5 less. Adjust at rate slow enough that the burner pressure is controlled. Never allow H_2 to be greater than Cl_2.

Remove lance.

Slowly cut back on the H_2 flow to the lance until the H_2 flow decreases about 10; then increase H_2 through FCV bypass about 10. Continue to do this until the H_2 to the lance is off. Pull the lance, insert the plug and allow the pressures to line out.

Bypass the burner pressure shutdown system (switch 1 or 3).

Depress the safety override timer - this activates the Cl_2 solenoid and the Cl_2 FCV may be operated.

Check the Cl_2 FCV out with the operator observing the valve movement.

Close the Cl_2 FCV with manual control.

Open upstream and downstream block valves one at a time, watching for leak-through.

Put the Cl_2 flow controller on automatic and adjust the set point to where the valve barely opens. Probably the gain will have to be set to .25 $\rightarrow$ .30. Slowly close FCV bypass.

When valve is closed, put controller on cascade with ratio = 1.1 or 1.2. Check to be sure the ratio controller is working and controller is in cascade.

Open the block valve downstream of the H_2 FCV.

Open the impulse to the H_2 FCV from the burner pressure.

Have the operator toslowly close the block valve in air system. When it is closed, seal off the air controller.

Slowly close the 1" H_2 FCV bypass.

You probably will have to adjust the gain to approximately .2 to stop surging.

Open the Maxon valve.

Open the block valve to the Maxon valve; with somebody watching the H_2 flow, slowly close the Maxon valve bypass.

Follow A or B

A. If the other burner is not in operation, open the valve in the line between the acid tower and the compressor.

Have one man cut the air off to the compressor at the same time the valve downstream of secondary cooler is slowly opened. The board will have to be watched for the compressor suction pressure and to make sure the rate increase is not too rapid.

Bring the Cl_2 rates to = 120 $\rightarrow$ 140.

Slowly close off the ball valve to the jets.

Simultaneously increase compressor suction to hold fairly constant rate.

Slowly bring the burner to H_2 excess. Be sure to do this slowly and never allow system to swing from $H_2 \longrightarrow Cl_2$ excess.

Put burner pressure shutdown back in service if needed.

Line out unit and cut off cell liquor, jets, etc.
Hotify HCl consumers.

B. If other burner is in operation:
   1. Switch burner pressure control to manual.
   2. Slowly change the burner to an H_2 excess.
   3. Sample through the aspirator set-up and adjust the H_2 excess to approximately 3%.
   4. Slowly open the valve downstream of the secondary cooler. The ratio controller will have to be adjusted as rates increase.
   5. Slowly close ball valve to jet system.
   6. Put burner pressure shutdown back in service if needed.

WET HCl PROCESS

WET HCl PROCESS DESCRIPTION

The wet HCl system is a process that will produce the same product as the dry system produces. The end product and the raw material feed are essentially the same for both processes. More dry HCl capacity was not added because the wet system had many advantages that were desired at the present time. Among these are ease of control, use of cell gas, some surge capacity, and some reclaiming ability.

HCl will form an azeotrope with water at 20% acid, so the wet system is designed to operate between the azeotrope and concentrated acid (36%). The actual strong acid concentration will be 33% HCl for economic reasons.

HCl is produced by burning H_2 and Cl_2 in graphite combustion chambers. The feed system, the control system, and the burners are exactly the same as is used in the dry system with one exception, the chlorine is not vaporized Cl_2. Because inerts will cause no impurity problems in the wet system, cell gas may be used. Cell gas and H_2 are fed into the bottom of the burner, react and the product HCl is removed at the top through a 6" "Karbate" line into the absorber-cooler. The gas should enter the top of the absorber-cooler at about 400° F., because the "Karbate" line is water sprayed, and the burner is water-cooled. The gas enters the top of the absorber, flows down the center of the tubes and is absorbed by the weak acid flowing down the tube walls.

The heat of solution that is generated is removed by the cooling water flowing through the shell side of the absorber-cooler. The strong acid is removed from the bottom of the absorber-cooler through a seal pot and gravity flows into a strong acid storage tank. The non-condensables, as well as some non-absorbed HCl, leave the bottom of the absorber and are fed into the bottom of the tails tower. The gas flows up through the 1" pall rings contacting weak acid that is flowing down through the packing. All non-condensables are removed from the top of the tails tower by a steam jet. The steam and the inerts are fed to the Tails Tower Vent Scrubber, where they are water scrubbed and the inerts vented from a stack above the process platform. The weak acid that is used for absorbing is pumped from the weak acid storage by "Durcon" pumps and fed to the top of the tails towers through TCV's. The temperature used for controlling the weak acid feed is the temperature of the tails tower bottom. This temperature should run between 150° F. and 160° F. From the bottom of the tails tower the weak acid is gravity fed to the top of the absorber-cooler. The weak acid is fed to each tube in the absorber-cooler by a weir which causes the acid to spin down the walls of the tube.

From the strong acid tank, the muriatic acid is pumped to the top of the stripper through a FCV. The strong acid flows through weirs down the inside walls of the tubes in the stripper. Steam is fed to the shell side of the stripper. When the strong acid is heated, HCl is liberated and flows back up the middle of the tubes. The weak acid leaves the bottom of the stripper through the bottoms cooler, a level control valve and into the weak acid storage tanks. The HCl gas leaves the top of the stripper and flows to the top of the primary cooler. The temperature of the gas leaving the top of the stripper controls the stream flow to the stripper and should run about 210° F. at 14.2 psig. The gas flows down the tubes of the primary cooler and is cooled to about 110° F. by cooling tower water flowing up on the shell side. The HCl gas leaves the bottom of the primary cooler and enters the top of the secondary cooler. The gas flows down the tube side of the secondary cooler,
through the tertiary cooler
out the bottom, through the entrainment separator and into the dryer. Brine from the refrigeration unit at 0° F. is fed into the bottom of the shell side

of the tertiary cooler, out the top and into the bottom of the shell side of the secondary cooler. From the top of the secondary cooler the brine at 5° F. is fed to the refrigeration machine. All piping for the HCl gas is Haveg until after the entrainment separator; it then becomes steel. The stripper, primary cooler, secondary cooler, tertiary cooler and entrainment separator are of "Karbate" construction on the acid side. The condensate from the cooling system is fed back to the top of the stripper. The condensate is required for good stripper performance. There are two identical stripper systems and the two product streams mix after the entrainment separators.

From the stripper section, the gas is fed to the bottom of a H_2SO_4 dryer. The gases flow up the tower contacting H_2SO_4 acid that is flowing down the packed tower. From the top of the H_2SO_4 dryer, the gas flows to the compressors. The temperature of the gas entering the tower will be about 10° F. and it will warm to about 30° F.

The gas is compressed in the compressors from 14.5 psig to 125 psig or from ~~40~~ 35 psig to 160 psig. When the compressors are operating at the high pressure, a distance ring will be required on the compressor. This distance ring is already on the compressors. After compression, the gas is cooled to 110° F. and sent to the EC plant.

Some gas is removed from the compressor suction and pumped by #4 compressor to the MC plant. This gas is replaced in the suction line by HCl from the TCE reactor.

The control system around the compressors merits some explanation. Follow this discussion on figure 1, page 54. In the HCl plant there is an oversized (60 TPD) absorber-cooler and its tails tower. This absorber is to reclaim all vents from the HCl plant as well as the EC vent stream. For this reason all PCV's in the HCl system vent to Absorber-Cooler #2. To keep

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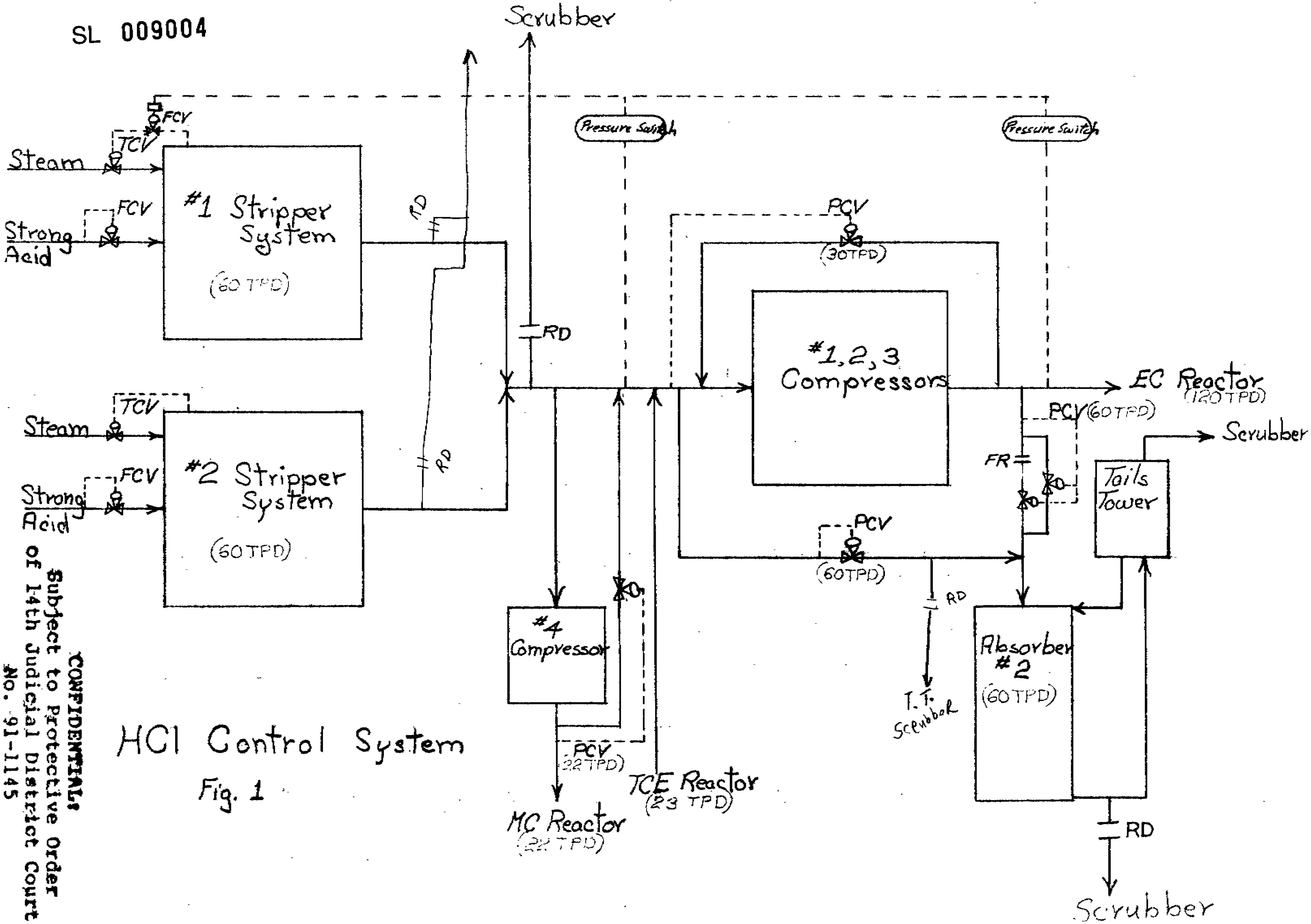

HCl Control System

Fig. 1

the compressor suction pressure constant, there is a PCV that recirculates HCl from the compressor discharge to the compressor suction. This valve will handle 30 TPD. To prevent the compressor suction pressure from going too high, there is a PCV that will send the excess HCl to Absorber #2. This valve has a capacity of 60 TPD. There is a rupture disc and a pressure switch that further protects the stripper system from overpressurizing. To keep line pressure to the EC plant constant, there is a PCV that will send HCl to Absorber #2. This PCV actually is 2 valves, one of which is small. The small valve has an orifice in it so that rates may be adjusted upwards before the consumers increase their consumption. The valves are arranged so that the small valve opens first. These two valves have the capacity of 60 TPD.

Should something upset the system quick enough, it would be possible to overload Absorber-Cooler #2. To prevent this from happening, the absorber has a rupture disc that will burst. All rupture discs vent to the scrubber.

All piping in muriatic acid service is "Karbate" or Haveg. All valves in Haveg service are glass-lined with Teflon diaphragms.

GASEOUS CHLORINE SYSTEM

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The gaseous Cl_2 is a 10" line from the chlorine compressors in liquefaction to the organics area. The 10" line goes to the EDC plant where it reduced to a 8" line. The 8" line reduces at the EDC control building to a 6" where there is a valve in the line. The 6" line continues down the east-west pipe rack. A 4" line takes off the E-W rack and runs to the HCl plant. The Cl_2 line is insulated and steam traced to the EDC takeoff. From this point on the line is only insulated.

The Cl_2 should arrive in the HCl at a pressure of 40 psig. The Cl_2 will be pressure reduced to 25 psig. After the PCV, the Cl_2 flows through a double meter run. When the projected cell gas usage is for 2 burners, use the smaller orifice run. If cell gas is to be used for more than 2 burners, use the large orifice meter.

From the metering station the Cl_2 goes to burners #2, 3, 4 and 5. Burner #2 may be fed with cell gas or with vaporized Cl_2. Never feed cell gas to the burner when it is operating in the dry system.

In the Cl_2 feed system to each burner is a FCV. This flow control valve receives its impulse from a ratio controller. The ratio controller will keep the Cl_2 flow proportional to the H_2 flow. The ratio is set to control 3% to 5% excess H_2 in the product gas. The Cl_2 FCV is designed to fail closed. Located in the air supply line to each Cl_2 FCV is a solenoid that will close when the shutdown system is activated. When the solenoid closes the air supply to the FCV the valve will close. Since the valve is in Cl_2 service, it is probable the valve will gunk up and stick. After any shutdown, emergency or not, the valve should be blocked off to prevent any leakage. The Cl_2 flows through a loop just before entering the burner nozzle. The purpose of the loop is to prevent acid from draining from the bottom of the burner back to the FCV. The drain on the burner side of the loop should be checked after a burner shutdown, and while the burner is down, for acid.

H_2 SYSTEM

(The H_2 system for the wet HCl system is the same as the H_2 system for the dry HCl system.)

A. Equipment

1. Hydrogen Surge Drum 62A-60-420 - The H_2 Surge Drum is 36" OD x 5'0" tan to tan. The design pressure of the vessel is full vacuum to 75 psi. The rupture disc is set for 75 psig.

2. H_2 Cooler 62A-71-517 - The hydrogen cooler is a 6 5/8" OD exchanger with 26 8' tubes 3/4" OD 16 gauge. The material of construction is steel for everything.

B. Operation

The hydr gen line t the HCl plant is a 4" line that comes from the top of the H_2 scrubber in the cell area. The line has several low spots in it that have float traps to remove moisture. These traps should be checked regularly, especially during cold weather. The H_2 system has very little extra capacity since the maximum pressure available is about 22 psig. The booster compressor to other H_2 consumers is set to cut off at about 10 psig. So any failures in the H_2 system will result in a rapid pressure loss to 10 psig, then the only consumer will be HCl. The pressure loss below 10 psig will determine how much to cut back the burner rates.

The H_2 line runs down the main rack and enters the plant south of the acid storage tanks. The H_2 system has a PCV and two meter runs at this point. The PCV should be set to give H_2 pressure to the burners of about 20 psig. This pressure as well as the Cl_2 pressure will affect the ratio between the two gases, so care should be taken in changing the pressures on the systems. The larger meter run should be used whenever more than two burners at full rates are operating or the total hydrogen flow is greater than 500 SCFM. From the meter run the H_2 flows through a surge drum and a cooler to the individual burners. The purpose of the cooler is to keep the H_2 at a fairly stable temperature for metering at each burner.

The hydrogen flow to each burner is controlled by the burner pressure. The burner pressure should be set to keep from -2" to + 2" of H_2O pressure. The set pressure is maintained by increasing or decreasing the H_2 flow. The H_2 fow is measured and sent to a ratio controller. The ratio controller keeps the Cl_2 flow to the burner in a preset ratio to the H_2 flow. The normal ratio

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ratio is about ~~1.05~~ .95 H_2 to Cl_2, but this will vary according to the pressures and temperatures of the gases. The set ratio is the ratio that gives 3% to 5% excess H_2 in the product HCl.

Located in each H_2 system is a positive shutoff Maxon valve. This valve will shut during any system failure.

SHUTDOWN SYSTEM

The shutdown system (DWG. 62A-7703) for the wet HCl system is designed to shut down burners 2, 3, 4 or 5. When the shutdown system is activated, it will shut down the affected burner by closing the Maxon valve on the H_2 line, and by closing the solenoid valve in the air supply line to the Cl_2 FCV. There is some discrepancy in this description concerning #2 burner since it is used in both the wet and dry system. When burner #2 is operating in the wet system, a thorough check of the bypass switches should be made to ascertain that everything is protected and a failure in the dry HCl will not shut down the wet HCl or vice versa.

The Maxon valve is a positive shutoff valve located in the H_2 feed system to each burner. It is possible to bypass this valve and it is bypassed during start-up. AT NO OTHER TIME SHOULD THIS VALVE BE BYPASSED. The most dangerous thing that can happen around an HCl plant is to fill the system with H_2 and human reflexes are not quick enough to close off a valve that is wide open. The Maxon valve is spring loaded to close and is kept open by an engaging solenoid.

The Cl_2 FCV is designed to fail closed with a loss of air supply. The shutdown system has a solenoid in the air supply that closes for system failure. Most valves in Cl_2 service gunk up, so in order to assure that no Cl_2 is going through the burner, the block valves will have to be closed.

The shutdown system is activated by: a flame failure, low burner pressure, high burner pressure or loss of cooling water. A failure of any of the items will cause the affected burner to shut down. The shutdown systems can be bypassed by timers, and individual parts of it may be bypassed with switches. The reason for the bypass switches and timers is that under different circumstances different items are of importance. The timers are for equipment checking and starting up. Periodically the burner shutdown system should be checked to see what shutdown relays are bypassed and these checked to see if it is necessary for these to be bypassed under the conditions of operation at that time.

A flame failure is detected by a "Firetron" photo-conductive cell, which continuously monitors the flame. The fire-eye is located at one of the sight ports on each burner bottom. High and low burner pressures are monitored, recorded and used to control the H_2 flow. The cooling water flow is monitored in two spots. Cooling tower water flowing into each cooler-absorber is monitored through a no-flow switch on the inlet as is the well water flow to the top of each burner. Both of these switches must have at least 50 GPM and failure of either one will activate the shutdown system.

In case of an emergency shutdown in the HCl plant, the alarm on the panelboard will indicate the first one to fail. It will be the only one to flash. When the board is acknowledged, the others will flash; when it is acknowledged again, all alarms will clear. The sequential alarm system applies to flame failure, loss of cooling water, or high or low burner pressure for burners #1, 2, 3, 4, and 5.

The timers that are on each burner system bypass flame failure and high or low burner pressure. These timers may be set for up to 15 minutes and are generally set for 7 minutes. Once they are set they cannot be reset again until time has run out. Switch 1 when closed will prevent high or low burner pressure from shutting down the burner. Swtich 2 when open is an isolation switch so that the burner shutdown system may be worked on and a ground in it will not shut down other burners. (When switch 2 is open, the burner must be shut down)

BURNER SYSTEM

A. Equipment

1. HCl Burner 62A-71-797, 798, and 799- The HCl burners (combustion chambers) are 33" chambers. They are constructed of 3" thick graphite rings with each ring 3'3" OD and 5' 8-5/8" high. There are 4 full-sized rings and a top ring that is 3' 8-5/8" high. The rings are stacked on each other and all rest on a 4" thick "Karbate" base. When the sections are cemented together and set on the base, the over-all height is 27' 3½". The sections are cemented together with National Carbon C6 cement and heat cured. The outside of the chambers have a think washcoat of impervious material to prevent water from being absorbed through the burner walls. The top ring has a 4" thick graphite plate resting on it, and on top of this a water distributor. When the distributor is filled with water, the weight of the water, distributor and top will hold the top on the burner until a pressure of about 20" of H_2O is reached. The top has a guide bar so the top reseats itself properly whenever it is lifted. The burner has a hole in the bottom plate for the burner nozzle assembly, 2 4" nozzles with quartz sight glasses located near the bottom, a 3" and a 6" nozzle near the top. The 3" nozzle is for burner pressure and the 6" nozzle is the gas outlet.

2. Burner nozzle assembly. The burner nozzle assembly is a National Carbon size 8 "Karbate" impervious graphite with silica-coated caps. The diameter of the holes in the caps is to be at least 13/16" and they should be drilled to this diameter if they arrive with smaller holes. The hydrogen feeds in the outermost ring and Cl_2 in the center.

B. Operation

Chlorine and hydrogen are fed separately through the burner nozzle assembly. The two gases are mixed as they are ejected from the nozzle into the burner. Once a flame is started, the two gases will burn when they are mixed. Located on one of the bottom sight glasses is a fire-eye. The purpose of the fire-eye is to continuously monitor the flame and anytime the flame disappears the fire-eye will activate the shutdown system for that burner.

The burner must have some of the heat generated by the reaction dissipated or the graphite walls will overheat resulting in oxidation, cracking and leakage. For this reason there is a no-flow switch in the well water line going to each burner. Loss of well water flow will activate the shutdown system for that burner. The no-flow alarm on the well water is alarmed through the no-flow light and alarm on the CTW flow to each absorber. Should the CTW or the well water fail, it should be fairly obvious which one failed. If the switches fail, each one may be checked. The well water to each burner is distributed at the top of the burner through a water distributor. The water distributor causes the water to flow down the sides of the burner in an even manner. The burner is enclosed in a plexiglass shield to prevent the wind from blowing the water layer away and leaving the graphite with no cooling film. Care should be taken in adjusting the well water flow to the burner to see to it that enough water is used to provide a water layer over the outside of the burner from top to bottom. This will require from 100 GPM to 200 GPM,depending on the burner rate. The water is collected at the bottom of the burner in a rubber-lined pan and sent to the sewer. The bottom plate has grooves on its bottom to allow some water to flow beneath it. If the grooves are allowed to plug up, the rubber lining will have no protection and will be destroyed. Another problem with the cooling system will be algae. If the burner becomes coated with algae, the cooling water will have little effect. As the algae appears and gets thick enough to retard the heat transfer, it must be removed by (a) heavy chlorination of #8 deep well water, (b) bubbling a few TPD of HCl in the distribution crown (there is an HCl ring sparger for this purpose), (c) put Pittabs in the distribution crown, (d) shut burner down and expose it to sunlight,(e) physically scraping the burner. The best method is the HCl wash when excess HCl is available.

After the H_2 and Cl_2 burn, the HCl rises up the burner and leaves at the top through a 6" Karbate line. This line must be water cooled also and there are spray nozzles to keep it wet. The maximum recommended temperature for "Karbate" is 338° F. This temperature refers to the body temperature not the gas inside the pipe; i.e., gas temp of 440° F. and water on the outside of the pipe will give a "Karbate" temperature of about 310° F. The "Karbate" risers have no water on them as it was felt that enough cooling will take place in the ~~vertical~~ Horizontal run and the gases will not cause the "Karbate" risers to overheat. These risers should be checked fairly regularly, especially at high rates.

Near the top of the burner is a pressure transmitter. This pressure is used to control the burner rates. The ideal operating pressure is -2" of H20, but the burner will operate anywhere in the range of -2" to +2" of H_2O. When the burner pressure falls below the preset rate, the H_2 flow will be increased and since the Cl_2 flow is kept proportional to the H_2 flow, the Cl_2 flow is increased. The net result is an increase in HCl production. High and low pressures may be used to shut down the burner also.

The burner nozzle assembly has a hole in the bottom of it. When the burner is operating,this hole should have a plug in it. Whenever the burner is down, this plug should be removed and air allowed to flow through the hole, the burner and the jets for at least 5 minutes. The nozzle assembly also has a U-tube in it. This tube is to drain the condensate formed in the burner to the sewer. There should always be some water in the U-tube to form a seal. Generally, some additional water must be added to keep the tube full. Caution should be used around this condensate as it is 35% muriactic acid.

The wet system has 3 identical burner, numbers 3, 4 and 5. Number 2 burner may be used in either the wet or the dry system.

ABSORBER SYSTEM

A. Equipment

1. Absorber-Cooler 62A-71-800, 801, and 802 - The absorber-coolers are 14" OD steel shelled vertical exchangers. There are 42 7/8" ID tubes constructed of "Karbate" which are 16' long. The shell has 14 segmental baffles. Each tube has a 5-5/16" high Teflon weir at the top. The gas baffle is "Karbate" and the liquid distributor is Teflon. The design pressure of the tube side is 25 psig, of the shell side is 75 psig, both at a temperature of 338° F. The top tube sheet is fixed while the bottom is floating.

2. Tails Towers 62A-67-24,25, and 26 - The tails towers are 12" ID x 10' long Haveg 41 vessels. The tower has 5' of 1" polypropylene Pall Rings on top of 18" of 1½" carbon Raschig Rings. The packing is supported on 12" diameter standard Haveg grid bars. The tower is equipped with a liquid sparger and distributor at the top. Both are constucted of Haveg.

3. Seal Pot - The seal pot is a National Carbon seal pot assembly for series 31A-Absorber. The seal pot is constructed of "Karbate." The top of the liquid leg has a ¼" Saran pipe plug. The sample cock on the bottom is a CP2356-DA

4. Specific Gravity Indicator - The specific gravity indicator is fabricated by National Carbon to fit on the side of the seal pot. It is equipped with a TI and a 10-25 Baume' hydrometer.

5. Steam Jets - The steam jet ejectors are Schultte and Koerting, 1½" size 8, constructed of Haveg.

B. Operation

The absorber-cooler is a vertical shell-and-tube exchanger. The gas to be absorbed enters the absorber through an inlet at the upper end of the heat exchanger,flows through a baffle and into the center of the tubes. The HCl gas flows down the tube and is absorbed by the weak acid flowing down the tube walls. The heat of solution that is generated is removed by 200 GPM of cooling tower water flowing up the shell side of the exchanger. The strong acid is removed from the bottom of the absorber-cooler through a seal pot and flows by gravity into the strong acid storage tank. On the side of the seal pot is a specific gravity indicator. The specific gravity is indicated in ^{o} Baume' $\left({}^{o}Be = 145 - \frac{145}{Sp.Gr.} \right)$ The sp. gr. of the acid should be around 20^{o} Be. (The exact sp. gr. will be determined by analysis since the sp. gr. varies with the temp.)

The non-condensables, as well as about 30% of the total HCl fed to the absorber, will leave the bottom of the absorber and are fed into the bottom of the tails towers. The tails towers are packed with 1" polypropylene Pall Rings and 1½" carbon Raschig Rings. The packing support grids are exactly 1" apart and the 1" Pall Rings will fall through if they line up right, so a bed of 1½" carbon rings is used toisolate the Pall Rings from the grid. The Pall Rings cannot be changed for 1½" as the design load for the towers is based on 1" Pall Rings. Weak acid from storage is pumped to the top of the tails tower through a TCV, a sparger and a distributor to the packing, where it contacts the gas. As HCl is absorbed in the weak acid, the acid will become warmer due to the heat of solution. The temperature of the acid at the bottom of the tower is used to control the TCV that feeds acid to the tower. This temperature should run between 150^{o} F. and 160^{o} F. The exact temperature will be determined by analysis of the product acid. To make adjustments, a 10^{o} F. temp. change will change the product strength 1%. The temp will cycle about 10^{o} F. per hour under stable conditions. Under optimum conditions, about 1/3 of the HCl fed to the absorber will be absorbed in the tails tower.

The non-condensables are removed from the top of the tails towers by steam jet ejectors. From the steam jets the inerts plus the steam are fed to the tails tower vent scrubber. The steam jets are sized to pull 131#/hr. at 26 mm $H_g{}^{o}$ absolute. Since the capacity of the jets is constant, the only way to vary the capacity is to artificially load the system. This is done by bleeding N_2 through a PCV into the suction line of the jets. The impulse point for the

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PCV is in the line that comes off the top of the tails tower.

The weak acid is gravity fed from the bottom of the tails tower to the top of the absorber-cooler. In the top of the absorber the acid flows through a Teflon distributor (No. 1 absorber-cooler does not have a distributor, and therefore its capacity will be less than the others.) Each tube has a 5-5/16" high weir in the top of it. The weirs are constructed of Teflon in all but #1 Absorber-Cooler which has graphite weirs because of the high temperature the weirs will reach when the absorber is being used as a cooler. The Teflon weirs may be either white or black, as there is no difference in the properties of the two except the black will machine easier. Each weir has 4 tangential V- notches cut in it so that the acid is "spun" down the tube walls of the absorber. The strong acid is collected in the bottom of the absorber, flows through a seal pot, and gravity flows to a strong acid storage tank.

The absorber-cooler uses parallel flow of the gas and liquid for two reasons. The first reason is that much higher capacity is realized because higher velocities are possible. The second reason is that the hot gases entering the top of the absorber provide a counter-flow to the cooling water. This allows the strong acid to leave at a cooler temperature. Although the "Karbate" is impervious to most chemicals, it is oxidized by hypochlorus acid. For this reason any free Cl_2 in the system should be held to an absolute minimum. The top tube sheet must have cooling water held against it to prevent it from overheating. For this reason all air trapped or gases generated on the shell side of the absorber must be removed. Coming out of the top shell flange is a ½" line that goes to an air trap. The air trap is a float type trap that will allow gases to pass, but not liquid. As long as this trap is operating, the top tube sheet should not overheat.

The gas baffle located in the top of the absorber is a "Karbate" plate that serves to distribute the gas over the full diameter of the absorber by means of holes drilled in the plate. The liquid distributor is a Teflon sheet that forms a circle around all the weirs. All liquid, in order to reach the weirs, must flow through holes in the Teflon distributor. In this manner the acid is fed from 360^{o}. This arrangement of baffles and distribution will allow each tube to handle a maximum of 1 GPM.

Attached to the weak acid feed line to each tails tower is a well water line and a rotameter. This line is used to add water to the system. Under normal circumstances the HCl system will require no water to be added. Should any muriactic acid be sold, leak from the system, or be transferred from the system for any other reason, water will have to be added to make up for it.

The wet HCl plant will use the big jets at the dry HCl scrubber for starting up. The burner pressure controllers on burners 3, 4, and 5 may be switched so that their impulse is sent to a PCV that will bleed ~~air~~ N_2 into the jet suction. Attached to the gas riser between the absorber and the tails tower is a 3" line that ties into the jets suction. The jets may be used to start up one burner at a time. Both jets will be required as the steam supply has been changed from 125 psig to 75 psig.

At the top of the gas riser, between the burner and the absorber, is a piping takeoff for the H_2 analyzer. There is one analyzer for burners 1, 2, 3, 4 and 5. A sample line runs from each riser to the analyzer and by correct valving, the gas from a burner may be sent through the analyzer. Only one stream can be sampled at a time and the valve switching should be done at the riser or else the line will fill with condensate. The sample is drawn through the analyzer by a water aspirator.

START-UP PROCEDURE

The start-up procedure for the wet HCl burners is very much similar to the start-up procedure required for the dry burner. The burners will be started up by using the dry HCl jets.

The auxiliary equipment should be running and lined out. They include: dry HCl jets, scrubber with water and cell liquor, water on the absorber-cooler and water on the burner. Before any cell liquor is used, be sure and notify the MC operator.

Line up the following (it is assumed that other burners are operating):

- Cl_2 FCV - closed and blocked
- H_2 FCV - closed and blocked
- Weak acid feed to tails tower closed and blocked.
- Strong acid discharge from the absorber is closed.
- Valve to jets is open.

Call the cell bridge and notify them you are going to start taking more H_2.

Check the H_2 FCV with the manual control, be sure it is seated (visual check), block off the impulse to it and open the impulse to the air valve. (This valve will bleed air into the jet suction to give pressure control.) Set the gain on the burner pressure up (.35 → .5), put it on automatic and set it to control -5" of H_2O.

Start up Chlorine Flow

Adjust a chlorine flow of 30 on chart with the Cl_2 FCV bypass.

Check the stack to see if Cl_2 is being vented. If so, use more cell liquor.

Purge the H_2 flame arrestor with N_2

It should be enough flow to put the burner on a slight pressure when flowing. Do this 2 or 3 times for about 15 to 20 seconds each.

When Cl_2 has been purging for 5 minutes, light the lance. Open the appropriate valves only (1 block and the ½"). Use only H_2, get a small H_2 flow, point the lance at the shell, throw a match at the end. Adjust the flame until a good flame is present. Do Not Point on Epoxied base of burner.

With a man at the observation nozzle and water flowing into the U-tube, insert the lance. Be sure that the flame is visible (lance may have to be moved up or down). Allow the burner pressure to settle out. <u>If you can't see it at all it is out; get H_2 flow off immediately</u>. Wait 5 minutes.

With a man at the observation nozzle, have an operator <u>slowly</u> crack the 1" H_2 FCV bypass. Burner will light with a thump and a pressure fluctuation, <u>continue</u> to slowly open the H_2 bypass until the H_2 flow is 25 on the chart. The only reason to not bring the H_2 flow up is malfunctions; i.e., flame failure or some indication on board, flame failure is by observation, not alarm. <u>In the event of anything unusual, get H_2 flow off immediately</u>.

Have the operator increase the Cl_2 bypass flow to 35 then H_2 to 30, Cl_2 to 40, H_2, etc. until chlorine flow is 55 or 60 and H_2 is 5 less. Adjust at rate slow enough that the burner pressure is controlled. Never allow H_2 to be greater than Cl_2.

Remove Lance.

Slowly cut back on the H_2 flow to the lance until H_2 flow decreases about 10 then increase H_2 through FCV bypass about 10. Continue to do this until the H_2 to the lance is off. Pull the lance, insert the plug and allow the pressures to line out.

Close switch 1 on the respective burner.

Depress the safety override timer - this activates the Cl_2 solenoid and the Cl_2 FCV may be operated.

Check the Cl_2 FCV out with the operator observing the valve movement.

Close the Cl_2 FCV with manual control.

Open upstream and downstream block valves one at a time, watching for leak through.

Put the Cl_2 flow controller on automatic and adjust the set point to where the valve barely opens. Probably the gain will have to be set to .25 $\longrightarrow$ .30. Slowly close FCV bypass.

When valve is closed, put controller on cascade with ratio = 1.05. Check to be sure the ratio controller is working and controller is in cascade.

Open the block valve downstream of the H_2 FCV.

Open the impulse to the H_2 FCV from the burner pressure.

Have the operator to slowly close the block valve in air system. When it is closed, seal off the air controller.

Slowly close the 1" H_2 FCV bypass.

You probably will have to adjust the gain to approximately .2 to stop surging.

Open the Maxon valve.

Open the block valve to the Maxon valve; with somebody watching the H_2 flow, slowly close the Maxon valve bypass.

Switch the H_2 analyzer to the burner that is being started up.

Slowly bring the burner to a H_2 excess. Be sure to do this slowly and never allow the burner to swing from H_2 to Cl_2 excess. When finished, the analyzer should show about 3% H_2.

Start up the tails tower.

Start up the tails tower jet, line up and put on automatic control and slowly lower to -2" H_2O.

Open the valve at the bottom of the absorber to the strong acid line.

With the weak acid feed valve on manual control and closed, open the block valves around it.

Slowly open the weak acid feed valve to the tails towers. Increase the flow very slowly to about 12 GPM. At this point the burner should be operating at about 60% capacity. Slowly close off the line to the jets, never allowing the burner rates to go below 1/3 of capacity. Rates are increased by increasing the weak acid flow.

Shut down the dry HCl jets and scrubber.

Allow the tails tower to come to operating temperature, put it on automatic control.

STRIPPER SYSTEM

A. Equipment

1. Strippers 62A-710803 and 804 - The strippers are 38" OD steel shelled vertical exchangers. There are 439 7/8" ID tubes constructed of "Karbate" which are 16' long. Each tube has a 5-5/16" high Teflon weir at the top. The liquid distributor is Teflon. The design pressure of the tube side is 40 psig, of the shell side is 75 psig, both at a temperature of 338° F. The top tube sheet is fixed while the bottom tube sheet is floating.

2. Stripper Bottoms Cooler 62A-71-811 and 812 - The bottoms coolers are 16" OD steel shelled horizontal exchangers. There are 64 7/8" ID tubes constructed of "Karbate" which are 14' long. The tube side is 7 pass, designed for 75 psig at 338° F.The shell side has 18 segmental, top to bottom, baffles and it is designed for 75 psig at 338° F. The tube sheet at the acid inlet is fixed, the other tube sheet is floating.

3. Stripper Feed Pumps 62A-55-862, 863, 864 - The stripper feed and absorber feed pumps are "Durcon" 2 x 2P-10. The pumps are to pump 120 GPM at 118' head. The wet end of the pumps are Durcon which is an epoxy resin; the shafts are Superchlor. The motors are 15 HP, 1800 RPM. The seals are John Crane, type 20.

B. Operation

The stripper feed pump pulls strong acid from the storage tank and pumps it through a magnetic flow meter into the top of the stripper. The maximum feed to each stripper is 60 GPM. The strong acid flows through the weirs down the inside walls of the tubes in the stripper. Steam which is on the shell side heats the acid as it falls down the tubes and drives off the HCl. Weak acid (20% HCl) leaves the bottom of the stripper through the bottoms cooler, through a level control valve and to the weak acid storage. The bottoms cooler will require about 300 GPM of cooling tower water to cool the acid to 110° F. Extreme caution must be used to be sure that hot acid never enters the storage tank, as it will cause failure in the glass lining of the tank.

HCl gas that leaves the acid as it is heated flows back up the tubes of the stripper and out the top. From the top of the stripper the gas flows through three stages of cooling. The condensate acid from each cooler is collected and sent back to the top of the stripper. The condensate has an effect on the over-all efficiency of the stripper.

The stripper rate is controlled by the feed rate of strong acid; this is flow controlled. The steam flow to the strippers is temperature controlled by the temperature of the gas out the top of the stripper. The control temperature will be determined by the operating pressure and the operating pressure depends on the EC reactor pressure. The stripper system will operate at 14.5 psig to begin with. At this pressure the overhead temperature will be controlled at 210° F. The bottom temperature of the stripper will be 255° F. The steam used in the strippers is 75 psig, desuperheated steam. Do not, under any circumstances, use steam that has not been desuperheated. The maximum temperature allowable on the "Karbate" is 338° F. Saturated 75 psig steam temperature is 320° F.

On the steam to No. 1 stripper is an automatic shutdown control. The shutdown control will stop the steam flowing to No.1 stripper. The control is a solenoid in the air supply line to the steam TCV, so when the solenoid closes the air supply to the valve is cutoff and the valve closes. This shutdown system is used to cut rates in the HCl plant, should a consumer or a compressor kick off. The PCV's in the HCl system will handle an emergency shutdown if just one stripper is in service, but if two are in service, then some rupture discs would have to blow, venting HCl to the scrubbers. The pressure switches are located in the discharge of the entrainment separators and in the compressor discharge line. The pressure switch in the entrainment separator discharge line is set for 20 psig, while the one in the compressor discharge line is set for 130 psig. It is well to remember that Absorber-Cooler #2 will handle the capacity of one stripper and that all PCV's in the HCl system feed the excess HCl to this absorber. The strippers and coolers are protected by a rupture disc in a line going to the dry HCl scrubber. The rupture discs are located just after the tertiary coolers and are set for 40 psig.

There are two strippers, both just alike.

START-UP

Put cooling water on the primary and the bottoms coolers, put brine on the secondary and the tertiary coolers, put the steam TCV on manual control and closed, put the stripper bottoms LCV on automatic, be sure the lines are open to the dryer, have the dryer in service, and a compressor on. The strippers can be started up with the compressors down by sending HCl through the suction line PCV to Absorber #2. In any case Absorber-Cooler #2 must be in service prior to starting the strippers up.

After all of the auxiliary equipment is up and lined out, start strong acid feed to the stripper. Be sure the stripper LCV is working, then increase the acid feed to about 20 GPM. Open the steam to the stripper very slowly and continue to increase the steam until the top temperature reaches operating temperature. If the top temperature starts to fall as the steam is increased and the feed has not increased, then cut back on the steam as too much water is going overhead. When operating temperature is reached, check the stripper bottoms strength and adjust the top temperature to get 21% HCl in the bottom stream. When the stripper is lined out on automatic control, then increase the feed rates to the desired HCl production.

PRIMARY COOLER

A. Equipment

1. Primary Coolers 62A-71-805 and 806 are 18" OD steel shelled vertical coolers. There are 85 7/8" ID tubes constructed of "Karbate" which are 16'0" long. The shell has 20 segmental baffles. The top tube sheet is fixed and bottom tube sheet is floating. The design pressure of the shell side is 75 psig and of the tube side is 40 psig, both at 338^{o} F.

B. Operation

The primary cooler cools the HCl from the stripper from 210^{o} F. to 110^{o} F. with cooling tower water. The HCl enters the top of the tube side and leaves the bottom. The water enters the bottom of the shell side at the rate of 200 GPM and leaves at the top. Some moisture will be condensed from the HCl. This strong acid leaves the bottom of the cooler and flows back to the stripper. There is a bulls-eye in the condensate line so the amount of condensate may be observed. When the condensate flow is high, it means too much water is coming over with the HCl (the stripper control temperature is too high) or one of the tubes has developed a leak. The bulls-eye should be checked on every outside round.

Each stripper has one primary cooler.

SECONDARY COOLERS

A. Equipment

1. The secondary coolers 62A-71-807 and 809 are 18" OD steel shelled vertical coolers. There are 85 7/8" ID tubes constructed of "Karbate" which are 16' long. The shell has 20 segmental baffles. The top tube sheet is fixed and the bottom tube sheet is floating. The design pressure of the shell side is 75 psig and of the tube side is 40 psig, both at 338° F.

B. Operation

The secondary cooler cools the HCl from 110° F. to 40° F. The HCl leaves the bottom of the primary and is fed into the top of the secondary, where it flows down the tubes and out the bottom. Brine is fed into the bottom and out the top of the shell side. The brine rate will be about 100 GPM. The secondary cooler has a bulls-eye in the condensate line so the condensate rate as well as any tube leakage may be observed. Any high condensate rate should be accompanied by a high feed temperature. The rate of cooling the HCl gas is extremely important, as a high cooling rate will cause fog to form and consequently high moisture. For this reason the gas from the secondary should never be cooler than 35° F. and should operate around 40° F.

The brine system is set up so that the secondary and the tertiary coolers are in series. The brine enters the tertiary, leaves it and enters the secondary before returning to the refrigeration machine. If running the brine in this manner creates an unbalance in the two exchangers (i.e., in order to hold the 40° F. discharge of the secondary, the final gas must be 20° F.), then the brine may be valved so that (a) more brine is fed to the tertiary than the secondary, (b) vice versa, and (c) the two exchangers are run in parallel.

The brine out of the secondary cooler flows through a pH meter. The pH meter will sound an alarm if the pH should fall indicating a tube failure in the coolers. Should one of the pH meters indicate a low pH, shut down and isolate the system immediately, check the brine pH in the laboratory and drain the brine out of the system if the pH is actually low. The high acid in the brine will destroy the refrigeration system. Each pH meter has a recorder but the alarm is common. Only a small amount of the total brine is routed through the meter, so open the lines through the meter and throttle the valve in the main brine line until the brine flowing through the meter is about 3/4 the line capacity as observed through a bulls-eye.

Each stripper has one secondary cooler.

TERTIARY COOLERS

A. Equipment

1. Tertiary Cooles 62A-71-808 and 810 are 18" OD steel shelled vertical coolers. There are 85 7/8" ID finned tubes constructed of "Karbate" which are 16' long. The shell has 20 segmental baffles. The top tube sheet is fixed and the bottom tube sheet is floating. The design pressure of the shell side is 75 psig and of the tube side is 40 psig, both at 338° F.

2. Entrainment Separator - The entrainment separators are National Carbon's size #8. They are constructed of"Karbate" internally.

B. Operation

The tertiary coolers cool the HCl from 40° F. to 10° F. The HCl leaves the bottom of the secondary and is fed into the top of the tertiary, where it flows down the tubes and out the bottom. From the tertiary the HCl flows through an entrainment separator, a block valve, and into a steel line where it joins the HCl from the other stripper system. The tertiary cooler has a bulls-eye in the condensate line, so the condensate rate as well as any tube leakage may be observed. All condensate from the entrainment separator is drained back to the stripper.

Enough brine should be used to get 10° F. HCl. (See brine write-up under the secondary cooler.)

ABSORBER-COOLER #2 AND THE HCl CONTROL SYSTEM

A. Equipment

1. Absorber-Cooler #2 (62A-71-817) is an 18" OD steel shelled vertical exchanger. There are 85 7/8" ID tubes constructed of "Karbate" which are 16' long. This absorber-cooler is exactly like all of the others except larger.

2. Tails Tower #2 (62A-67-23) - This tails tower is 15" ID x 10' long and isexactly like the other tails towers except it is larger.

B. Operation

This absorber is used to absorb all HCl that would normally have to be vented. The absorber-cooler has twice the capacity of any of the other absorbers. Weak acid is fed to the top of the tails tower at the rate of 60 GPM and after flowing through the absorber the liquid is sent back to the weak acid storage. If strong enough acid is being made in Absorber-Cooler #2, then the bottom product may be sent to strong acid storage. Under normal circumstances only a small amount of HCl will be fed to the absorber, but should an emergency occur, up to 60 TPD could be fed. The absorber is protected from over-pressurization by a rupture disc located in the feed line to the absorber. The rupture disc is set for ~~40~~ 15 psig and it will vent to the tails tower vent scrubber.

Whenever the HCl strippers, dry HCl system, or the EC plant are in operation, Absorber-Cooler #2 should be. The vent HCl from the EC plant is normally fed to the absorber as is the excess HCl produced in the dry system. The wet system is designed so a little HCl is always being vented to the absorber; but should an HCl consumer shut down or the compressors shut down, up to 60 TPD could be sent to the absorber.

The PCV 's that feed Absorber-Cooler #2 are:

1. The customer line pressure control valve in the dry plant. Under normal circumstances, this valve will have very little flowing through it. If the customer suddenly shuts down, up to 60 TPD could flow through it. This line can be blocked off and the excess HCl sent to the scrubber. The upstream pressure on this valve is 45 psig.

2. The vent stream from the EC plant. This stream will generally run

about 7 TPD. The stream will have some EC in it and it may be diverted to a scrubber in the EC plant. The upstream pressure on this valve is 50 psig.

3. Compressor suction line. The compressor suction line pressure is maintained by a recirculation valve that recirculates enough HCl from the compressor discharge to keep the suction pressure constant. Should the suction line over pressure, then a PCV will open to #2 Absorber-Cooler. This valve will be set for 20 psig at first. If the stripper pressure is raised, then this set point will be raised to 38 psig. This valve will pass up to 60 TPD. If both strippers are operating, No.1 stripper will shut down at the same time this valve opens.

4. Compressor discharge line. This PCV is really 2 PCV's, one with a small capacity and an orifice and a flow recorder in it. The small valve will open first and then the large valve will open when the small valve is about 50% open. This PCV system will maintain a constant line pressure to the HCl consumers. Under normal circumstances, only a small flow will be flowing through this valve. The maximum flow through this system will be 60 TPD, as the second stripper will shut down before the valve is wide open. The upstream pressure on this valve will be 125 psig at first.

5. Vents from the acid storage tanks. Displaced air from the acid tanks is fed into the tails tower #2. High inerts in #2 absorber can be caused by the pressure pad system leaking through this system.

STORAGE TANKS

A. Equipment

1. The Strong and Weak Acid Storage Tanks 62A-60-611, 612, 613 and 614 are 12'diameter by 23'1" long tan to tan. The capacity of the tank is 20,000 gallons with no outage. The inside of the tanks are lined with 7,000 volt "Glasteel." The gaskets used on the tanks are Pfaudler type CRT, which are a type of Teflon envelope. The tanks have tantalum plugs and thermowells, so care should be used in using any other metals around the tanks. The tanks have two "Glasteel" dip tubes (12" long). The tanks are designed for 15 psig and 12" Hg^{o} absolute at 300° F. Recommended maximum average temperature is 180° F. Carbon rupture discs are set to relieve at 15 psig.

B. Operation

These tanks should be treated with kid gloves, no thermal shocks, hot material, pounding on, or dropping on. The top inlets have a short standleg so material falls into the tank and mixes with the material in the tank. This will help prevent damage should hot material inadvertently be dumped in the tank. The dip tubes will also prevent wear of the glass on the sides where it runs down. The dip tubes should be pulled regularly and inspected. Do not allow acid to spill on the outside of the tanks, as the acid eats the steel and liberates H_2 which breaks the glass to steel bond, causing failure.

The tank failures can be repaired with plugs.

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SCRUBBER SYSTEM

A. Equipment

1. The Tails Tower Vent Scrubber (62A-67-27) is a 20" diameter by 10'0" high Haveg 41 vessel. The vessel has 2 spargers, a packing support tray and 6' of 1½" Intalox saddles. The packing support and the packing are constructed of ceramic. The design pressure is 10 psig at 200° F.

B. Operation

The scrubber is designed to condense all steam from the jets. The scrubbing water will be the cooling tower blowdown. The scrubber will take up to 40 GPM through it. If the cooling tower blowdown is not enough to scrub all steam, then some more water may be added by opening up some well water through the other sparger. Under no conditions allow the water in the scrubber to be warmer than 200° F.

Non-condensables are vented from the top of the scrubber through a stack above the platform. It is possible to have flammables in this stack at times.

CONDENSATE SYSTEM

A. Equipment

1. Condensate Collection Tank 62A-60-715 - This is a 5' OD by 10' high steel vessel. The tank will hold 1470 gallons with no outage. The design pressure is 3 oz. external and 12 oz. internal.

2. Desuperheater Feed Pump 62A-55-973 - The desuperheater feed pump is a Moyno 6M4 designed to give 7.5 GPM at 200 psig. The speed decreaser gives an output speed of 420 RPM. The motor is 3 HP, 1800 RPM.

3. Desuperheater - The desuperheater, for all steam fed to the EC and HCl plants is a Rockwell-Republic SA-30 which will cool 75 psig steam from 550° F. to 315° F.

B. Operation

The desuperheater cools the 75 psig steam to all areas. The steam must be desuperheated to keep from damaging the "Karbate" in the HCl strippers. The desuperheater works by cooling the steam with atomized condensate. The condensate is pumped from the condensate storage to the desuperheater where it is atomized with 150 psig steam.

The condensate storage tank is equipped with an overflow 9½' above the bottom (1400 gallons). The vapors are vented above the process platform. The overflow goes to the sewer.

DRYER SYSTEM

A. Equipment

1. Dryer 62A-73-61 - H_2SO_4 Dryer #1 is a 36" OD by 16½' tan to tan steel vessel with a 3'8" skirt. The dryer is packed with 6' of 1½" Intalox saddles. The saddles are supported on a porcelain gas injection plate. The liquid is distributed with a procelain distributor and all entrained liquid is knocked out with a 6" Teflon demister. The design pressure is 38 psi and full vacuum at 300° F. The relief valve and rupture disc are set for 38 psig.

2. H_2SO_4 Pumps #1 and 2, 62A-55-865, 62A-55-866 - The H_2SO_4 circulation pumps are Goulds type 3196 1 x 2-6 constructed of GA-20. The shaft has a GA-20 sleeve. The seal is a John Crane type 20. The pump is to pump 25 GPM at 25' of head. The motor is 1½ HP, 1800 RPM.

B. Operation

This dryer is surrounded by a shield because it operates under pressure. No one is to enter the area without thoroughly checking for leaks, and then he is to walk slowly. If a leak is detected, the area is to be blocked off and full safety equipment put on before entering. The sight glass is tubular and is protected with a shield. Before the S.G. shield is removed, full safety equipment will be put on.

The HCl from the entrainment separators flows through a steel line into the bottom of the dyrer. The gas then flows up through the packing, through the demister, and out the top into a steel line that goes to the compressor suction. The bottom 4' of the dryer is used as an acid reservoir. The acid is pumped from the bottom of the dryer, through an acid heater and into the dryer below the demister. The bottom of the acid dryer is steam traced and there is a heater on the recirculation line (double pipe heat exchanger) which has hot water running to it to keep the acid from freezing. The acid temperature should be kept between 70° F. and 95°F. Below 70° F. the acid will freeze and above 95° F. the acid is extremely corrosive to steel. The acid is changed whenever its strength gets below 90%.

Hot water for the heater is made by bleeding steam into well water. Adding steam directly to the heat exchanger causes a "hot spot" and therefore rapid deterioration of the steel exchanger.

COMPRESSOR SYSTEM

A. Equipment

1. HCl Compressors 1, 2, 3 - 62A-56-148, 149, 150. The HCl compressors are Ingersoll-Rand, 12 x 13 ES-1-NL-2 HCl compressors. The compressor at 300 RPM will compress 51 TPD HCl from 14 psig to 125 psig. The motor is 150 HP, 900 RPM. The HP required is 127. The SRV's are 1½ F2 with an RD under it; both are set for 180 psig.

2. HCl Compressor #4 - 62A-56-176. HCl compressor #4 is a Worthington 8 x 7 HBB HCl compressor. The compressor at 450 RPM will compress 22 TPD of HCl from 14 psig to 45 psig. The motor required for this is 25 HP, 1800 RPM. The required HP is 22.4. The SRV is a 1½ F 2 set at 90 psig.

3. Aftercoolers - 62A-71-814, 815, 816, 883. Aftercoolers 1, 2 and 3 are Brown Fintube Model 53-1#000420 with 543 $ft.^2$. Aftercooler #4 is a Brown Fintube 53-1#000-807.5 containing 98 $ft.^2$

4. Low Pressure Surge Tank - 62A-60-616. The Low Pressure Surge Drum is a 24" ID x 24' long steel tank. The design pressure is 150 psig and full vacuum at 300° F.

5. High Pressure Surge Tank - 62A-60-617. The High Pressure Surge Tank is a 24" ID x 24' long steel tank. The design pressure is 300 psig and full vacuum at 400° F.

6. Surge Tank for #4 Compressor - 62A-60-686. The high pressure surge drum for #4 compressor is 42" OD x 5'8" tan to tan. The tank is designed for full vacuum to 100 psi at 250° F. This drum is sized to fit into the discharge pit and give some surge time to #4 compressor discharge PCV.

7. N_2 Compressor - 62A-56-139. The N_2 compressor is a Worthington HBB size 3 3/4 x 5, single stage, to compress 20 CFM from 114.7 psia to 239.7 psia. The RPM is 445, and the horsepower required is 11 .3 The compressor is equipped with automatic unloading valves set at 225 psig.

8. N_2 Receiver 62A-60-608 - The N_2 receiver is a 30" ID x 5'0" tan to tan steel tank. The tank is designed for 300 psi at 150° F. The impulse for the unloaders is on the surge drum. The SRV is 1D 2 set at 300 psig.

B. Operations

The HCl from the H_2SO_4 dryer flows through a steel line to the low pressure surge tank, which serves as a suction header for compressors 1, 2 and 3. ·pressure in the suction system is held at 14.5 psig by recirculating gas from the compressor discharge to the suction header. From the suction header the HCl flows to the operating compressors and is discharged at 125 psig and 288^{o} F. The gas then flows into the high pressure surge tank. From the H.P. surge tank, the gas is fed to 3 aftercoolers (Nos. 1, 2 and 3) operating in parallel, where the gas is cooled to 110^{o} F. After the aftercoolers, the HCl is either recirculated back to the suction, or sent to Absorber-Cooler #2 through a PCV that holds the discharge pressure constant, or it is sent to an HCl consumer.

As has been previously explained, it is possible that the HCl strippers may be run at 25 psig instead of 14.5 psig. To prevent the compressors from overloading, clearance rings will be necessary. These rings have been installed on the compressors and will be left on until the capacity is needed. At the higher suction pressure, the frames on the compressors are at the maximum design. The compressor cylinder is designed to go up to 160 psig, and this will be the discharge pressure of the compressors. The maximum working pressure on the distance piece is to be 170 psig. To prevent any overload on the compressors and still allow the compressors to operate,the relief valves are set for 180 psig. Since this is so close to the operating pressure, the relief valves would leak through, so they are isolated with rupture discs. Care should be exercised in starting up the compressors as the relief valve and rupture discs are set for a differential pressure 180-25= 155 PSIG, so it is possible to exceed the rupture point when starting up the compressors.

To further complicate the compressor situation, #3 compressor is piped to run in the dry HCl system as well as in the wet HCl system. When running in the dry system, the capacity of the compressor is 24.5 TPD without clearance rings and 20.2 with the rings. To switch from one system to another will require some valve manipulation.

The compressors are designed with two distance pieces to prevent HCl from getting into the drive end. The first distance piece (one nearest the cylinder) will be pressurized to 10 psi above the discharge pressure with N_2. Since the plant N_2 pressure is not high enough, a N_2 booster compressor is used. This compressor will boost the N_2 pressure to 225 psig. The compressor automatically loads and unloads to maintain this pressure. The N_2 compressor discharges the N_2 to the N_2 surge tank and from the surge tank the N2 is reduced to 170 psig and fed to each compressor through a rotometer. The rotometer will give some idea of the condition of the packing on the shaft. The higher pressure N_2 will leak into the cylinder instead of HCl leaking out. Attached to the first distance piece is a line that goes to Absorber-Cooler #2. An attempt will be made to run the compressors with no N_2 on the distance piece and any leakage back through the packing will be sent to the absorber. This system will work until enough leakage causes the distance piece to have a pressure. then the N_2 system must be used. The second distance piece has air on it. This air is continuously swept through the piece so any leakage from the first distance piece is purged out. The air should sweep out the top and bottom of the distance piece and enough air added to maintain 3 psig while sweeping out both nozzles.

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Located in the suction line to each compressor is a strainer. This is a steel sieve that will prevent any large objects from entering the compressor. When this strainer becomes gunked with corrosion products, the capacity of that compressor is seriously affected. On the discharge of each compressor is a SS expansion joint. This joint should be inspected for cracks periodically. The relief valve relieves from the discharge to the suction so the compressor will overheat if much HCl leaks through the SRV. The maximum discharge temperature is 340 ^{o}F., so when this temperature is approached, the compressor should be taken out of service. These compressors are equipped with Ni-resist liners, carbon rings, carbon packing and a carbon wear plate.

Number 4 compressor is a compressor to pump HCl to the MC reactor. The HCl that is removed from the system by this compressor is replaced by HCl from the TCE reactor. The suction line for #4 compressor is in the line upstream of the low pressure surge tank and the TCE reactor return is into the surge tank. No. 4 compressor is built exactly like the large compressors except it has Teflon packing, and graphite impregnated Teflon rings and wear plate. The discharge of the compressor goes through a high pressure surge drum, #4 aftercooler, and to the MC reactor. The line pressure is maintained by bleeding the excess HCl through a PCV back into the suction line to compressors 1, 2 and 3.

To maintain a constant pressure on the consumer HCl line, there is a PCV system which will bleed any excess HCl back to #2 Absorber-Cooler. In this system there are two valves, one much larger than the other. The small valve will open first. In the line to the small valve is an orifice and this flow is recorded on the control board. The stripper system should always be running at a slightly higher rate than the consumers are taking. The excess HCl will flow back into the system through this orifice and valve. When all plants are lined out, this flow should be minimal. When consumer rates are going to increase, the stripper system should be increased until the flow through the orifice is greater than the anticipated increase. This system should be lined out before the consumers are allowed to increase rates. When the consumer cuts back on rates, the HCl operator will know how much to cut the strippers back.

The compressor cylinders and heads have cooling water flowing through them. The water is well water and the maximum outlet temperature of this water is 120^{o} F. The discharge flows into a funnel so a quick check may be made to ascertain that the water is flowing.

When shutting down a compressor, block off the suction, open the discharge to suction bypass, close the discharge, and then cut off the power. After the compressor is stopped, open the N_2 into the suction line, open the purge line in the discharge line and purge a small stream of N_2 through the compressor.

NEVER START A COMPRESSOR WITH A CLOSED DISCHARGE LINE. To start a compressor, line up the distance piece purges, open the discharge to suction bypass, cut off any N_2 and block the purge line, open the discharge and start the compressor. After the compressor is running, throttle back the bypass until the suction pressure is 25 psig (suction header pressure), open the suction line and at the same time close off the bypass. The suction pressure should remain constant.

NEVER AT ANY TIME DURING START-UP OR SHUTDOWN OF A COMPRESSOR ALLOW THE DIFFERENTIAL PRESSURE BETWEEN THE SUCTION AND THE DISCHARGE TO EXCEED 150 PSI.

Carrier

OPERATING INSTRUCTIONS

62H-71-715

DESIGN DATA

Tons Rating	50
Compressor Full Load B.H.P.	112
Compressor Full Load Speed (RPM)	8130
Cooler Refrigerant Temp. (°F)	-9.4
Refrigerant Condensing Temp. (°F)	101
Brine: Type	Ca Cl_2 (25% by wt.)
Brine: Specific Heat (Mixture)	0.674
Brine: Specific Gravity (Mixture)	1.254
Brine: Freezing Point °F (Mixture)	-20
Brine Flow (GPM)	225
Brine Inlet Temp. (°F)	6.4
Brine Outlet Temp. (°F)	0
Brine Fouling Factor	.0005
Brine Pressure Drop (Ft.)	26.2
Refrig. Cond. Water Flow (GPM)	225
Refrig. Cond. Water Inlet Temp. (°F)	90
Refrig. Cond. Water Outlet Temp. (°F)	98
Refrig. Cond. Water Fouling Factor	.001
Refrig. Cond. Water Press. Drop (ft.)	27.5
Turbine Maximum H.P.	-
Turbine Full Load Speed	-
Turbine Ent. Steam Condition (psig)	-
Turbine Lvg. Steam Condition (in Hg. Vac.)	-
Turbine Full Load Steam Rate (#/Hp/Hr)	-
Steam Cond. Water Flow (GPM)	-
Steam Cond. Water Inlet Temp. (°F)	-
Steam Cond. Water Outlet Temp. (°F)	-
Steam Cond. Water Fouling Factor	-
Steam Cond. Water Press. Drop (ft.)	-
Steam Cond. Ent. Steam Condition (in Hg. Vac.)	-
Motor - Type	Squirrel cage induction
Motor - Nameplate H.P.	125
Motor - Power Characteristics	440-3-60
Motor - Speed (RPM)	1775

Compressor is a 17P30

Anodes in condenser - 17R5-486-6
17R5-486-2

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REFRIGERATION UNIT

The refrigeration machine is fully described in the Carrier manual. This manual will be located in the foreman's office in the files. It will be under 62A-71-795.

The only descriptions left out of the manual concern the modes of control, auxiliary oil pump and the block valve in the economizer line.

The compressor suction damper is automatically controlled by the outlet temperature of the brine. The hot gas bypass is manually controlled. The bypass is opened enough to prevent the compressor from hunting.

In the line between the economizer and the second stage is a block valve. This valve is to be used whenever the Freon is hot and the compressor is being started up. By closing this valve, Freon from the chiller is prevented from backing through the economizer section and into the turbine. After the compressor is up to speed, and the suction damper partially open, the block valve may be slowly opened. The valve is opened slow enough to prevent overloading the compressor (watch ammeter) or prevent any liquid from entering the turbine.

The auxiliary oil pump is to aid in keeping the bearings lubricated during start-ups and shutdowns, to aid in case of an oil pump failure, and to provide a means to remove Freon from the oil when the unit is down. The oil system for the compressor is external. The oil pump discharges out of the compressor through a check valve, a water cooled cooler, through a filter and back into the compressor and the compressor oil system. The auxiliary pump pulls oil from the oil basin in the compressor, through the pump, through a check valve, and into the discharge line of the internal pump. The auxiliary pump, when set on automatic, will come on when the system oil pressure is less than 10 psig, and will kick off when the pressure is 21 psig. The auxiliary pump should be started before the compressor is started, and stopped after the compressor has stopped turning. If the oil becomes saturated with Freon, put hot water into the oil cooler and circulate oil through it with the auxiliary pump. The oil should be heated to about 110^{o} F. Hot water is made by injecting steam into the well water before the water enters the cooler.

The oil system inside the compressor has a relief valve set at 20 psig. The external oil pump has a relief valve that is set at 20 psig.

The Carrier Centrifugal Refrigeration Machine is a compact assembly of seven major elements. A list of these elements and their function follows:

1. COOLER OR EVAPORATOR 62A-71-793 - which cools the "brine"* passing through the tubes, by the evaporation of the refrigerant in which the tubes are immersed.
2. COMPRESSOR 62A-56-152 .- which compresses the evaporated refrigerant and discharges it to the condenser.
3. CONDENSER 62A-71-819 - which liquefies the refrigerant coming to it from the compressor.
4. ECONOMIZER - which partially cools the condensed refrigerant before passing it on to the evaporator. The cooling of the refrigerant liquid is effected by its partial evaporation. The vapor thus formed is passed to the second stage of the compressor.
5. PURGE RECOVERY UNIT 62A-71-796, Motor 62A-50-1665 - which extracts a mixture of air (or other non-condensable gas) and refrigerant from the condenser, condenses and returns recovered refrigerant to the cooler while the air is discharged to the atmosphere.
6. DRIVE 62A-50-1656 - which supplies the power to drive the compressor. It may be an electric motor driving through speed increasing gears, or a turbine directly connected.
7. CONTROLS - for *protection* of the various elements of the machine. When specified, additional automatic controls for *regulation*, are furnished.

*NOTE: The term "brine" is used throughout these instructions as applying to the substance cooled, whether it be water, a salt brine, or other fluid.

MACHINE DESIGNATION

Machine assemblies are designated according to the size of compressor, evaporator, and condenser. For example:

17M43 - 7 - 6

denotes - - - - - - 17 - Centrifugal Refrigeration unit
M - Two stage (P is 3-stage)
43 - Compressor size
7 - Evaporator size
6 - Condenser size

Besides the size designations, each machine is given a serial number which appears on the machine control panel. In referring to machines in correspondence with Carrier Corporation, always give the size, serial number and the name of the owner.

REPAIR PARTS

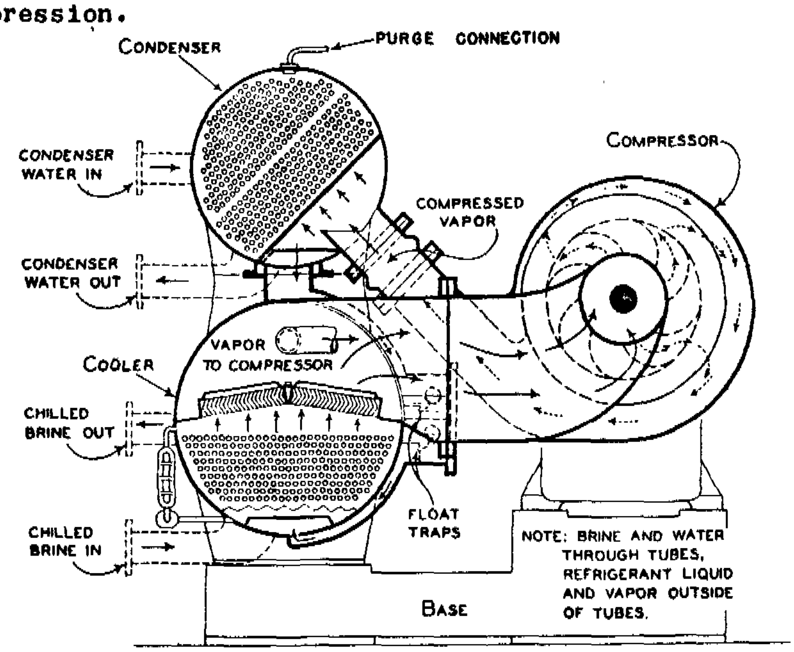
In ordering parts or in correspondence regarding any part of the machine use the designations, figure numbers, etc., assigned in these instructions - give number and date of page referred to - give serial number of machine, which can be found on name-plate on instrument panel.

Oil Pump - 62A-55-857
Oil Cooler - 62A-71-776
Oil Pump Motor - 62A-50-1881
SRU - 3K4 Farris Type 26KC10-120

REFRIGERATION CYCLE

The Centrifugal Refrigeration System employs the same general type of compression refrigeration cycle used universally. Its unique features are:

1. *A Centrifugal Compressor* of two or more stages.
2. A low pressure refrigerant, *Carrene No. 2;** known otherwise by the trade name, "Freon-11", and the chemical name, trichloromonofluoromethane. Other refrigerants may be used when desirable.
3. An *Economizer* in the liquid return from Condenser to Evaporator. The use of this pieceeof equipment materially reduces the horsepower required per ton of refrigeration because it increases the efficiency of the refrigeration cycle. It is made possible by the use of a turbo-compressor having more than one stage of compression.



DIAGRAMMATIC DRAWING OF
CARRIER CENTRIFUGAL REFRIGERATING MACHINE

SL 009041

The refrigerant cycle starting at the evaporator of the machine is as follows: Here the "brine" flowing through the tubes is warmer than the refrigerant in the shell surrounding the tubes. Consequently, heat is transferred from brine to refrigerant. This heat evaporates the refrigerant at a temperature corresponding to the pressure in the evaporator (see pressure-temperature relation chart).

The refrigerant evaporated is drawn into the suction of the compressor. The suction gas is partially compressed by the first stage impeller and joins the stream of gas coming from the economizer before entering the second stage impeller. Compression of the mixture of suction and economizer streams is completed by the following stages and the compressed gas is discharged into the condenser. Note that the economizer gas is compressed through only a portion of the total pressure difference between evaporator and condenser. If the economizer were not used, this gas would all be generated in the evaporator and would have to be pumped from the evaporator pressure to the condenser pressure. The pumping of a portion of the flash gas back to the condenser from the intermediate economizer pressure increases the cycle efficiency and saves horsepower

* Reg. U.S. Pat. Off.

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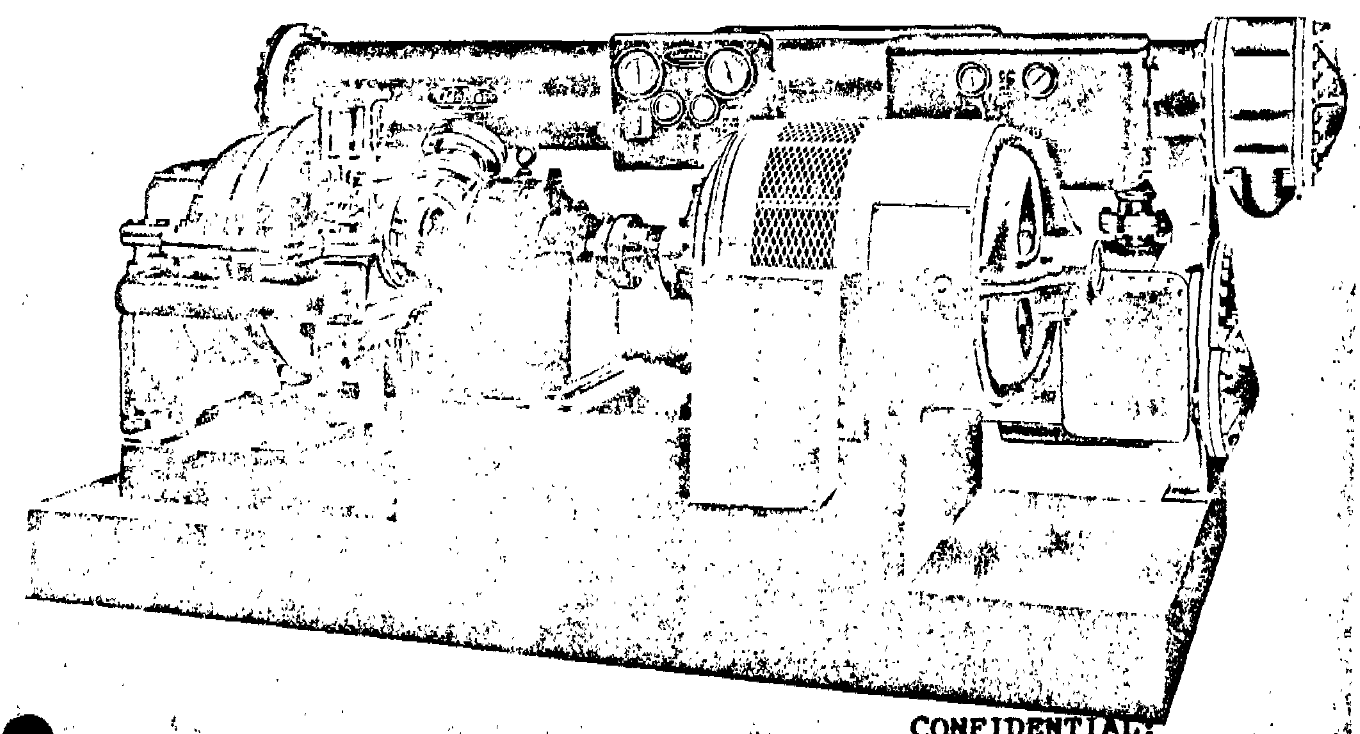
The refrigerant discharged by the compressor condenses on the outside of the condenser tubes at a temperature corresponding to the condenser pressure (see pressure-temperature chart). This temperature is higher than that of the water in the tubes so the heat of condensation is transferred to the condenser water.

The liquefied refrigerant drains from the condenser tubes down through an inside conduit into the condenser float chamber, which is built on the side, at the end of the cooler. The rising refrigerant level in this chamber opens the float valve and allows the liquid to pass into the economizer chamber, which is built into the end of the cooler. The pressure in the economizer chamber is approximately half way between the condensing and evaporating pressures; consequently, enough of the warm liquid evaporates to cool the remainder to the lower temperature corresponding to the lower pressure in the economizer chamber. This evaporation takes place by rapid "flashing" into gas as the liquid passes through the float valve and the conduit leading into the economizer chamber. The evaporated portion passes through eliminators to the compressor, to join gas coming from the cooler which has been compressed by the first stage impeller. The mixture enters the second stage impeller.

The cooled liquid then flows into the economizer float chamber located below the condenser float chamber. The rising level in the economizer float chamber opens the float valve and allows this liquid to "flash" again into the bottom of the cooler. As the cooler pressure is lower than the economizer pressure, some of the liquid is evaporated to cool the remainder to the cooler temperature, and this gas passes up through the liquid to the compressor suction. The remaining liquid serves as make-up for the refrigerant continually being evaporated by the "brine". This completes the cycle.



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REFRIGERANT

Refrigerant 11 (Trichloromonofluoromethane, CCl_3F) is a colorless liquid at normal atmospheric pressures and temperatures. It is very volatile and boils at 74.8° F. It may be handled in open containers with little loss by evaporation. The liquid is about 1.5 times as heavy as water and weighs about 12-1/2 lb per gal. A mixture of water and liquid refrigerant will separate completely, the water floating above the heavier refrigerant. The liquid will dissolve oils and greases in all proportions. It dries the skin by removing the natural oils. It also dissolves rubber and will, therefore, destroy packing materials containing rubber.

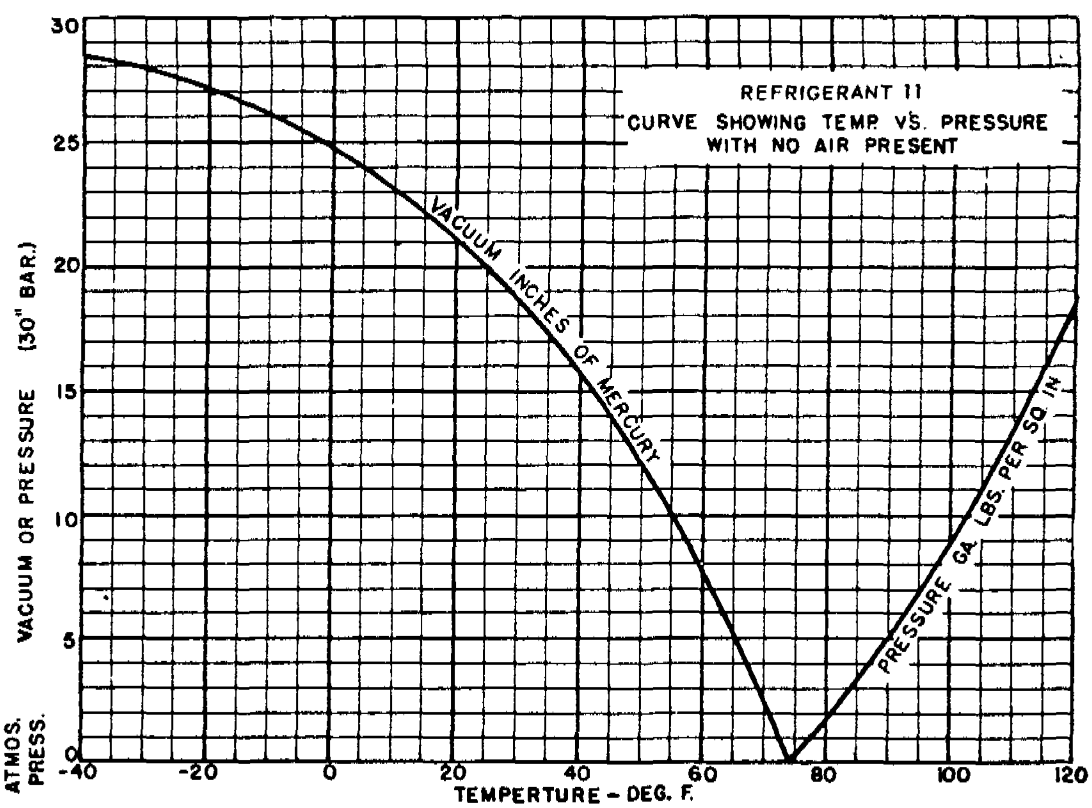
The vapor is heavy - about 4.8 times as heavy as air. Being heavy, it will drop to the floor of a room and settle in low places. For this reason, openings in the top of chambers containing refrigerant vapor will cause little loss.

The odor of the vapor is sweet. Large concentrations in air are not harmful, but will cause dizziness and eventually headache.

The vapor will not support combustion and is classed as non-inflammable and non toxic.

The refrigerant is shipped in drums of 200 lb net. The quantities for charging machines depend on the cooler size and may be determined by reference to Part 2 of these instructions.

PRESSURE-TEMPERATURE RELATION



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SUPERSEDES
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PROPERTIES OF SATURATED F-11 LIQUID AND VAPOR

Temp. °F. t	Pressure Abs. lb./in.² p	Pressure Gage lb./in.² p_d	Volume Liquid ft.³/lb. v_f	Volume Vapor ft.³/lb. v_g	Density Liquid lb./ft³ $1/v_f$	Density Vapor lb./ft³ $1/v_g$	Heat Content from −40° Liquid Btu/lb h_f	Heat Content from −40° Latent Btu/lb. h	Heat Content from −40° Vapor Btu./lb h_g	Entropy from −40° Liquid Btu/lb °F. s_f	Entropy from −40° Vapor Btu/lb °F. s_g	Temp °F. t
−20	1.420	27.03*	0.01002	24.06	99.77	0.04157	3.94	85.93	89.87	0.0091	0.2046	−20
−18	1.510	26.85*	.01004	22.72	99.63	.04401	4.33	85.78	90.11	.0100	.2043	−18
−16	1.605	26.65*	.01005	21.47	99.48	.04658	4.73	85.62	90.35	.0109	.2040	−16
−14	1.705	26.45*	.01007	20.30	99.33	.04927	5.12	85.47	90.59	.0118	.2036	−14
−12	1.810	26.24*	.01008	19.20	99.18	.05209	5.52	85.31	90.83	.0127	.2033	−12
−10	1.920	26.01*	0.01010	18.17	99.03	0.05503	5.91	85.16	91.07	0.0136	0.2030	−10
−8	2.035	25.78*	.01011	17.21	98.87	.05810	6.31	85.00	91.31	.0145	.2027	−8
−6	2.156	25.53*	.01013	16.32	98.72	.06129	6.70	84.85	91.55	.0153	.2024	−6
−4	2.283	25.27*	.01015	15.47	98.57	.06464	7.10	84.69	91.79	.0162	.2021	−4
−2	2.416	25.00*	.01016	14.68	98.42	.06813	7.49	84.54	92.03	.0171	.2018	−2
0	2.556	24.72*	0.01018	13.94	98.27	0.07176	7.89	84.38	92.27	0.0179	0.2015	0
2	2.700	24.42*	.01019	13.24	98.11	.07554	8.28	84.23	92.51	.0188	.2013	2
4	2.852	24.11*	.01021	12.58	97.96	.07949	8.68	84.07	92.75	.0197	.2010	4
5†	2.931	23.95*	.01022	12.27	97.88	.08152	8.88	84.00	92.88	.0201	.2009	5†
6	3.0.2	23.79*	.01022	11.96	97.81	.08361	9.08	83.92	93.00	.0205	.2008	6
8	3.179	23.45*	.01024	11.38	97.65	.08790	9.48	83.76	93.24	.0213	.2005	8
10	3.352	23.10*	0.01026	10.83	97.50	0.09233	9.88	83.60	93.48	0.0222	0.2003	10
12	3.534	22.73*	.01027	10.31	97.34	.09697	10.28	83.45	93.72	.0231	.2000	12
14	3.724	22.34*	.01029	9.823	97.19	.1018	10.68	83.29	93.97	.0239	.1998	14
16	3.923	21.94*	.01031	9.359	97.03	.1068	11.07	83.14	94.21	.0248	.1996	16
18	4.129	21.52*	.01032	8.925	96.88	.1120	11.47	82.98	94.45	.0256	.1993	18
20	4.342	21.08*	0.01034	8.519	96.72	0.1174	11.87	82.82	94.69	0.0264	0.1991	20
22	4.567	20.62*	.01036	8.129	96.57	.1230	12.27	82.66	94.94	.0273	.1989	22
24	4.801	20.15*	.01037	7.760	96.41	.1289	12.68	82.50	95.18	.0281	.1987	24
26	5.043	19.66*	.01039	7.414	96.25	.1349	13.08	82.34	95.42	.0289	.1985	26
28	5.294	19.14*	.01041	7.087	96.10	.1411	13.48	82.18	95.66	.0297	.1983	28
30	5.557	18.61*	0.01042	6.776	95.94	0.1476	13.88	82.03	95.91	0.0306	0.1981	30
32	5.830	18.05*	.01044	6.481	95.78	.1543	14.28	81.87	96.15	.0314	.1979	32
34	6.115	17.47*	.01046	6.200	95.62	.1613	14.68	81.71	96.39	.0322	.1977	34
36	6.411	16.87*	.01048	5.934	95.46	.1685	15.08	81.55	96.63	.0330	.1976	36
38	6.718	16.25*	.01049	5.682	95.30	.1760	15.49	81.38	96.87	.0338	.1974	38
40	7.032	15.61*	0.01051	5.447	95.14	0.1836	15.89	81.22	97.11	0.0346	0.1972	40
42	7.362	14.94*	.01053	5.220	94.98	.1916	16.30	81.06	97.36	.0354	.1970	42
44	7.702	14.24*	.01055	5.006	94.82	.1998	16.70	80.90	97.60	.0362	.1969	44
46	8.055	13.52*	.01056	4.802	94.66	.2083	17.11	80.73	97.84	.0370	.1967	46
48	8.422	12.78*	.01058	4.607	94.50	.2170	17.52	80.57	98.08	.0378	.1966	48
50	8.804	12.00*	0.01060	4.421	94.34	0.2262	17.92	80.40	98.32	0.0386	0.1964	50
52	9.199	11.20*	.01062	4.245	94.18	.2356	18.33	80.24	98.56	.0394	.1963	52
54	9.605	10.37*	.01064	4.078	94.02	.2452	18.74	80.07	98.81	.0402	.1961	54
56	10.02	9.53*	.01066	3.921	93.85	.2550	19.15	79.90	99.05	.0410	.1960	56
58	10.45	8.65*	.01067	3.770	93.69	.2652	19.56	79.73	99.29	.0418	.1959	58
60	10.90	7.73*	0.01069	3.626	93.53	0.2758	19.96	79.57	99.53	0.0426	0.1958	60
62	11.37	6.78*	.01071	3.487	93.36	.2868	20.37	79.40	99.77	.0434	.1956	62
64	11.85	5.80*	.01073	3.356	93.20	.2980	20.78	79.23	100.01	.0442	.1955	64
66	12.35	4.78*	.01075	3.229	93.04	.3097	21.19	79.06	100.25	.0450	.1954	66
68	12.87	3.72*	.01077	3.107	92.87	.3219	21.61	78.88	100.49	.0457	.1953	68
70	13.40	2.64*	0.01079	2.993	92.71	0.3342	22.02	78.71	100.73	0.0465	0.1951	70
72	13.95	1.53*	.01081	2.883	92.54	.3469	22.43	78.54	100.97	.0473	.1950	72
74	14.51	0.39*	.01083	2.779	92.38	.3598	22.84	78.37	101.21	.0481	.1949	74
76	15.09	0.39	.01085	2.679	92.21	.3732	23.26	78.19	101.45	.0489	.1948	76
78	15.69	0.99	.01086	2.584	92.04	.3870	23.68	78.01	101.69	.0496	.1947	78
80	16.31	1.61	0.01088	2.492	91.88	0.4012	24.09	77.84	101.93	0.0504	0.1947	80
82	16.94	2.24	.01090	2.406	91.71	.4157	24.51	77.66	102.17	.0512	.1946	82
84	17.60	2.90	.01092	2.322	91.54	.4307	24.93	77.48	102.41	.0519	.1945	84
86†	18.28	3.58	.01094	2.242	91.38	.4461	25.34	77.31	102.65	.0527	.1944	86†
88	18.97	4.27	.01096	2.165	91.21	.4619	25.76	77.13	102.89	.0535	.1943	88
90	19.69	4.99	0.01098	2.091	91.04	0.4783	26.18	76.95	103.12	0.0542	0.1942	90
92	20.43	5.73	.01101	2.020	90.87	.4950	26.60	76.76	103.36	.0550	.1941	92
94	21.19	6.49	.01103	1.952	90.70	.5122	27.01	76.58	103.59	.0557	.1941	94
96	21.97	7.27	.01105	1.887	90.53	.5299	27.43	76.40	103.83	.0565	.1940	96
98	22.77	8.07	.01107	1.825	90.36	.5480	27.85	76.21	104.07	.0572	.1939	98
100	23.60	8.90	0.01109	1.765	90.19	0.5666	28.27	76.03	104.30	0.0580	0.1938	100
102	24.45	9.75	.01111	1.707	90.02	.5857	28.70	75.84	104.54	.0587	.1938	102
104	25.33	10.63	.01113	1.652	89.85	.6054	29.12	75.65	104.77	.0595	.1937	104
106	26.23	11.53	.01115	1.599	89.68	.6256	29.54	75.46	105.00	.0602	.1937	106
108	27.15	12.45	.01117	1.548	89.51	.6461	29.97	75.27	105.24	.0610	.1936	108
110	28.09	13.39	0.01119	1.499	89.34	0.6671	30.40	75.08	105.47	0.0617	0.1936	110
112	29.05	14.35	.01122	1.452	89.16	.6885	30.82	74.89	105.71	.0625	.1935	112
114	30.04	15.34	.01124	1.407	88.99	.7107	31.24	74.70	105.94	.0632	.1935	114
116	31.07	16.37	.01126	1.363	88.82	.7335	31.67	74.50	106.17	.0639	.1934	116
118	32.11	17.41	.01128	1.321	88.65	.7570	32.10	74.30	106.40	.0647	.1933	118
120	33.20	18.50	0.01130	1.281	88.47	0.7808	32.53	74.10	106.63	0.0654	0.1933	120

* Inches of mercury below one atmosphere.
† Standard ton temperature.

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~~17M~~ & 17P COMPRESSORS

~~The 17M compressor is a two-stage turbo compressor,~~ the 17P is three-stage. ~~They are~~ designed for use with Carrene No. 2 as refrigerant. ~~At normal speed, the 17M type will produce a suction temperature about [illegible] F. below the temperature of condensation~~. The 17P at normal speed will produce a corresponding temperature of about 95° F. The speed may be selected greater or less than normal, and at maximum speed, ~~[illegible]~~ (and the 17P type approximately 120° F.) below the condensation temperature. Other refrigerants when desirable, can be used -- these possibly requiring some changes in design from standard.

The *Compressor Casing* and the various stationary passages are of cast iron.

The *Shaft* is a forging, turned and ground with keyways provided for each impeller.

The *Impellers* are of the built-up type. The hub disc and cover are machined steel forgings. The blading is sheet steel formed to curve backward with respect to the direction of rotation. The assembly is riveted and lead coated. Each impeller is balanced after fabrication and the completed rotor is also balanced dynamically.

The *Rotor* assembly consisting of shaft and impellers runs in two sleeve type bearings.

Thermometers are inserted in the top half of each bearing for indicating their temperature.

Brass *Labyrinth* packing in the *Diaphragms* prevents interstage leakage of gas. Similar packing of the shaft at the ends of the casing restricts the flow or gas between the main compressor casing and the *Bearing Chambers*.

In operation the pressure differential across each impeller produces an axial thrust toward the suction end of the compressor. This thrust is supported by a *Kingsbury Thrust Bearing* at the suction end of the shaft.

The compressor has a complete lubrication system, including *Oil Pump, Bearing Oil Rings, Pressure Regulating Valve, etc.* Detailed description of the oil system may be found under the heading of "*Compressor Oil System*".

COMPRESSOR SHAFT SEAL

Description

A shaft seal is provided where the shaft extends through the compressor casing. The seal is formed between a ring, called the *Rotating Sealing Seat* which is vacuum fitted against a shoulder on the shaft -- and the *Stationary Sealing Seat* attached to the *Seal Housing* through a flexible member or *Bellows* assembly. The faces on these seal seats are carefully formed to make a vacuum-tight joint when in contact on shutdown. In order that these faces will seal properly when the compressor is shut down, the *Seal Spring* between the stationary sealing seat and the *Seal Housing Cover* moves the stationary seal seat into contact with the rotating seal seat. Between the hub of the stationary sealing seat and the hub of the rotating sealing seat is located a floating ring. A *Seal Oil Reservoir* with filter chamber is attached to the compressor housing above the seal. The reservoir provides oil to keep the seal faces flooded during shut down periods. An orifice between filter chamber and reservoir restricts oil flow to the reservoir during starting, if the reservoir has partially drained during shut down. By this means, full oil supply is assured for the seal immediately on starting.

Operation

The operation of the seal mechanism is as follows: When the compressor starts up, oil is pumped through external piping and internal passages in the compressor, as outlined in section on "*Compressor Oil System*", through the filter and to the interior of the bellow assembly. The oil pressure expands the bellows, moving the stationary sealing seat against the pressure of the spring, back to a stop on the seal housing cover, leaving a space between the faces of this seat and the rotating seal seat on the shaft. The oil in the bellows passes through drilled passages to an oil groove cut eccentrically in the face of the stationary sealing seat. From this groove the oil, *filling the space between the seal faces,* passes in two directions:

a. Across the outer section of the face of the stationary sealing seat and into the space between the shaft and the bellows assembly. Oil flow from this space is prevented by a floating ring called the *Inner Floating Ring*.

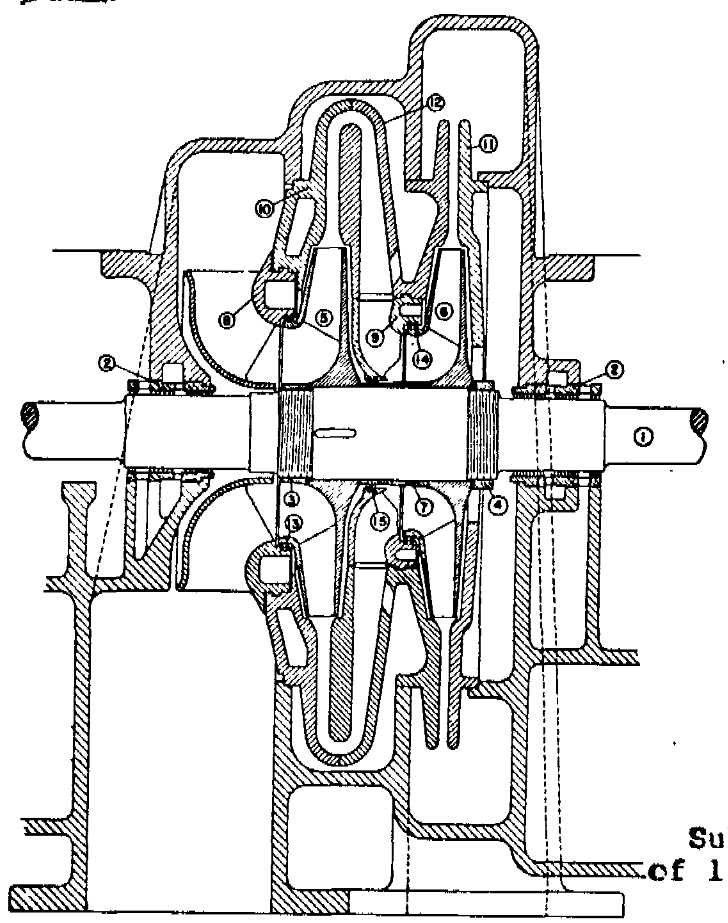
b. Across the inner section of the face of the sealing seat and through the clearance between the rotating sealing seat hub and stationary sealing seat. This flow is restricted by the close clearance of the floating ring between these two rts as well as by the *Outer Floating Ring* betwe n s al housing cov r and rotat-ng seal hub.

The oil in the space between the shaft and the bellows, as described in paragraph a" above, passes through an opening to the shaft bearing providing a fresh oil supply to this bearing. The oil pressure in this space actuates the oil pressure regulat-ng valve in the oil pump discharge, acting through a passage in the seal housing and capillary tube connection from this point to the *Pressure Regulating Valve*. Since pressure is not developed in this annular space between the bellows and the shaft until after the seal has opened, the pressure regulating valve remains closed on tarting and the full capacity of the oil pump is assured for initial oil supply. Th ressure in this space also controls the action of the *Low Oil Pressure Cutout*. See "Safety Controls".

The oil passing between the hubs of the seal seats, as described in paragraph "b" bove, goes to the *Atmospheric Float Chamber*.

For completion of these circuits "a" and "b" refer to "Compressor Oil System".

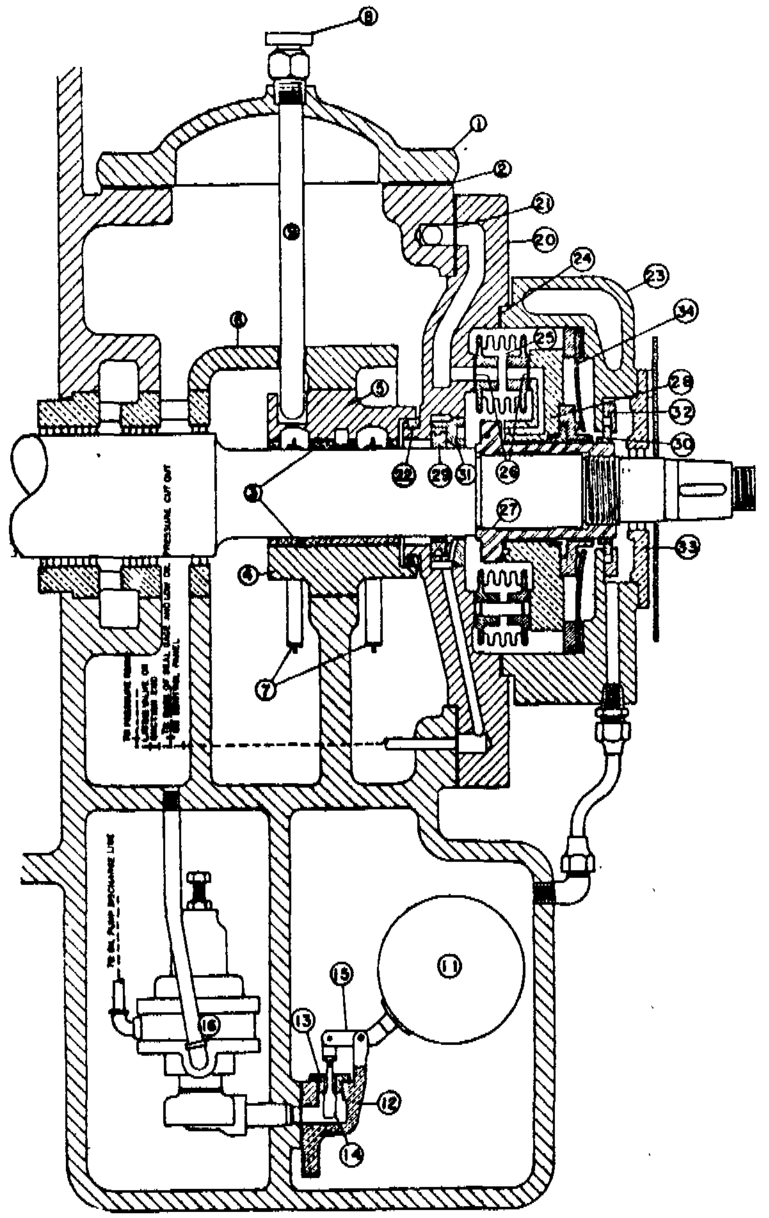
During operation the oil passing between the seal faces, seals the shaft against nward leakage of air and avoids the necessity of a metal to metal contact of the seal. [redacted].



TYPE 17M COMPRESSOR

Item No.
1. Shaft
2. Shaft Labyrinth - either end
3. Impeller Lock Nut - suction end
4. Impeller Lock Nut - discharge end (L. H. T.)
5. Impeller - first stage
6. Impeller - second stage
7. Impeller Spacer
8. Inlet Guide Vane - first stage

Item No.
9. Inlet Guide Vane - second stage
10. Intake Wall
11. Discharge Wall
12. Diaphragm - first stage
13. Inlet Labyrinth - first stage
14. Inlet Labyrinth - second stage
15. Spacer Labyrinth



SEAL (DISCHARGE) END

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Item No.	SEAL END BEARING
1.	Bearing Inspection Cover
2.	Bearing Inspection Cover Gasket
3.	Bearing Liner (Upper and Lower)
4.	Lower Shaft Bearing Retainer
5.	Upper Shaft Bearing Retainer
6.	Bearing Cap
7.	Oil Rings (2)
8.	Thermometer Clamp
9.	Thermometer Well
	ATMOSPHERIC FLOAT VALVE
10.	Float Valve Assembly
11.	Float Ball
12.	Valve Body
13.	Valve Seat
14.	Valve Stem
15.	Valve Arm
16.	Oil Stop Valve Assembly
17.	Oil Stop Valve Bellows (Not shown)
18.	Oil Stop Valve Seat (Not shown)

	SEAL
20.	Seal Housing
21.	Seal Housing Gasket
22.	Bearing Felt Ring
23.	Seal Housing Cover
24.	Seal Housing Cover Gasket
25.	Bellows Assembly
26.	Bellows Gaskets(2)
27.	Rotating Seal Seat
28.	Stationary Seal Seat Assembly
29.	Inner Floating Seal Ring
30.	Outer Floating Seal Ring
31.	Inner Floating Seal Ring Retainer (L.H.T.)
32.	Outer Floating Seal Ring Retainer
33.	Shaft End Labyrinth
34.	Seal Spring

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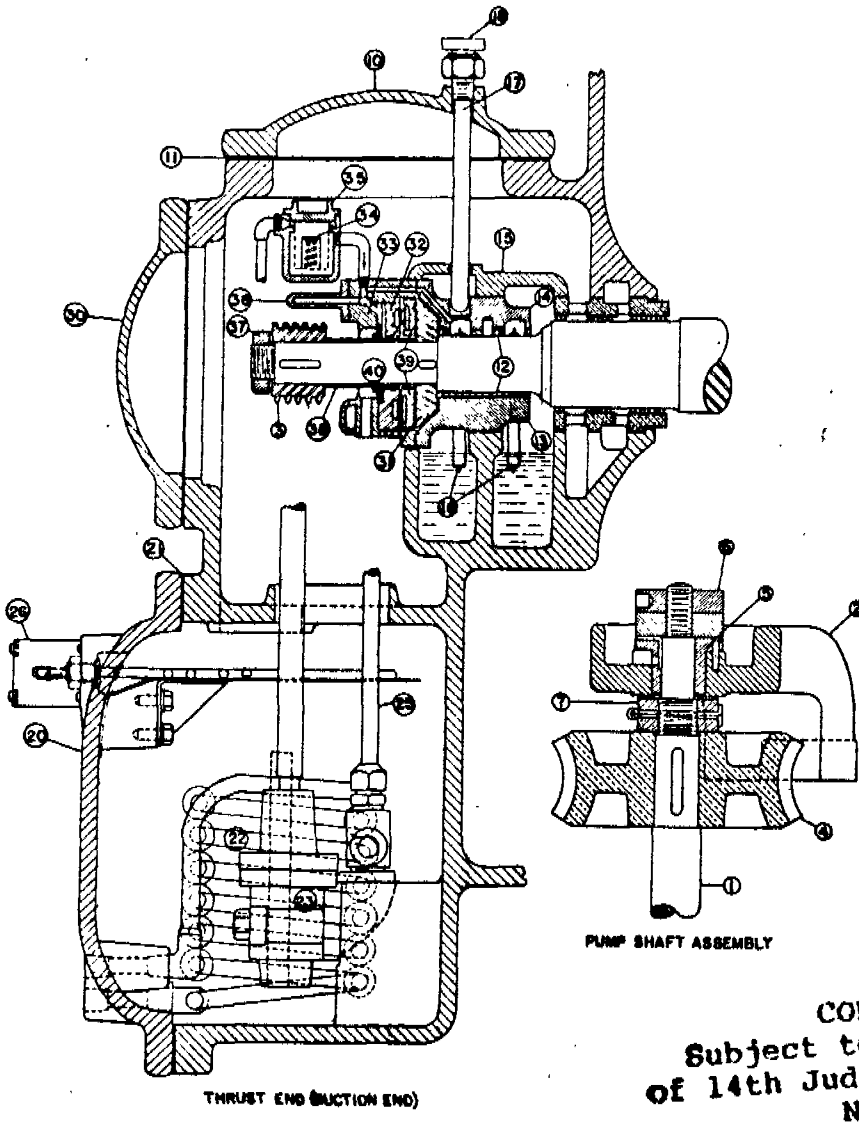

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Item No. OIL PUMP DRIVE

1. Shaft
2. Bracket
3. Worm
4. Worm Gear Wheel
5. Bushing
6. Shaft Lock Nuts (L.H.T.)
7. Worm Gear Lock Nut

THRUST END BEARING

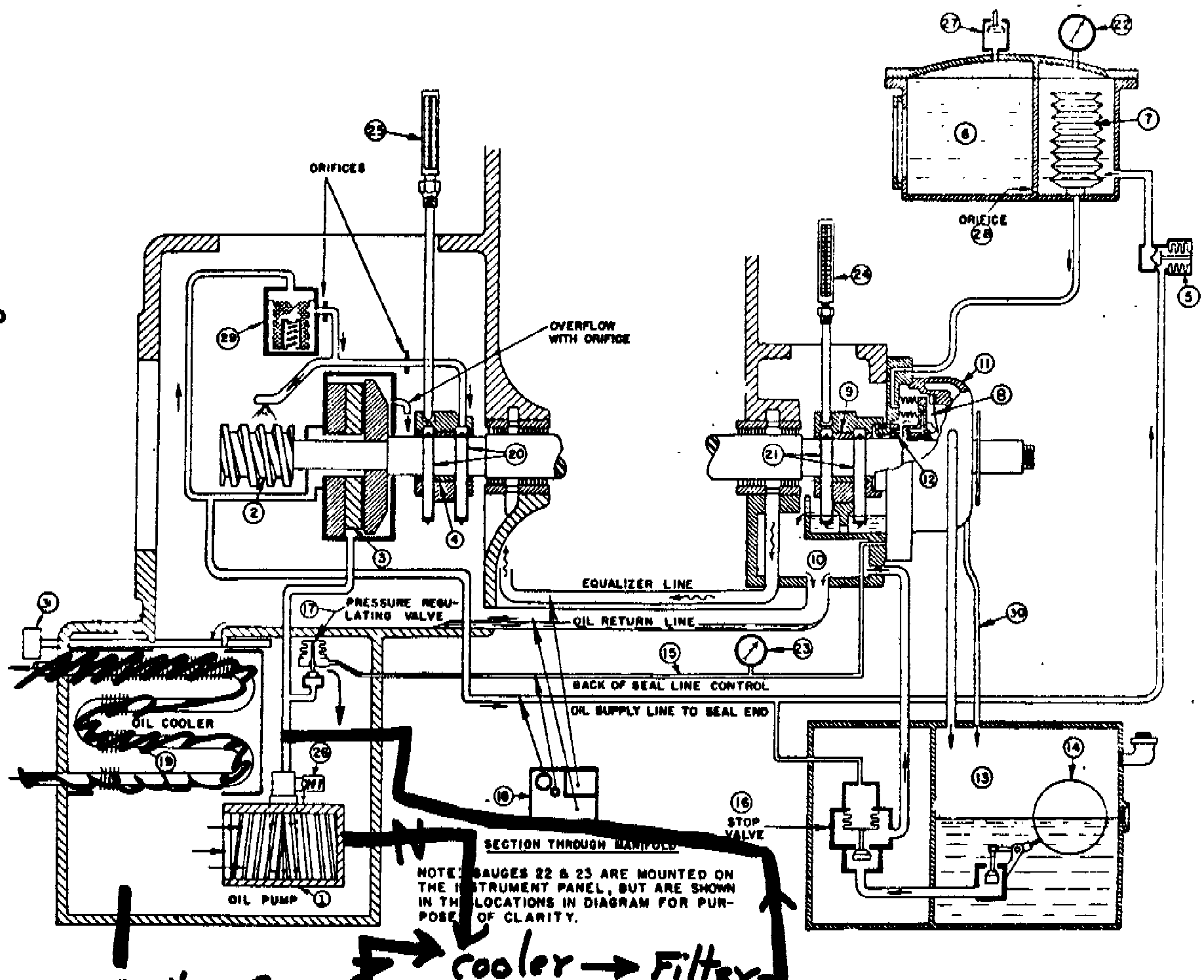
10. Bearing Inspection Cover
11. Bearing Inspection Cover Gasket
12. Bearing Liner (Upper and Lower)
13. Lower Shaft Bearing Retainer
14. Upper Shaft Bearing Retainer
15. Bearing Cap
16. Oil Rings (2)
17. Thermometer Well
18. Thermometer Clamp

Item No. OIL PUMP CHAMBER

20. Chamber Cover
21. Chamber Cover Gasket
22. Oil Cooler Assembly
23. Oil Pump Assembly
24. Oil Relief Valve
25. Oil Discharge Pipe
26. Oil Heater

THRUST BEARING

30. Thrust End Cover
31. Thrust Disc
32. Kingsbury Thrust Bearing.
33. Thrust Bearing Housing
34. Oil Strainer Assembly
35. Oil Strainer Cap
36. Pump Drive Oil Nozzle
37. Worm Lock Nut
38. Worm Spacer
39. Thrust Bearing Shoes (2)
40. Thrust Bearing Housing Floating Ring



OIL PIPING DIAGRAM

In general, this system consists of an *Oil Pump* of the gear type, driven from the main compressor shaft, and supplying oil through various connections and passages for the *Thrust Bearing*, the two *Shaft Bearings*, the oil pump *Worm Gear Drive* and for the *Shaft Seal*; -- with the necessary gauges and control valves to permit the system to operate automatically.

The oil pressure or feed circuits are as follows:

When the compressor starts, the pump 1 starts to circulate oil -- which is applied first entirely to the thrust bearing 3. From the thrust, the oil divides into two circuits --

A. Through *Strainer* 29 and the proper orifices to the pump drive gear 2, and the rear shaft bearing 4.

B. Through *Check Valve* 5 and *Filter* 7 to the shaft seal and front shaft bearing 9.

In reference to circuit A, since the thrust, rear journal bearing and worm drive are all located above the *Oil Pump Chamber*, th return flow of oil from these parts simply drops back t this chamber.

In reference to circuit B supplying oil to the front bearing and for the operation of the shaft seal, since part of the oil passes to the atmosphere, various valves are required in the supply as well as in the return to the pump chamber. In this circuit when pump pressure, on starting, has reached approximately 8 pounds, the valve No. 5 -- which is set to open at this pressure on its inlet -- allows oil to pass from manifold 18 through filter 7 and to seal 8. (If the seal oil reservoir 6 is not full, a small part of the oil passes through orifice 28 to fill the reservoir). The oil pressure then passes through the seal bellows, expands the bellows, moving the stationary seal back against its stop and allowing the oil to pass through the seal in two directions - (I) inside the compressor and (II) to the atmosphere, as explained in detail under the paragraph on "Shaft Seal".

The oil passing to the vacuum side of the seal (refer to I above) flows to the front bearing 9, through an opening in the inner floating seal ring 12 which is located in the seal housing, to prevent unnecessary flow of oil from the vacuum side of seal. The bearing overflow drops to the bottom of the *Bearing Chamber* 10 draining back to the *Oil Pump Chamber* through the proper passage in manifold 18.

In reference to II above, the oil passing to atmosphere is restricted by floating rings between stationary seal and rotating seal hubsand between housing cover and rotating seal hub. Most of it passes directly to the *Atmospheric Float Chamber* 13. Th water jacketed seal housing cover 11, cools this oil and minimizes the refrigerant loss from it. A small amount passes these rings and is returned to the atmosphere float chamber 13 through connection 30. From the float chamber the oil goes through the *Automatic Oil Stop Valve* 16, up to bearing chamber 10, - where it returns through e *Manifold,* to the oil pump chamber, with the oil overflow from the front bearing. il returns from the atmospheric float chamber since the pressure in the bearing chamber is always below atmospheric, -- this pressure being equalized with the compressor suction through the rear *Shaft Labyrinth,*-and therefore always is a vaccuum during operation. From the *Bearing Chamber,* the oil flows by gravity through the manifold 18, to the oil pump chamber. Automatic stop valve 16 is provided to prevent flow of refrigerant vapor from the machine in case the pressure inside the machine during shutdown, rises above atmospheric. The valve is set to open at approximately eight pounds, and is actuated by an oil pressure line taken from the oil pump discharge and, therefore, opens immediately after the compressor is started. Valve 16 also prevents outside air from entering into the machine when the machine pressure is below atmospheric. This valve is necessary because the atmospheric float valve 14 is designed for level control only, and is not a stop valve.

Valv 17 is the *Oil Pressure Regulator.* It is actuated by pressure "back of seal" through line 15 and con trols oil pressure by returning excess oil back to the oil pump chamber.

Oil Pressure Gauges 22 and 23 on control panel, indicate the seal reservoir pressui and the pressure "back of seal", respectively. When the reservoir is full, 22 indicates the pressure on the seal bellows. Gauge 23 indicates the pressure in the space between the seal and inner floating ring, or "back of seal" pressure, which controls valve 17.

Air Vent and Vacuum Breaker 27 admits atmospheric pressure during shut down, to th seal oil reservoir to maintain a head of oil on the seal. It operates as a gravity ck valve.

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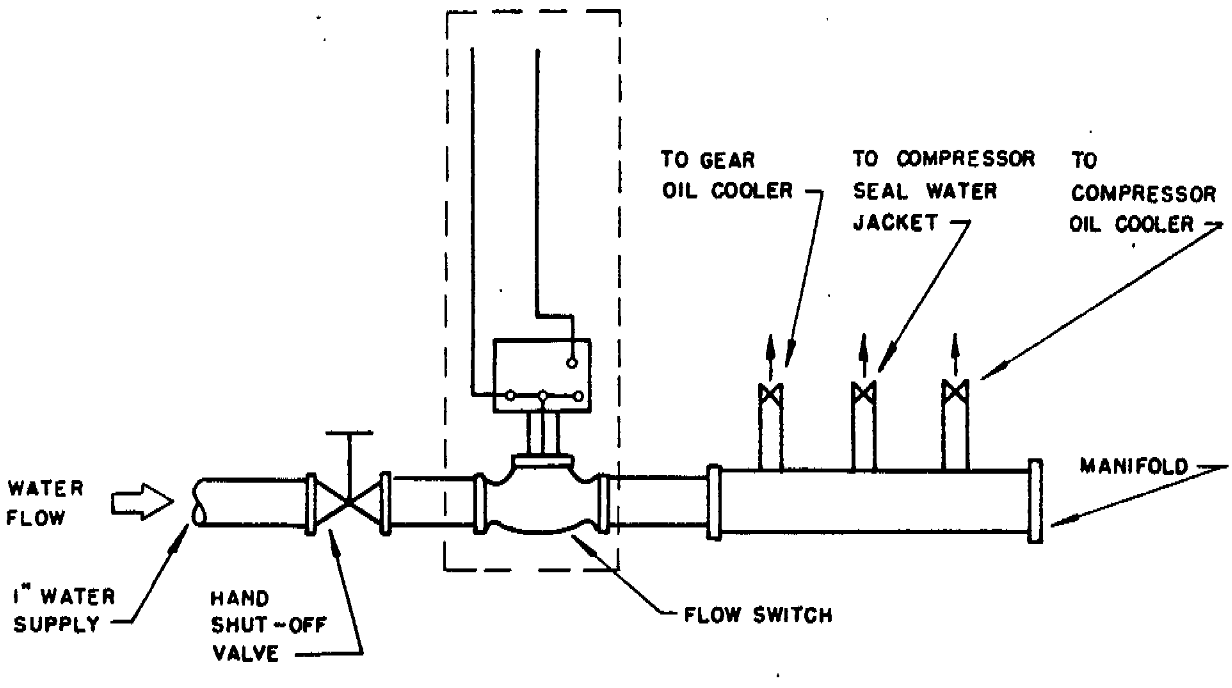
The *Oil Heater* 31 heats the oil during shut-down to prevent excessive absorption of refrigerant by the oil. A *flow switch* (not by Carrier) may be located in the water supply to the oil cooler manifold. This automatically turns on the heater when the water supply is shut off by hand, and cuts the heater off when the water is turned on.

The *Oil Cooler* [redacted] cools the oil as it is returned to the pump chamber during operation.

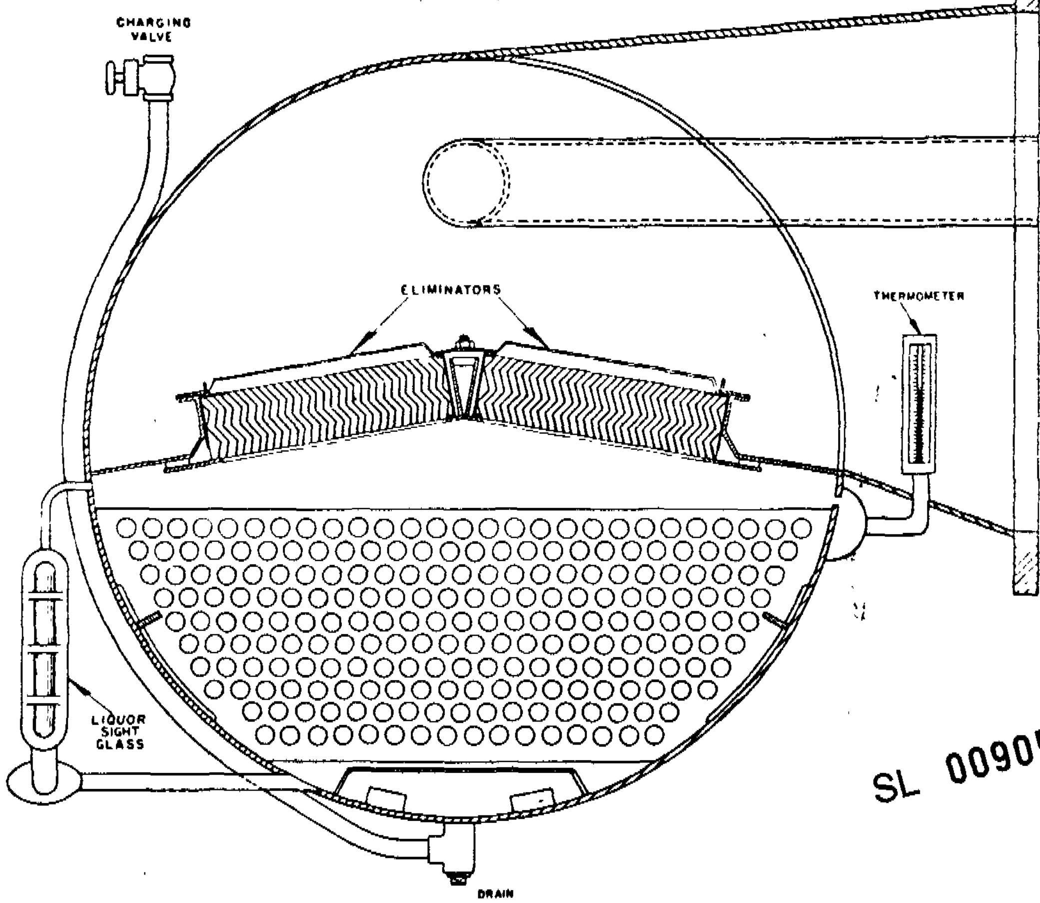
Bearing Thermometers 24 and 25 indicate the temperature of the shaft bearings.

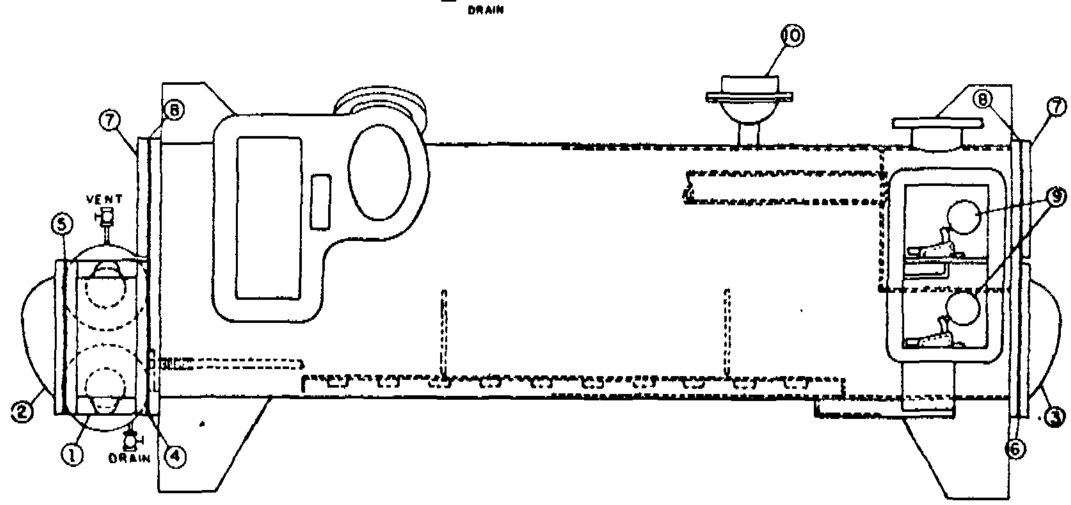
Oil Rings 20 and 21 bring additional oil from the bearing wells to the shaft.

Relief Valve 26 in the oil pump discharge line, relieves any unusually high pressure that may occur accidentally, and thus protects the system against any damage.



CROSS SECTION OF 17Q COOLER
(DIAGRAM)





Item No.

1. Water Box with Nozzles*
2. Water Box Cover - nozzle end
3. Water Box - plain end
4. Gasket (Water Box to Tube Sheet)
5. Gasket (Water Box to Cover) - nozzle end
6. Gasket (Water Box to Tube Sheet) - plain end

Item No.

7. Inspection Cover - either end
8. Gasket - Inspection Cover
9. Condenser and Economizer Liquor Float Valve Assemblies
10. ~~Rupture Valve~~ SRV

*NOTE: For three-pass construction, there is a water box with nozzle on each end.

17Q COOLER

The 17Q Coolers are shell and tube flooded type. See cuts showing construction details.

The standard construction includes Lo-Fin copper *Tubes* rolled into cupro-nickel *Tube Sheets*. Other metals are furnished if required by particular"brine"conditions.

The tubes are provided with belled ends so that the advantage of a removable tube is obtained. They are rolled into the tube sheets and expanded into two internal *Support Sheets* .

The normal refrigerant charge covers only about 50% of the tube bundle. During operation, however, the ebullition or violent boiling of the refrigerant completely covers the bundle.

Above the tube bundle are *Eliminators* to prevent the carry-over of liquid refrigerant particles into the compressor suction.

Inspection Covers are provided in the ends of the cooler to permit access to the eliminators.

A ~~Rupture Valve with 15 lb. Bursting disc~~ SRV set at 15 psig is also provided on cooler.

The cooler *Water Boxes* are designed for a maximum working pressure of 200 lb. Sq. In. and are tested in excess of this pressure. They are provided with the necessary *Division Plates* to give the required flow. The *Water Box Covers* may be removed without disturbing any refrigerant joint since the tube sheets are welded into the cooler end flanges. *Vent* and *Drain* openings are provided in the water circuit.

A *Refrigerant Thermometer* is provided to indicate the temperature within the cooler during operation.

A *Refrigerant Sight Glass* is provided for observing the charging and operating refrigerant level.

A *Charging Valve* with connection will be found on the side of the cooler for the addition and removal of refrigerant. The connection is carried to the bottom of the cooler so that complete drainage or refrigeration is possible. A *Refrigerant Drain* to atmosphere is also provided near the charging connection.

EXPANSION THERMOMETER CHAMBER

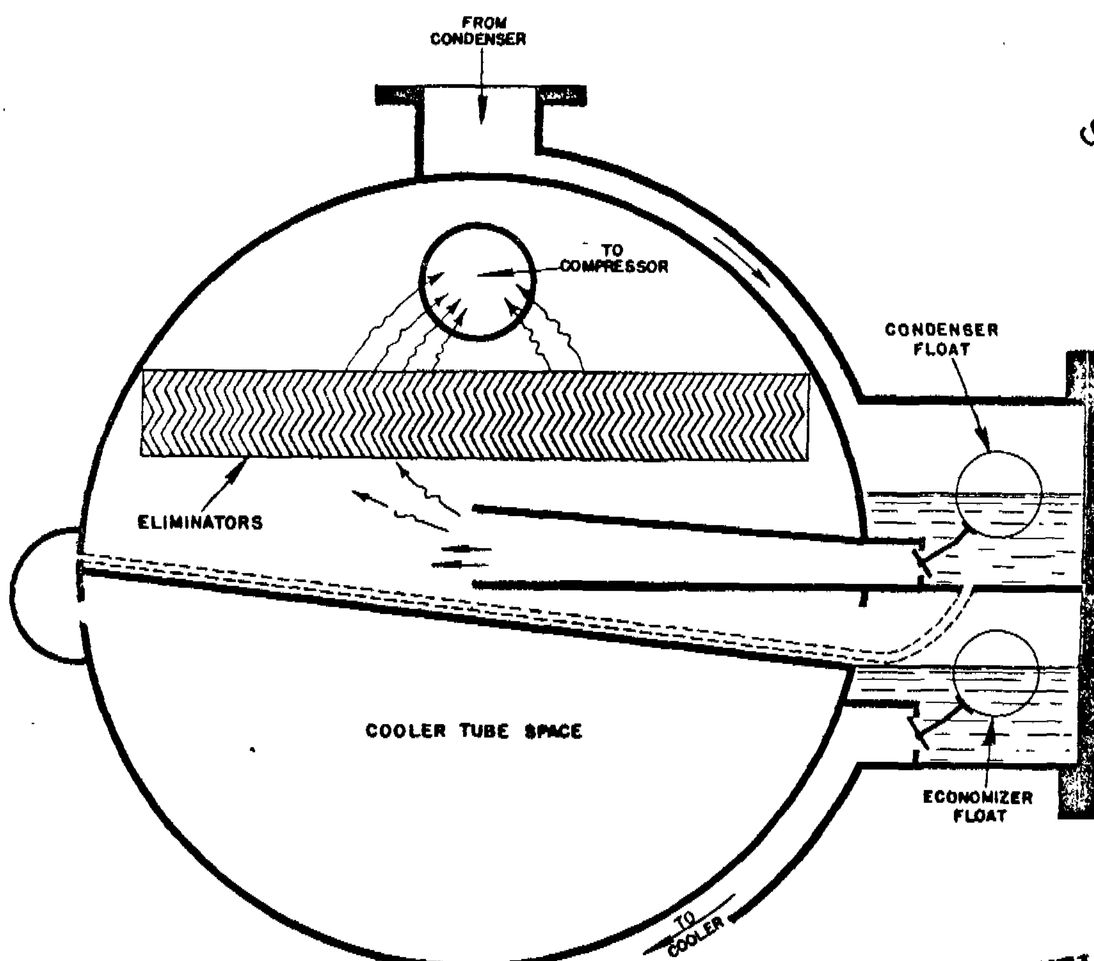
A small chamber is welded to the cooler shell, at a point opposite the economizer and above the tube bundle. An opening in the shell permits free passage from the chamber to the cooler. A continuous supply of liquid from the condenser float chamber is brought to the expansion chamber while the machine is running. This expands in the chamber which is at cooler pressure and, therefore, maintains a small body of liquid and gas passing to the cooler through the above mentioned opening. The bulb of the refrigerant thermometer and the refrigerant safety thermostat bulb are inserted in this expansion chamber.

ECONOMIZER

A complete description of the function of the economizer is given under the heading of "Refrigerant Cycle". It is located in the cooler shell at the end opposite the compressor suction connection. It is above the tube bundle and entirely separate from the cooler gas space.

The economizer is a chamber with the necessary passages and float valves, connected by an internal conduit passing longitudinally through the cooler gas space to the compressor second stage inlet. This connection maintains a pressure in the chamber intermediate between the cooler and condenser pressures and carries away the vapor generated in the chamber. Before entering the conduit, the economizer vapor passes through an eliminator which extracts any free liquid and drains it back into the chamber.

On the front of the economizer will be found a chamber for two float valves. In the top is the *Condenser Float Valve* which keeps the condenser drained of refrigerant and admits the refrigerant from the condenser into the economizer chamber. In the bottom is the *Economizer Float Valve* which returns the refrigerant to the cooler.



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ECONOMIZER

17R CONDENSER

The 17R Condensers are shell and tube type using the same tubing as the 17Q Coolers. The standard tube bundle employs copper tubes rolled into steel *Tube Sheets*. Other metals are furnished if required to meet water conditions. The ends of the tubes are belled where they are rolled into the sheets and the advantage of a removable tube is thus obtained. The tubes are supported by two intermediate support sheets.

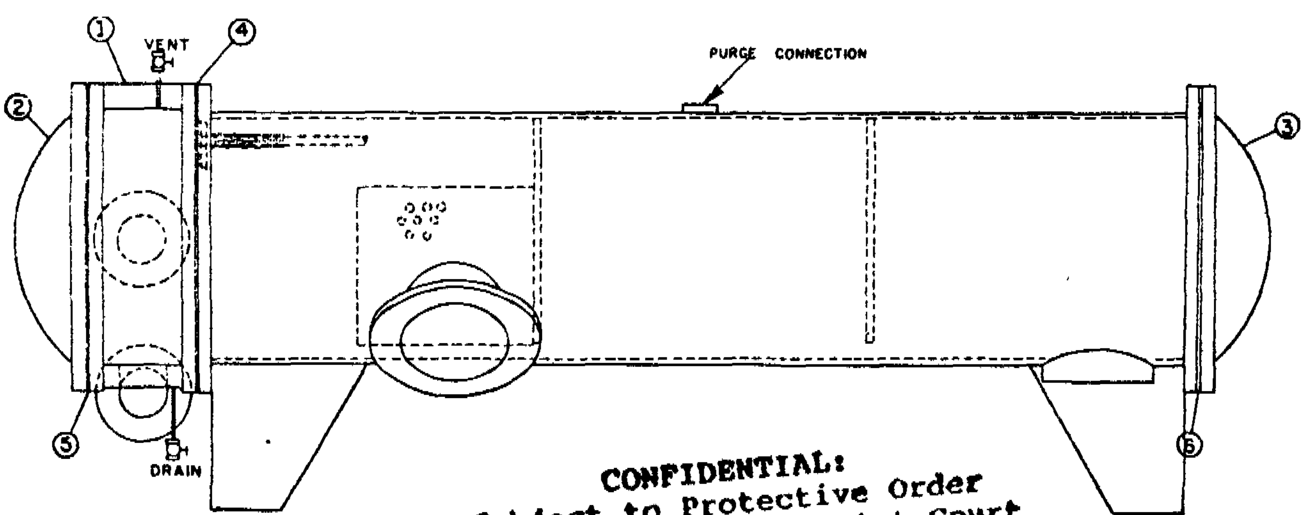
An important function of the condenser is to collect and concentrate non-condensable gases so that they may be removed by the purge recovery system. The top portion of the condenser is baffled for this reason. This *Baffle* encloses a portion of the first water pass. The non-condensables rise to this location because of their lower density and because it is the coolest portion of the condenser.

A perforated baffle is installed along the tube bundle to prevent direct impact of the compressor discharge on the tubes - and to distribute the gas longitudinally through the condenser.

The condensed refrigerant leaves the condenser through a bottom connection at one end and flows into the *condenser float chamber* in the cooler shell below.

The *Water Boxes* of most condensers are designed for a maximum working pressure of 200 lb. per sq in and are hydrostatically tested in excess of this pressure. They are provided with the necessary *Division Plates* to give the required flow. *Water Box Covers* may be removed without disturbing any refrigerant joint since the tube sheets are welded into the condenser end flanges. *Vent* and *Drain* openings are provided in the water circuit.

The condenser is connected to the compressor and the cooler shell with expansion joints to allow for differences in expansion between them.



Item No.
1. Water Box with Nozzles*
2. Water Box Cover - nozzle end
3. Water Box - plain end

Item No.
4. Gasket (Water Box to Tube Sheet)
5. Gasket (Water Box to Cover) - nozzle end
6. Gasket (Water Box to Tube Sheet) - plain end

*NOTE: For three pass construction, there is a water box with nozzle on each end.

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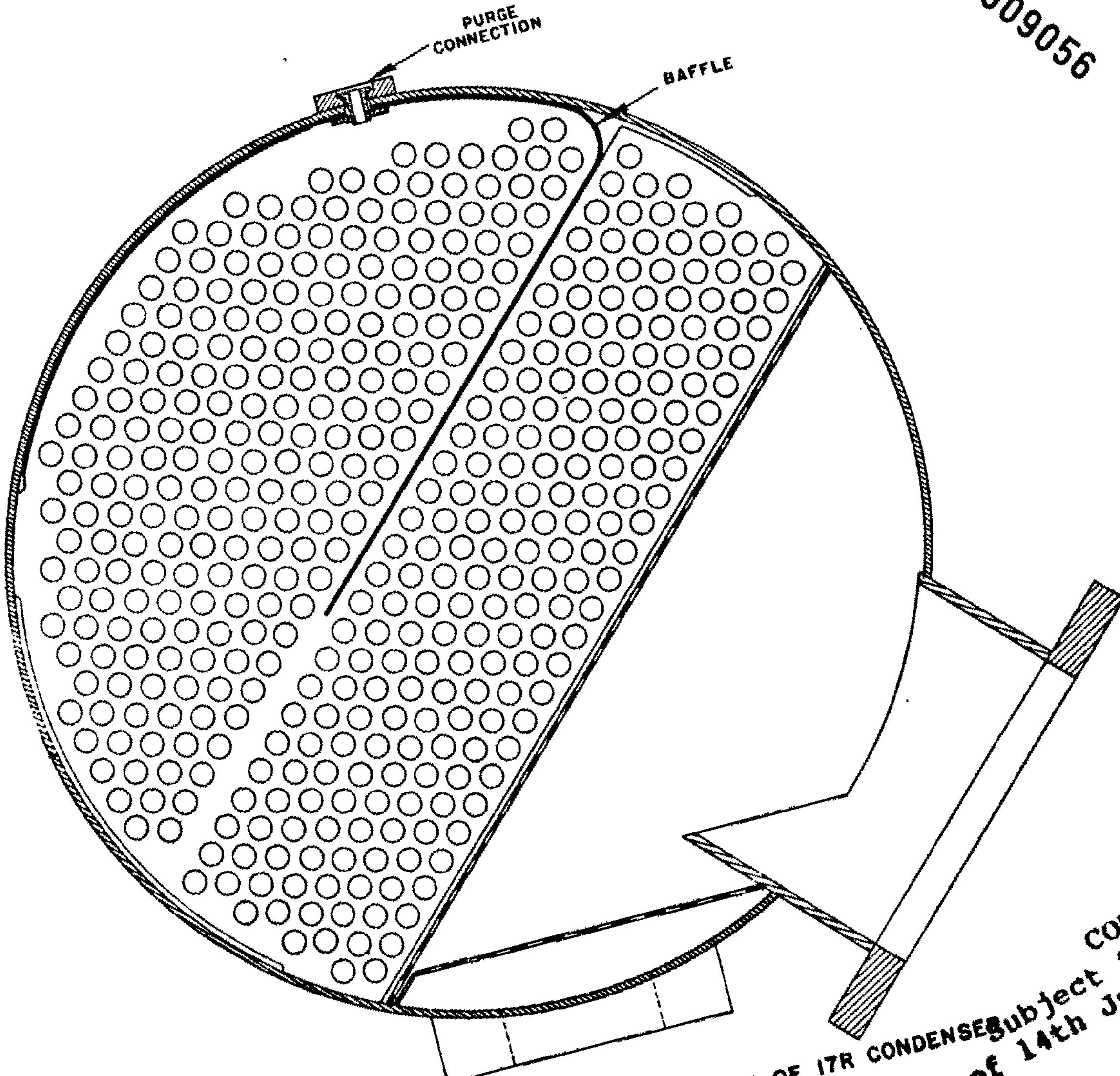

CROSS-SECTION OF 17R CONDENSER

SUPERSEDES
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TYPE "L" PURGE RECOVERY SYSTEM

The presence of even a small amount of water in a refrigeration system is to be avoided at all times; otherwise excessive corrosion of various parts of the system may occur. Any appreciable amount of water is due to a leak in one of the water circuits.

The pressure within a portion of the centrifugal refrigeration system is less than atmospheric; therefore the possibility exists that air may enter the system. Since air contains water vapor, a small amount of water will enter whenever air enters.

The function of the purge system is to indicate air and water leaks into the refrigeration system, and to recover refrigerant which is mixed with these gases. The air is automatically purged to the atmosphere, the refrigerant automatically returned to the cooler as a liquid, and the water, if present, trapped in a compartment from which it can be drained manually. Thus the purge and recovery system maintains the highest possible refrigerating efficiency.

Information regarding the Purge Recovery System is given below, with respect to the diagram and the items as numbered thereon:

1. *Stop Valve* on main condenser. Open except during repairs.

2. *Pressure Reducing Valve* in suction line to regulate the compressor suction pressure. See page 37 for explanation of duty and suggested setting point.

3. *Stop Valve* in suction line, located in end of the casing and marked "From Condenser." This valve is to be open when the purge unit is in operation, and closed at all other times.

4. *Suction Pressure Gauge* on front of casing.

5. *Compressor* to be operated continuously when the centrifugal compressor is operating, and before starting the machine, as required by the presence of air.

6. *Discharge Pressure Gauge* on front of casing.

7. *High Pressure Cut-out Switch* connected to compressor discharge. Adjusted to stop the compressor if the condenser pressure increases to about 110 lb because of some abnormal condition. The switch closes again automatically on reduction of pressure to about 75 lb.

8. *Auxiliary Oil Reservoir* This reservoir serves as a chamber to relieve the refrigerant from the compressor crankcase to the suction line without loss of oil, and to contain extra oil for the compressor.

9. *Sight Glass* for the oil level in the compressor and auxiliary oil reservoir, located in the front of the casing.

10. *Oil Separator* removes oil from the compressor discharge gas.

11. *Condenser* cooled by air from a fan on the compressor motor. It liquifies most of the refrigerant and water vapor contained in the mixture delivered by the compressor.

12. *Evacuator Chamber* for separation of air, refrigerant and water. Flanged compartments provide ready access for inspection or repairs.

13. *Inlet Opening* from purge condenser.

14. *Trap* - Refrigerant, being heavier than water, falls to the bottom of the trap and forms a seal. As more liquid enters, the level is built up, causing water to flow over the *Water Weir* (15) and refrigerant to flow over the *Refrigerant Weir* (16).

17. *Settling Compartment* A quiet area where the water and refrigerant separate.

18. *Float Valve* designed to open when the liquid level rises, allowing the gas pressure to force the liquid refrigerant into the economizer.

19. *Loop Seal* prevents liquid refrigerant from collecting in the water compartment.

20. *Sight Glass* on lower liquid compartment, visible at the end of the casing, shows refrigerant level in the separator.

21. *Sight Glass* on upper compartment indicates the presence of water.

22. *Stop Valve* at end of casing permits water to be drained from the upper compartment. The valve is marked "Water Drain" and is closed except when draining water.

23. *Automatic Relief Valve* to purge air to the atmosphere. See page 37 for suggested setting.

24. *Stop Valve* marked "Refrigerant Return", in the return liquid refrigerant line, located at the end of the casing. Open only when purge is operating.

25. *Stop Valve* on economizer in the return refrigerant connection. Open at all times except when machine is shut down for a long period, or is being tested.

26. *Plug* in oil filling connection of reservoir. Pressure in the system must be balanced with the atmospheric pressure to add oil through this fitting.

27. *Cap* for draining oil from the compressor crankcase and oil reservoir. Oil may also be added through this connection if (a) a packless refrigerant valve is installed in place of cap at this connection, and (b) the purge compressor is operated on a vacuum.

28. *Connections* between auxiliary reservoir and compressor crankcase.

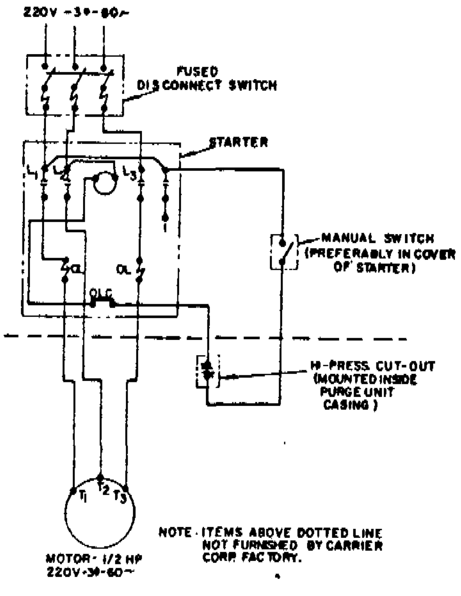
29. *Motor and Belt* not shown.

30. *Wiring Diagram* inside the casing.

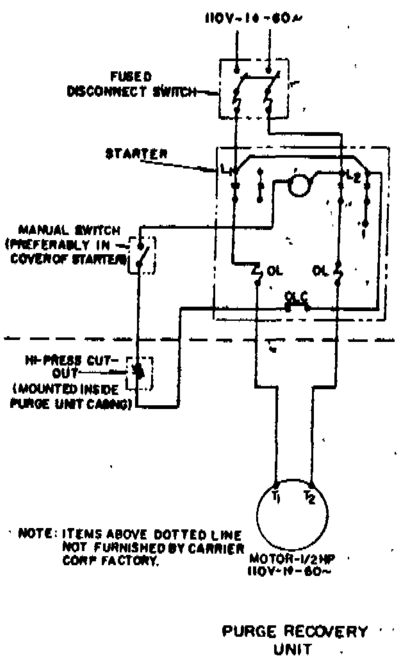
31. Casing completely encloses the purge recovery unit and is removable to provide access to the equipment.

See Sect. 17Z-5, pages 40 - 41, "Leak Testing" for the use of the following parts:

32. *Plugged Tee*
33. *Capped Tee*
34. *Temporary Connector Pipe*



PURGE RECOVERY UNIT

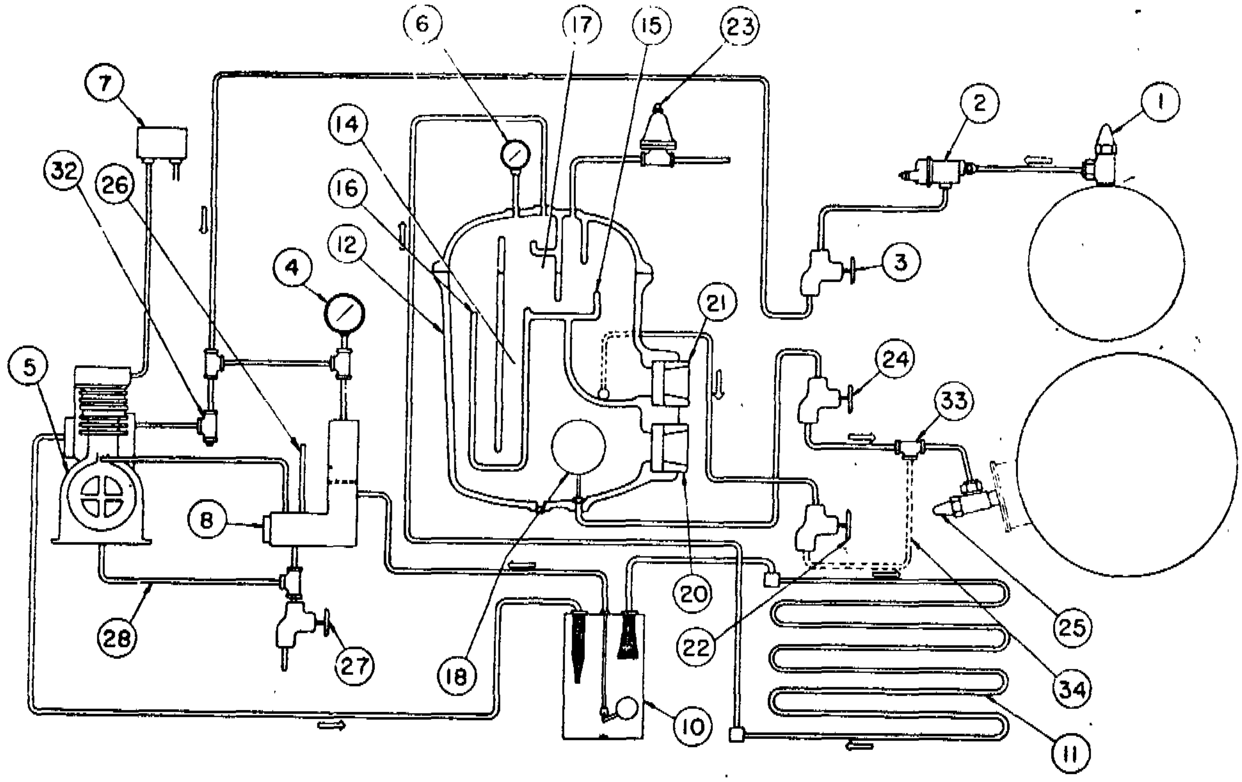


PURGE RECOVERY UNIT

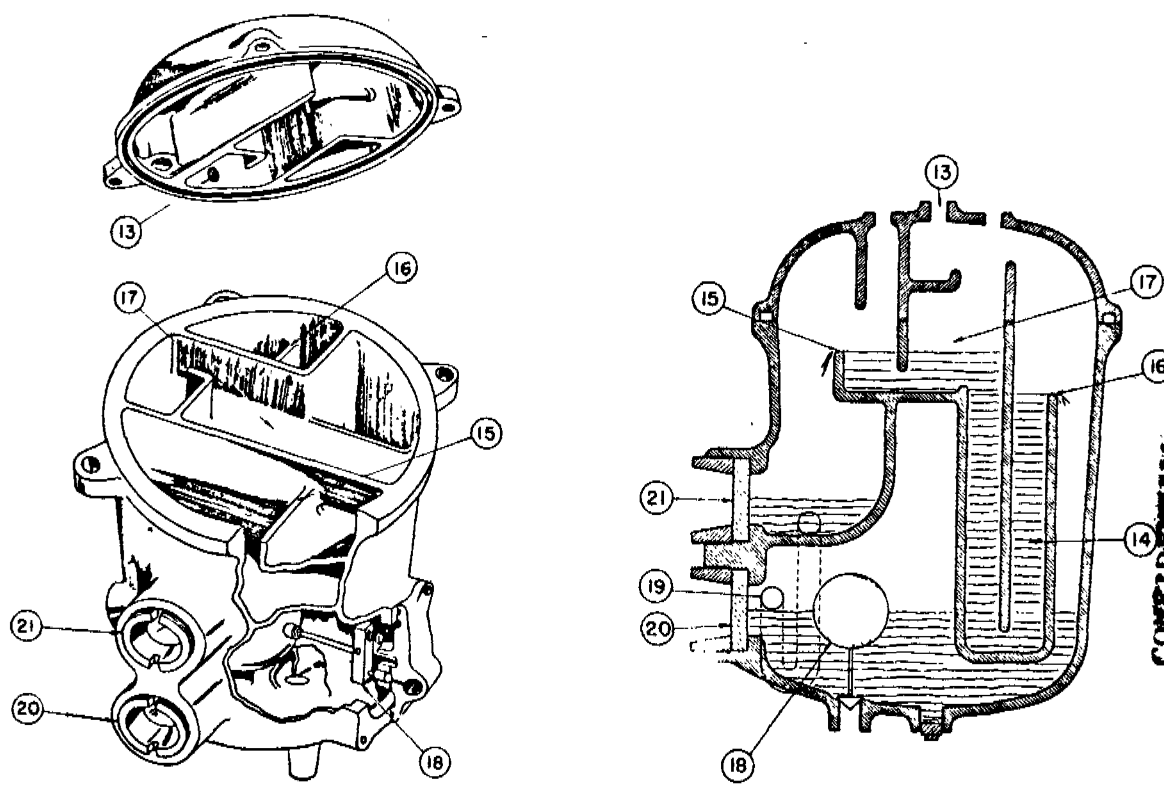
NOTES:

1. Starter wiring diagrams shown are suggestions only. Check starter manufacturer's wiring diagrams for details.
2. 220 volts is the maximum voltage recommended in the purge unit control circuit. If a higher voltage motor is used, a transformer reducing from the line voltage to 110 volts for the control circuit is recommended.
3. 220 volt, 3 phase motors are the standard for the purge compressor.
4. 110 and 220 volts, single phase; 208, 220, 440 and 550 volt, 3 phase motors are available for the purge units. Specify voltage and current characteristics in purchase order to factory.

TYPE "L" PURGE UNIT WIRING DIAGRAM



TYPE "L" PURGE



PURGE SEPARATION CHAMBER

Brine Storage Tank - 62A-60-618- The brine storage tank is a 5' OD tank by 6'0" high. The total capacity of the tank is 880 gallons. The tank is designed for atmospheric storage. The tank is designed to hold the contents of the brine system, so the tank should be nearly empty the majority of the time. The tank cannot float against the line as it will overflow. The brine strength should be maintained to give a freezing point of around -40° F. The caustic strength should be from 0.2 to 0.3 and chromate strength 0.4 to 0.5 as $Na_2Cr_2O_7$.

Brine Circulation Pumps - 62A-55-867 and 868 - The brine circulation pumps are Gould's 3196 size 2 x 3-6. The pump end is ductile iron. The impeller is 5 5/16" which will pump 225 GPM at 100' head. The shaft has a SS sleeve. The motor is 15 HP, 3500 RPM. The seals are John Crane, type 9, internally mounted.

OPERATING CONTROL — MANUAL

There are listed below three methods for controlling the capacity output of a machin .

~~1. Controlling the speed of the compressor.~~

2. Throttling the suction of the compressor.

3. Increasing the discharge pressure of the compressor.

The three methods above are given in order of their efficiency. At partial loads the power requirements will be least if the compressor speed is reduced - not quite as low if the suction is throttled - and highest if the condenser water is throttled to increase the discharge pressure.

Speed Control (No. 1) may be effected in various ways depending on the type of drive. On machines driven by turbines, speed may be adjusted by means of the manual speed control in the turbine governor system.

On machines driven by wound rotor (slip ring) induction motors, speed is adjusted by means of a drum controller which inserts different amounts of resistance in the rotor.

On machines driven by DC motors, speed control is obtained through altering the field strength by means of inserting or removing resistance.

On machines driven by constant speed motors of the squirrel cage or synchronous types, variation of the compressor speed may be altered only through the use of a magnetic slip coupling or a hydraulic coupling. Separate description and operating instructions will be furnished for the specific type used.

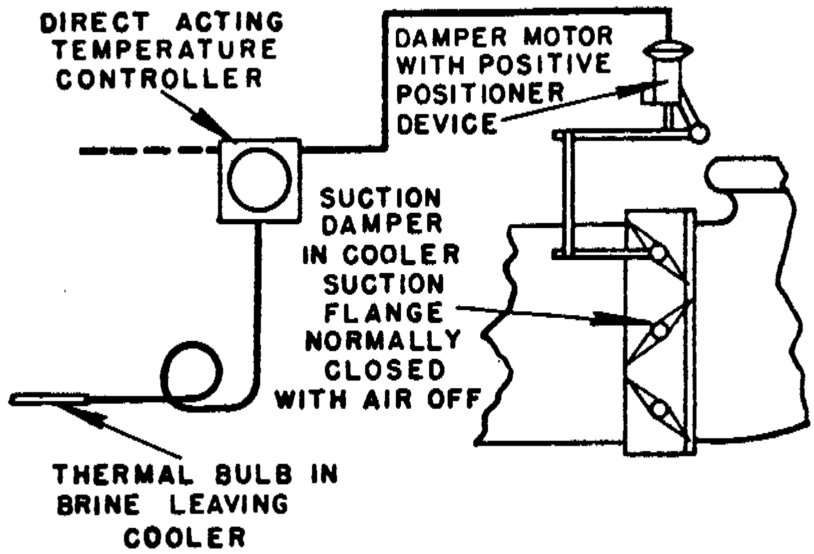
Suction Damper Control (No. 2) is obtained by means of a throttling damper built into the cooler suction flange. By throttling the compressor suction, the pressure differential through which the compressor must handle the refrigerant vapor, is increased. The centrifugal compressor has a very flat characteristic, i.e., the pres sure differential against which it will deliver, is definitely limited by the speed at which it is running. Consequently, increasing the differential will result in a decrease in the amount of refrigerant pumped. Therefore, throttling of the suction of the compressor is a very effective method of capacity control.

Suction damper control requires somewhat more power at partial loads. This is som - times over-balanced by its effectiveness in maintaining stable (non-surging) operation to lower loads than the variable speed control. For this reason, some machines are equipped with dampers even though the main control has variable speed.

Condenser Water Contròl (No. 3) is very seldom used. When machines are arranged to use city water or other costly water for condensing purposes, it has advantages. Again the flat compressor characteristic explained under *Suction Damper Control* above, makes the condenser water throttling control possible. By throttling the condenser water, the condenser pressure is increased. This increases the pressure differential on the compressor and reduces the capacity.

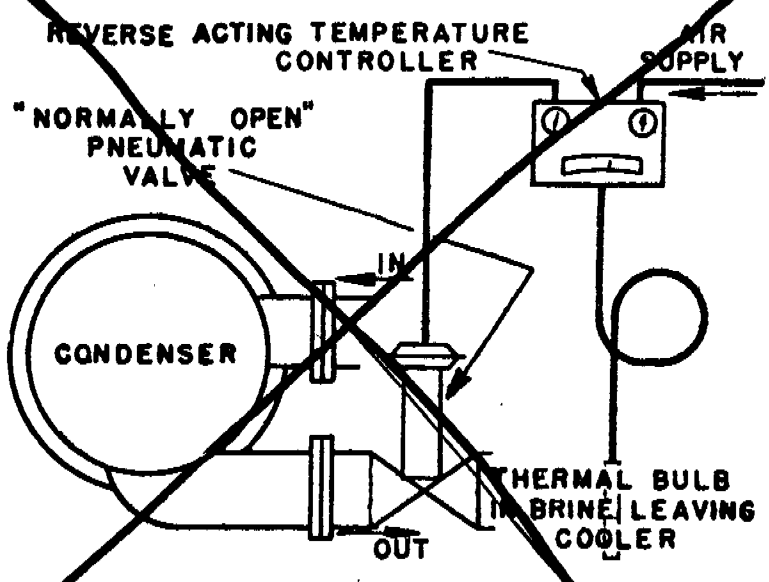
Occasionally the lowest speed available by means of the variable speed control furnished, may be insufficiently low to meet the operating conditions. In such a case the condens r water may be throttled and the c mpressor speed requirement brought up into the range of the speed control.

Automatic Suction Damper Control - Synchronous or Squirrel Cage Motor



For automatic damper control, a temperature controller regulates the degree of damper throttling by supplying to or bleeding air from a pneumatic damper motor.

Automatic Condenser Water Control - Constant or Variable Speed Motor Drive



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For automatic Condenser Water control, a "normally open" Diaphragm valve in the condenser water discharge is automatically positioned in response to changes of the delivered brine temperature. This is done by means of a Reverse Acting temperature controller which supplies air to or bleeds air from the valve diaphragm. A similar control may also be applied with the bulb in the leaving condenser water for conservation when water is scarce or expensive.

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BY-PASS - HOT GAS TYPE

One of the characteristics of a centrifugal compress is the fact that the compressor will "surge" if the suction volume is reduced below a certain limit. Surging will occur when the evaporator does not carry a large enough load to evaporate a sufficient amount of refrigerant. Surging of a centrifugal compressor is perfectly natural. Occasional surging will not damage a centrifugal compressor, however, continued surging will heat up the compressor and may ultimately cause high bearing temperatures. The operating efficiency of the compressor during periods of surge is extremely low and the effective temperature lift that can be achieved is reduced. For this reason a hot gas by-pass when desirable is installed between the condenser and the evaporator to keep the compressor out of the surge region. See note at end of this section. The by-pass should only be operated when necessary, that is, when the compressor would otherwise begin to surge. As soon as the load has increased beyond the surge point, the by-pass should be closed.

Since the gas leaving the condenser is hot, continual by-passing of this gas might cause the compressor to overheat. For this reason, an automatic liquid injection device is connected to the by-pass and th temperature of the gas is reduced by flashing liquid refrigerant into the gas stream.

Each autom... liquid injection system com...ises a pair of flanges (one of which is special) in the hot gas lir. a liquid line from the condenser to the special flange, and a liqu line strainer with two shut-off valves.

As the by-pass valve is opened, a pressure drop will exist across the orifice which is a function of the rate of gas flow through the orifice. In other words, the higher the flow of hot gas through the by-pass and orifice, the lower the pressure below the orifice will become in relation to condenser pressure, and the greater will be the available pressure drop to force desuperheating liquid through the liquid line. Thus, as the amount of hot by-pass gas is increased or decreased with operation requirements, by opening or closing valve, the amount of desuperheating liquid forced through the liquid line is correspondingly and automatically increased or decreased.

The two shut-off valves (G) in the liquid line (E) are normally to be left wide open and will be closed only to service or clean the dirt strainer (H). It should be noted that the special flange (D), through which the liquid enters the hot gas stream, just below the orifice (Plate F), is installed at a slightly higher level than the surface of the liquid lying in the bottom of the condenser. Thus, when no hot gas is flowing through the by-pass, there will be no liquid flow.

The special flange is used merely to provide a means of distributing the liquid into the hot gas stream, below the orifice, as evenly and as finely as possible. The flange is made with a groove in one face, for the circumferential distribution of liquid. The liquid then enters the gas stream through a 1/8" wide slot, formed between the undercut inner face of the flange and the orifice plate.

<u>NOTE:</u> In some cases it is possible for greater efficiency to use a partial by-pass, the condenser gas going to a compressor stage other than the suction, by means of the connection from an econ mizer.

REGULATOR, BACK PRESSURE, REVERSE ACTING POSITIONER	* CHANGED PER	ADDED	SUPERSEDES: NO. SEE NOTE 2	TO DATE

MFG'D BY: BLACK, SIVALLS & BRYSON INC.

MFR'S TYPE: 70-11-2-R

STYLE: DOUBLE PORTED NORMALLY CLOSED DIAPHRAGM SPRING LOADED CONTROL VALVE

TYPE: VALVE TO CLOSE ON AIR FAILURE. TOP & BOTTOM GUIDED THROTTLE PLUG.

NORMAL OPEN AIR PRESSURE: VALVE TO CLOSE AT 9#, FULLY OPEN AT 3# ON DIAPHRAGM

MAX. STATIC PRESS. ON BODY: 175 PSI AT 100°F.

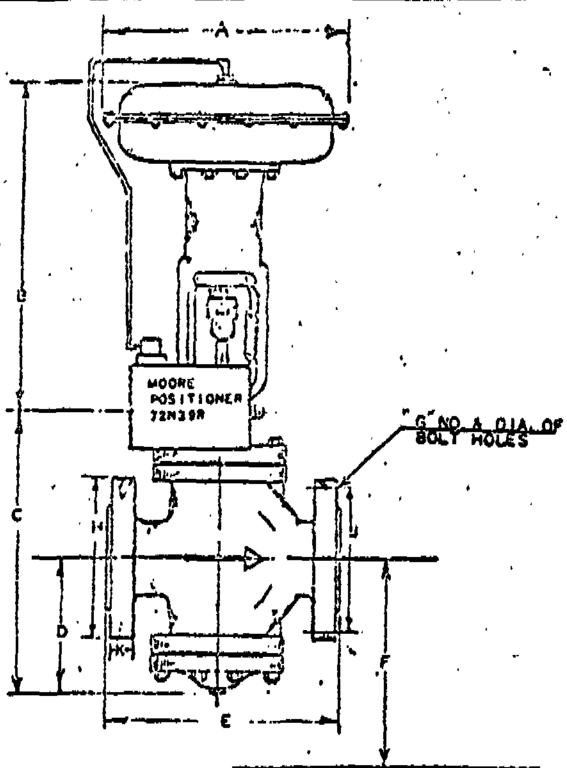
MAX. INLET PRESS.: 125 PSI AT MAX. TEMP. OF 360°F.

SERVICE: REFRIGERANT 11, 12, 113

MATERIAL: BODY – 125 PSI FLANGED CAST IRON, STAINLESS STEEL TRIM
STEM – STAINLESS STEEL
PACKING – TEFLON
DIAPHRAGM – BUNA "N" WITH NYLON FABRIC INSERT

NOTES:
1. VENDOR TO ATTACH OPERATING INSTRUCTIONS ON EACH UNIT.
2. SUPERSEDES EF67MP481 TO EF67MP791 DATED 3/24/61 ISSUED FOR PURCHASING ONLY.
3. FLANGES TO BE IN ACCORDANCE WITH ASA B16.1.

STANDARD PART NO.	SIZE	DIMENSIONS									
		A	B	C	D	E	F	G	H	J	K
EF67MP481	2	$12\frac{5}{16}$	$21\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{3}{8}$	10	$20\frac{5}{8}$	$4-\frac{3}{4}$	6	$4\frac{3}{4}$	$\frac{5}{8}$
EF67MP601	3	$12\frac{5}{16}$	$21\frac{1}{2}$	$16\frac{1}{4}$	$7\frac{7}{8}$	$11\frac{3}{4}$	$24\frac{1}{2}$	$4-\frac{3}{4}$	$7\frac{1}{2}$	6	$\frac{3}{4}$
EF67MP711	4	$16\frac{1}{2}$	$21\frac{3}{4}$	$18\frac{7}{8}$	9	$13\frac{7}{8}$	$26\frac{1}{8}$	$8-\frac{3}{4}$	9	$7\frac{1}{2}$	$\frac{15}{16}$
EF67MP791	6	$16\frac{1}{2}$	$26\frac{3}{4}$	$23\frac{3}{4}$	$11\frac{5}{8}$	$17\frac{3}{4}$	$36\frac{3}{4}$	$8-\frac{7}{8}$	11	$9\frac{1}{2}$	1



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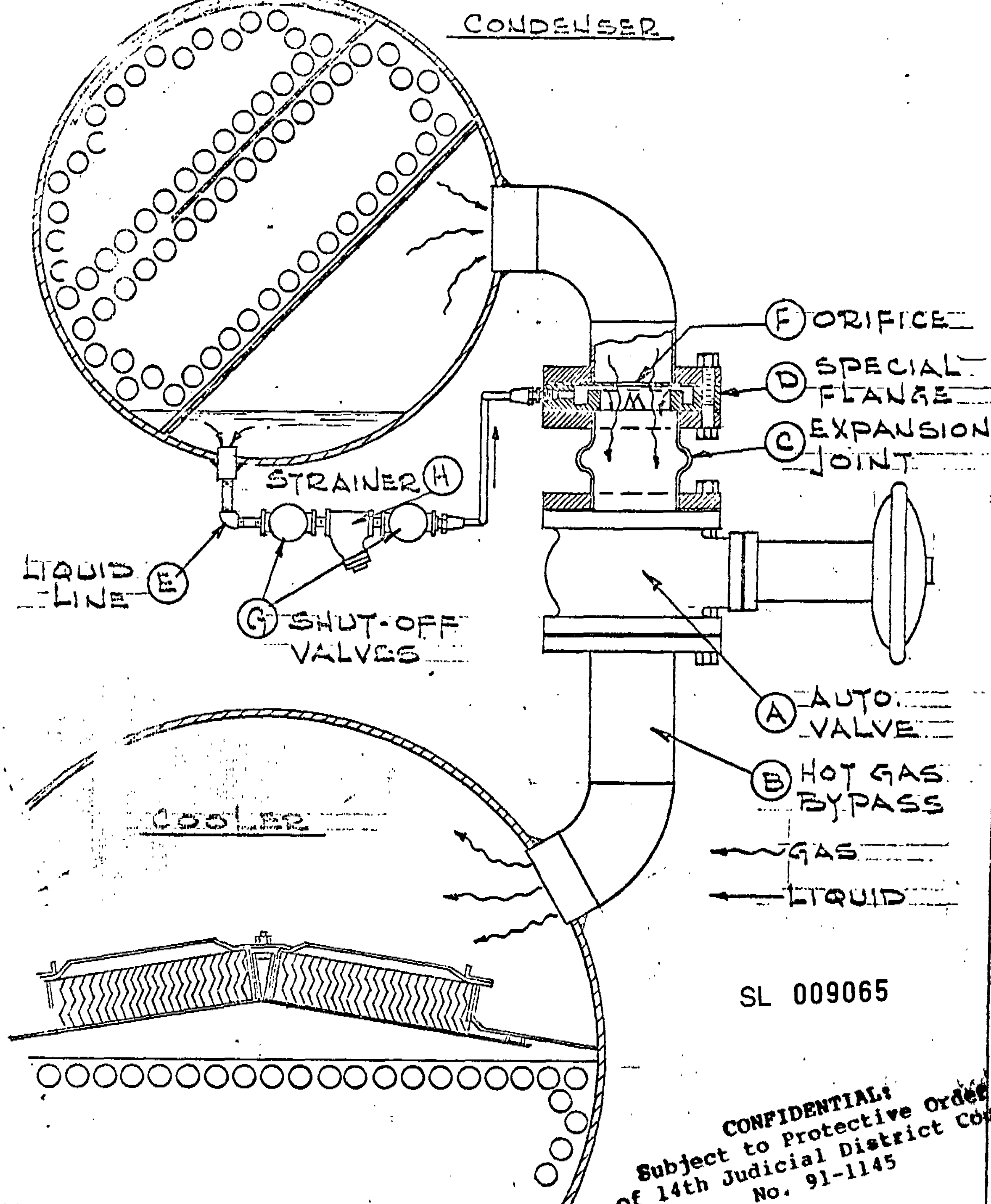
2.23 MACHINERY

CARRIER CORP. MUST BE NOTIFIED BEFORE ANY CHANGE IS MADE FROM THE CONSTRUCTION DEFINED BY APPROVED SAMPLES OR DWGS.

USED ON: 17 SERIES	PREP. BY: [signature]	APPD BY: [signature]

 ENGINEERING STANDARDS



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WN. DATE 8-28-57 CH'D. SCALE. AP'D. REV'D.	TITLE. AUTOMATIC HOT GAS BYPASS	Carrier SYRACUSE NEW YORK NO.

PART II - OPERATION

STARTING

GENERAL INSTRUCTIONS

1. Check oil levels, etc. for compressor, motor, gear, turbine, couplings, etc.
2. Start condenser water through condenser, being careful to avoid water hammer.
3. Start "brine" circulation through cooler, being careful to avoid water hammer.
4. Be sure air pressure is available for any air operated controls.
5. If a great deal of air is in the machine, run purge unit to remove it. This will practically never be necessary unless a vacuum of more than 10 inches has been broken by admitting air. In any case, start the purge recovery unit before starting the machine. To start purge recovery unit, open valves 3 and 21 (see description of purge recovery unit and also diagram) and turn starting switch on front of casing, to "On" position. The unit should be operated continuously while the main machine is running.
6. On synchronous motor driven machines, close suction damper only as far as necessary to start and then open damper as soon as compressor reaches full speed.

[redacted] ~~On turbine driven machines, warm the turbine by admitting a small amount of steam, (especially on the condensing type) not enough to turn the shaft, with all condensate drains open. Adjust the governor control valve to minimum setting and when all the drains blow steam, close contact on push button station, open the throttle valve and bring turbine up to this speed quickly. See turbine manufacturers instructions.~~

7. Start auxiliary oil pump

8. On motor driven machines, close holding circuit for safety controls by holding button on motor panel. 4 seconds
9. Bring machine up to speed, observing seal oil gauges to make sure oil pressure is developed. If oil pressure does not develop within 10 seconds, stop machine and re-start.
10. On automatically controlled machines, opening of the air supply to the controller causes the machine to come under the supervision of the automatic control. See Part 1, under the heading of "Operating Controls" and "Safety Controls".
11. Open cooling water valve supplying compressor oil cooler, gear or turbine oil cooler and seal jacket. The water to compressor oil cooler should be kept low until the highest bearing temperature reaches 130°. Then adjust to give 140° to 180° bearing temperature. Keep under observation, the temperatures of all bearings on compressor, gear, motor or turbine until they have leveled off at a satisfactory point.

Immediately after starting, there may be a period of surging until evacuation of air from the condenser has been completed. During this period, the machine should be run at high speed. The high speed will produce a high condenser pressure and accelerate the process of purging. However, the condenser pressure should not exceed 15 lb./sq. in. gauge during this period and the input current on the motor driven machines should not be run over 100% of the full load motor rating (see motor name plate). Do not overcool evaporator or non-freeze control will stop the machine. As soon as the machine has steadied and all air has been purged, the speed or damper may be adjusted to give the desired "brine" temperature.

If surging persists after all air has been purged and speed has been adjusted to give the desired brine temperature, it is an indication of a light load. Surging operation is perfectly normal for centrifigal compressors and is no cause for alarm. At very low loads, (10% to 20% of full load) surging will cause the compressor to overheat and bearing temperatures will go above normal. Continuous operation under such conditions is inadvisable. If continuous operation is desired under these extremely light load conditions a by-pass may be necessary.

ROUTINE OPERATION

To increase oil pressure, loosen the locknut on the regulator and turn the adjusting screw clockwise (tighten it). To reduce oil pressure, loosen locknut and turn screw counter-clockwise. Maximum pressure (at high speed) 25 lb. - minimum (at low speed) 8 lb. approx.

Adjustment of the amount of cooling water through the pump chamber coil, controls oil temperature. Bearing temperatures as shown on the bearing thermometers, ordinarily should be from 140° to 170°, but under some operating conditions may go beyond this range. Oil temperature should not be too low, to prevent excessive absorption, of refrigerant in the oil.

The oil filter should be replaced periodically depending on the service, but at least yearly as its main purpose is to protect the seal. The thrust housing strainer should be cleaned yearly.

Record the addition and removal of oil on the operating log so that the reasons for any excessive amounts can be investigated. Change oil yearly.

All oil valves are set and locked during factory tests on the compressor. Adjustment by the operator of any valves other than the pressure regulator should be made only after proper diagnosis.

See that oil is at proper levels in all parts of the oiling system as explained in the various instructions. At hairline when unit is down.

Do not permit cooling water to flow through the oil cooler or seal housing cover on shut down. This minimizes refrigerant absorption on the oil.

During shut-down, the oil will absorb refrigerant. The colder the oil the greater the absorption. The higher pressure during shut-down the greater the absorption. On start up, the pressure reduction may cause the refrigerant to boil out of the oil with resultant foaming. Excessive foaming is a possible cause of oil being carried into the refrigerant spaces. The electric heater minimizes these conditions.

CHECK ALL SAFETY CONTROLS PERIODICALLY, BUT BE CAREFUL NOT TO OVERCOOL THE BRINE CAUSING DAMAGE TO THE TUBES.

The three primary duties of the average operator are:

1. To adjust the refrigeration output to the requirements of the load with th use of the least power.
2. Maintain complete and clear records of the operating conditions including all temperatures, pressures, speeds, and control positions - also refrigerant and oil levels and amount of each when charged or withdrawn.
3. Inspect and maintain the equipment and furnish the necessary servicing such as lubrication, painting and simple adjustments.

In carrying out No. 1, the operator should know approximately at all times the amount of load being carried by the machine and should through experience have a general idea of the frequency, magnitude and time of load changes which normally occur. In this way he is prepared for many of the load changes and may achieve real economies by ither cooling down slightly before an increase in load so that the machine does not have to be pushed or by unloading and saving power before the load goes off.

To increase the output or reduce the temperature of brine being delivered by variable speed machines, it is only nec ssary to increase speed. To reduce output or raise temperature, reduce speed.

If circumstances arise (low load and cold condenser water) where the control cannot urther reduce speed but still less load or higher brine temperature is required, throttle the condenser water. This will raise the condensing temperature and require higher speed bringing the required speed within the range of the control. The output and delivered brine temperature of constant speed machines with suction damper control is regulated as follows: Open the damper to increase load or lower brine temperature. Close damper to reduce load or raise brine temperature. The damper should always be closed on starting.

On machines equipped with variable speed drive and suction damper control, it is often possible, at the expense of a slight increased power requirement, to stabilize the compressor at low load by partially closing the damper. At the same time the speed will have to be increased to counteract the pressure drop across the damper and still maintain the same brine conditions and load.

The problems of operation naturally increase when the refrigeration installation consists of more than one unit. To achieve the greatest economy, the output of multiple units operating together on the same load must be balanced.

To obtain a balance with multiple units, it is first necessary to balance the brine and condenser water rates so that the flow through each unit is proportional to its full load rating. For example, suppose the plant consists of two units; the smaller unit rated at 300 tons and the larger one at 500 tons. Suppose the total brine flow is 1600 gpm and the total condenser water flow is 2000 gpm. The total plant capacity is 800 tons. Dividing the total brine and water quantities by the total plant capacity, w obtain:

$$\text{Brine rate} = \frac{1600}{800} = 2 \text{ Gpm per ton}$$

$$\text{Condenser water rate} = \frac{2000}{800} = 2\text{-}1/2 \text{ Gpm per ton}$$

The flows of brine and condenser water should then be:

Brine Flows

Small Machine gpm =	300 x 2 =	600 Gpm
Large Machine gpm =	500 x 2 =	1000 Gpm
	Total	1600 Gpm

Condenser Flows

Small Machine gpm =	300 x 2-1/2 =	750 Gpm
Large Machine gpm =	500 x 2-1/2 =	1250 Gpm
	Total	2000 Gpm

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If flow meters are not available for making these flow adjustments, they may be made by observing the pressure drops across the coolers and condensers. The gauges used for indicating these pressure drops should be located so they read only the drop across the cooler or condenser and do not include any additional piping, valves, or fittings. For pressure drops not exceeding 15 lb. per Sq. In., one 36" mercury "U" tube may be connected across the coolers and condensers of one machine after another and the pressure drops recorded.

Due to the complexity of the calculations to obtain the relation between these pressure drops on multiple machine installations, it will be necessary for you to obtain this specifically for your installation. It is advisable to perform this balancing immediately after installation while the Carrier operator is available. He will assist you in th proper procedure.

~~When proper balance of flows has been made, the valve positions should be noted and whenever more than one machine is used the water and brine valve positions of the units operating should be so adjusted. The flow through other units should be shut off.~~

~~With the brine and condenser water flows of multiple machines adjusted in this manner, it is only necessary to adjust the individual machine speeds or damper positions so that the temperature difference (between entering and leaving brine) on all coolers in operation is alike. The temperature differences on condensers may also be used as a guide. The plant is then operating most efficiently since each machine is carrying its proportionate share of the load.~~

~~Increases in load should be taken by adjusting *each* machine to a higher output and reductions in load by adjusting *each* machine to a lower output. Always attempt to keep temperature differences alike. When load reduces the temperature differences across the coolers and condensers will become less. Experience will indicate when machines may be shut down and the load transferred to the remaining units, by increasing the output of *each*.~~

~~Automatically controlled machines will, of course, perform in the manner outlined above provided each controller is set for the same brine temperature and the brine and condenser flows are properly balanced.~~

~~Multiple machine installations of identical units, having identical ratings, need no balancing of water and brine flows. All valves of any unit may be opened wide as long as it is operating. The load should, of course, be divided equally between the units in operation as explained above.~~

PURGE RECOVERY UNIT AND REFRIGERANT LOSSES

The operation of the purge recovery system is automatic, once it is placed in operation by turning switch on side to "ON" position and by opening valves 1, 3, 21 and 22.

An increase in head pressure in the condenser, which pressure occurs either suddenly or gradually during operation (all other conditions of load, speed, temperature, etc., remaining uniform), indicates the presence of air. Observation of the difference between outgoing condenser water temperature and the temperature shown on the condenser gauge may also be useful in determining the presence of air, since an increase in this difference under the same circumstances as outlined above may be caused by air. Similarly, an increase in the cooler pressure (or decrease in the vacuum) over the pressure corresponding to the cooler temperature, during operation, may be caused by air.

The air should be removed by operation of the purge unit until normal pressures are re-established and the cause of any air leak found and corrected. The purge must be operated continuously when the main machine is operating.

Since some refrigerant leaves the purge recovery relief valve with the air purged, excessive air leakage into the machine will cause excessive refrigerant loss. The normal refrigerant loss for these machines depends on operating conditions. The type of operation, however, is something over which Carrier has no control. Therefore Carrier cannot assume responsibility for refrigerant losses.

Keep careful logs of refrigerant charged and the shutdown level in the evaporator. Excessive refrigerant loss ould be noted and the cause corrected.

If a machine operating with a pressure (not vacuum) in the condenser is perfectly tight or leaks only slightly during operation, but shows a large gain in air when shut down under vacuum for a few hours, a serious leak exists on the high pressure side of the system. Such a leak will leak outward during operation and will result in a refrigerant loss. It should, of course, be found and corrected.

The removal of moisture from the machine is even more important than the removal of air. This is also accomplished by the purge recovery unit. The source of moisture in a machine may be either humidity from the air leaking in or a small water or brine leak in cooler or condenser.

If any amount of water is removed by the purge, a leak is indicated. Air leakage, as indicated by high discharge pressure on the purge or discharging of air through the purge relief valve, can account for small amounts of water, since the air entering the machine will contain some moisture. If no air leakage is indicated, water in the purge is an indication of a direct water leak. All leaks must be repaired immediately, or serious damage to the tubes and other internal machine parts will result.

The purpose of the purge is to indicate leaks, not to pump air and water through the machine. A continuous water leak is dangerous, even though the water is continuously removed. Corrosive products entering with the water cannot be evaporated and removed.

Pressure reducing valve 2 (See Purge Diagram) must be adjusted to produce a suction pressure on the purge recovery unit, which will not allow condensation in the suction line between valve 2 and the purge recovery unit. If condensation occurs, the condensate will run into the crankcase of the purge recovery compressor, causing foaming and excessive oil loss. The table below is a guide for adjusting valve 2. When this valve is wide open, there exists a pressure drop of a few pounds across the valve. Consequently, the suction pressure cannot be adjusted higher than a few pounds below the machine condensing pressure.

The adjustment of relief valve 20 in the purge recovery unit must also be related to the room temperature for best refrigerant recovery. Adjustment may be made with a screw driver by removing the top of the purge recovery unit casing. For recommended pressures providing condenser pressure permits, see table below.

If large quantities of air, *without refrigerant*, are being removed from the machine (such as, after repairs, before recharging), the rate of removal may be increased by discharging the air from the water removal valve 19.

Room Air Temperature	65	75	85	95	105	115
Suction Pressure (Maximum allowable) By Adjustment of Valve 2	5" Vac.	0-lb. gauge	3.5 lb. gauge	7-Lb. gauge	Wide Open	Wide Open
Relief Pressure - By Adjustment of Valve 20	75-80	75-80	95-100	95-100	105-110	105-110

If liquid rises to the upper glass, normal delivery of refrigerant has ceased because valve 21 is closed or because the float valve is not opening. If liquid is not visible in the lower glass, the float valve is failing to close properly.

If any water collects, it will be seen on top of the liquid refrigerant, through this glass and it should be drained. The amount of water entering with air, is small. Accordingly, if an appreciable amount collects regularly, a leak in cooler or condenser has probably occurred which must be located and corrected.

Use the same oil in the purge compressor as is used in the main compressor. To add oil shut down the compressor, close valves 3 and 21, remove plug 24 in top of oil sight glass and add oil. Oil can be drained through plug 25. Check oil level daily. Oil level showing at any point in the glass with compressor running or shut down is satisfactory. Oil level is subject to considerable variation.

Check belt tension periodically to prevent slipping.

Check relief valve daily for tightness when closed to prevent loss of refrigerant.

Keep condenser clear of dust by brushing monthly.

High pressure cut-out shuts unit down if condenser pressure reaches 110 lb. for any reason.

CAUTION: It automatically remakes contact to start unit on 75 lb.

Single phase motors have "in-built" thermal overload stopping motor on overload.

CAUTION: This automatically re-sets itself to start motor after a few minutes.

SAFETY CONTROLS

Instructions for adjustment is printed on, or inside, each cut-out device on the panel.

The usual settings, which are subject to considerable variation are as follows:

Low oil pressure A cuts out at 6 lb. and in at 12 lb.

High condenser pressure B cuts out at 15 lb. and in at 8 lb.

Refrigerant temperature cut-out C is set by the erecting engineer after operation according to each job to cut out slightly below the minimum design temperature with proper regard to freezing point of the "brine" used. It cuts in on a rise of several degrees. The chilled water or "brine" temperature cut-out D is set after operation to cut out slightly below minimum leaving chilled water temperature. It cuts in on a rise of several degrees. The performance of these controls should be observed during operation and should be tested at least yearly to insure correct functioning.

Operation

The only difference in motor and turbine panel functioning is due to the different methods that must be used in shutting down a motor and a turbine. In the case of the motor, it is simply necessary to shut off the power by electrically de-energizing the low voltage release. In the case of the turbine, it is necessary to shut off the steam by mechanically tripping the overspeed mechanism. In each case, low compressor oil pressure, high condenser pressure, low refrigerant temperature and low leaving chilled water or "brine" temperature will shut down the machine. Low oil pressure may damage bearings and seal -- high condenser pressure may cause overloading of compressor, gear or motor and may result in damage to condenser. Low refrigerant or "brine" temperature may cause bursting of tubes due to freezing. Therefore, it is necessary to limit operating pressures and temperatures.

With the *motor* driven machine, as far as the safety controls are concerned, on starting the only operation is to hold momentary contact button P, which shorts out the low pressure cut-out since, until the compressor is running, no oil pressure exists and contacts A are open.

~~With the *turbine* driven machine due to the necessity for the latch and the solenoid, the operation on starting requires several movements. The sequence of operation is as follows: Refer to diagrams on "SAFETY CONTROLS" in descriptive section.~~

~~The first step will always be to close the fused disconnect switch. This provides current to the control circuit system.~~

~~The next step is to push the start button in the start-stop pushbutton panel Q-R. The start button is of the momentary contact type with a spring release. The start button closes a circuit from the line through the "brine" temperature safety device, through the refrigerant temperature safety device and the condenser pressurestat and completes the circuit through coil No. 2 in the mechanical latched relay M. This coil is energized only momentarily. As soon as the relay has shifted its position, coil 2 is automatically cut out of the circuit. After the start button is pushed, the circuits which are complete are from one side of the line through the brine refrigerant and condenser safety devices through the mechanical latched relay by means of contacts E and F through the stop button and into the solenoid trip mechanisms. This ties into the other side of the line. And, therefore, the solenoid is energized and the plunger is pulled up. This [illegible] the turbine trip lever. The other circuit which is complete is from contact C in the mechanical latched relay through the pilot light and then through the pilot light and then through contacts A and B to the other side of the line. The oil pressure switch is [illegible] these conditions. (See Sketch 1).~~

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After the start button has been push d and the relay assumes the position described above, the operator manually sets the turbine overspeed trip mechanism. There is no mechanical connection between the overspeed trip mechanism and the solenoid plunger which operates it. After the trip mechanism has been set by hand the operator is free to manipulate his steam valves, casing drains and any other equipment necessary. When the turbine has been satisfactorily warmed up and drained of condensate, the operator may bring the turbine compressor unit up to operating speeds, as outlined in the standard operating instructions. As soon as compressor oil pressure has developed, a circuit is completed through the oil pressurestat into coil No. 1 through contacts A and B of the mechanically latched relay. When this coil is energized, the m chanically latched relay shifts position to that shown in Sketch 2. This breaks the oil pressure by-pass and cuts the oil pressurestat into the control circuit. The solenoid is held in the up position by the circuit going through contacts G and H through the stop button and into the solenoid coil and then back to the line. The pilot goes out and the contacts are made which sets up the connections ready for the operation of coil 2 when the start button is pushed.

If any one of the safety devices opens, the solenoid plunger is released and the turbine speed trip is given a sharp mechanical blow which releases the valve and, if it is present opens the vacuum breaker. If the condition clears itself immediately, the control circuit assumes a safe position and the solenoid plunger is re-energized. Howev r, the overspeed trip mechanism must be reset manually before further operation is possible.

If the pilot light L remains on, it is an indication that the compressor oil pressure has not reached a satisfactory operating point.

If the start button is pushed during the operation of the unit with all of the safety devices in a safe position, all that will happen is that the relay will shift to th starting position and immediately snap back to the run position. There is sufficient overlap in the contacts E, F, G and H so that this should cause no difficulty or interruption of service.

The unit may be stopped during a normal shutdown by just pushing the *Stop* button which momentarily breaks the solenoid circuit causing the plunger to fall. Or, the steam throttle valve may be closed manually or the overspeed trip mechanism released manually. Regardless of the method used, as soon as the compressor has reached a low enough speed so that it is not maintaining satisfactory oil pressure, the safety control circuit will function in its normal manner and release the solenoid plunger. This means that the turbine overspeed trip mechanism must be reset at every start-up of the equipment.

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REFRIGERANT

In ordering refrigerant, be sure to specify Carrene No. 2. Other refrigerants are used in different types of Carrier machines.

CHARGING REFRIGERANT

CAUTION: At temperatures above 74°F. the drum will be under pressure. Therefore to prevent loss of refrigerant or personal injury, never open drums to atmosphere when above this temperature.

While it is possible, when the refrigerant in the drums is below 60° F., to charge from an open drum without loss, it is recommended that a leakage-tight connection be made from the drum to the charging valve on the side of the cooler. To assist in this procedure, a special type of plug is furnished in the side of each drum.

This is a 2" plug in which is inserted a smaller 3/4" plug. Inside the drum, covering his 3/4" opening is a friction cap similar to a bottle cap. This cap prevents leakage nto or out of the drum when the 3/4" plug is unscrewed and removed.

TO CHARGE THE MACHINE WITH REFRIGERANT AFTER INSTALLATION, proceed as follows:

The machine will be under a high vacuum as required for the test and dehydration.

1. Make up a 3/4" nipple into a standard globe valve and *Close* the valve.
2. Remove the 3/4" plug described above.
3. Scre~ the valve with nipple into the opening, turning it in far enough to push off the inside cap. Open the valve slightly for indication that the cap is off.
4. Elevate the drum in a horizontal position by means of a chain hoist or proper support, near the cooler charging valve and high enough to allow the refrigerant to flow, as a liquid, by gravity from the drum into the cooler charging valve.
5. Rotate the drum so that the valve is at the bottom.
6. Connect the two valves with a piece of copper tubing and the necessary fittings, making all joints tight.
7. Open both valves and allow the refrigerant to be drawn in by the vacuum of the machine.
8. When drum is empty, as determined by shaking it slightly, close valve on cooler and disconnect the drum. Remove the drum valve for use with the next drum.

TO ADD REFRIGERANT to a machine to bring the refrigerant level up to standard, proceed as above, or simply allow the refrigerant to be drawn in as a gas from the drum resting on the floor. The refrigerant can be added while the machine is in operation or idle.

See section on *Cooler* for proper refrigerant levels to be maintained.

It is a good plan to keep on hand enough empty drums to hold the entire charge of refrigerant in the event it is desired at any time to remove the refrigerant for repairs or for storage during seasonal shut-downs.

REMOVING REFRIGERANT OR TESTING FOR LEAKS

To remove refrigerant from the cooler, the following procedure is recommended. Inject air into the machine until a pressure of 5 lb. gauge exists, using the purge recovery system as outlined below. Connect tubing to the charging connection and allow the refrigerant to blow out into drum. In removing refrigerant, less loss will occur if the refrigerant is cold. Always l ave space in the drum for expansion to prevent excessive pressure when the drum warms up.

The purge recovery system can be used to develop an air pressure in the centrifugal machine for the purpose of removing refrigerant or for testing for leaks. See diagram of unit.

For this purpose, plugged tees 32 and 33 have been provided together with a separate connector pipe 34.

To build up a pressure in the machine with both the centrifugal machine and the purge recovery unit shut-down, proceed as follows:

Open valve 22 to drain any water that may be in evacuator chamber, and to relieve the pressure in it. Leave valve open.

Close valves 3 and 24.

Remove plug from 33 admitting air to the centrifugal machine and breaking vacuum.

Connect pipe 34 to 33 and to the water drain connection at bottom of cabinet, as shown by dotted line in diagram.

Remove plug from 32.

Close switch, placing purge recovery unit in operation. Continue operation until required pressure is reached (usually 5 lb. and not more than 8 lb.).

If air pressure is developed in the system for the purpose of testing for leaks while the system is charged with refrigerant, the air should always be evacuated through the purge recovery system to conserve refrigerant, as follows:

Stop purge recovery unit.

Close valves 25 and 22.

Remove pipe 34 and replace plugs in 32 and 33.

Open valves 3, 24 and 25.

Start recovery unit and evacuate air.

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COOLER AND CONDENSER

The only operating duties pertaining to the brine cooler and condenser are:

1. Maintaining the proper refrigerant level in the cooler.
2. Maintaining the tubes of both cooler and condenser in an efficient condition.

The correct refrigerant charging level as indicated by the cross wire on the sight glass must be observed when the machine is shut down. The initial shut down level should not be lower than 1/2" below the cross wire.

Size Cooler	Charge in Lb.	Maximum Distance below Cross Wire for Minimum Level In.
3	700	15/16
4	700	1-1/8
5	800	1-1/8
6	1100	1-1/8
7	1200	1-1/4
8	1800	1-3/8
9	2000	1-1/2
10	2800	1-1/2
11	3800	1-1/2
12	5200	1-1/2

After the machine has been in operation for an indefinitely long time, the shut down liquid level will reach the values given in the above table, due to loss of refrigerant. When this condition has occurred, additional refrigerant should be charged into the system to bring the refrigerant shut-down level up to, but not higher than the cross wire.

Coolers should not be overcharged unless specific instructions are received from Carrier Corporation.

A method of determining whether the tube bundle of either cooler or condenser is operating efficiently or not is to observe the relation between the change in temperature of the condenser water or brine passing through the tube bundle and the temperature difference between the leaving water or brine and the refrigerant temperature. In most cases, the brine and condenser water rates (Gpm) are held constant. Under such conditions the temperature change of brine or condenser water is a direct indication of the load. The greater the load, the greater will become the temperature difference between the leaving water or condenser cooler "brine" and the refrigerant.

The values of these temperature differences at full load should be noted when the machine is first operated, and a comparison made from time to time thereafter. As coolers or condensers become dirty or scaled on the water or brine side, the temperature differences between leaving water or brine will increase. An increase of more than 2° or 3° (at full load) indicates that cleaning of tubes should be undertaken.

In taking readings of the temperature difference between leaving condenser water and condensing temperature (read from condenser pressure gauge) always be sure no air is present in the condenser. The presence of air will greatly reduce the condenser efficiency. The purge unit should be in continuous operation for a day before readings are taken.

CARE OF TUBES IN COOLER AND CONDENSER

Careful, regular attention to the condition of the tubes particularly in the condenser, is absolutely necessary not only for good performance, but to secure best possible life. Neglect, particularly during the first season of operation after installation,

SHUT-DOWN PERIODS

There are two types of shut-down periods:

1. The stand-by shut-down during which the machine must be available for instant use.
2. The extended shut-down during which the machine is definitely out of service.

STAND-BY SHUT-DOWN. During this type of shut-down:

1. The purge recovery compressor should be operated as necessary to keep the pressure in the machine slightly below atmospheric.
2. Care should be taken to keep the machine free of leaks.
3. If building up of machine pressure is due to a warm machine room rather than the leakage of air into the machine, a small quantity of water below 70° circulated through the cooler or condenser either intermittently or continuously will hold the machine pressure below atmospheric, or sufficient cooling effect can be obtained from periodic operation of the purge recovery unit to accomplish the same result.
4. Unless other reasons prohibit (electric service demand charge or lack of steam), the machine should be operated a few minutes only, once a week to circulate the oil and reduce the refrigerant temperature.

   CAUTION: *In following this instruction be sure the refrigerant temperature in the cooler is not lowered below the freezing point of the water or brine in the tubes.*
5. Maintain oil level in seal reservoir and in suction damper stuffing box.
6. Maintain machine room above freezing temperature.

EXTENDED SHUT-DOWN. If it is known that the system is free of leaks and the purge r -covery unit satisfactorily holds down the machine pressure, it is sufficient to follow the instructions for stand-by shut-down.

There are, however, additional precautions that should be taken when the machine is shut down for long periods:

1. If freezing temperatures are likely at the machine location, drain all wat r from compressor, gear and turbine oil coolers. Also, drain water from the condenser, cooler, seal jacket, steam condenser, pumps, piping, etc.
2. Under certain conditions during long shut-down, it is possible that the oil may become excessively diluted by refrigerant. A certain amount of dilution always occurs but the oil level in the pump chamber should not be allowed to rise into the rear bearing chamber. If this occurs, remove the entire charge of oil from the machine and tag motor switch or turbine accordingly.
3. In restarting after long shut-down periods, follow the instructions under the section on lubrication.

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INSTRUMENTATION

GENERAL

One of the major requirements in a plant like the HCl Plant is smooth, uninterrupted control of the plant streams in order to obtain specification grade product. A distillation column cannot be operated with varying flows. Columns can take hours to level out after an upset, and rapid changes in operating conditions can cause such upsets with resulting poor quality product. To obtain the desired type of control, the HCl Plant has been equipped with automatic instruments wherever practical.

A thorough job of instrumentation has been done on this plant, but certain points must be understood to get full and efficient use of the instruments. The instruments are the operator's tools, and how he uses them determines how efficiently the plant will operate and how good will be the quality of the product produced.

All important control points in the HCl Plant are transmitted to the operating room where they are continuously recorded or indicated. The first indication of trouble within the plant will generally be from these instruments. These should be continuously checked for indications of abnormalities. Most of the records and/or indicators will be read and logged on the data sheets.

The instruments serve as your safety guard. All points in the plant which can cause serious trouble or operating difficulties have been equipped with alarm devices to give warning when abnormalities occur. If an alarm sounds for any reason, it should be checked immediately. Do not ignore the warning system. It is there for your protection as well as for protection of the equipment.

ALARM SYSTEM

When an abnormality occurs, it will be alarmed by a horn blowing and by a flashing light on the panel board. Under normal operation, the warning lights will show green as long as a piece of equipment is in operation. If a high flow, high pressure, high level, etc., occurs, the horn will blow and the warning light will flash red. If a low flow, low pressure, or low level occurs, the horn will blow and the warning light will flash amber. Pumps are also connected to warning lights. As long as a pump is in operation, the light on the panel board will show green. If for any reason a pump is shut down or stops, the light will flash red. In almost all motors in the area, the alarm horn will blow in addition to the flashing light. The motors that are not connected to the horn are on intermittant service and not continuously operating units.

The horn will continue to blow and the light flash until an acknowledgement is made. This is done by pressing the acknowledgement button located at the bottom center of the panel board. When this button is pressed, the horn will stop and the light will stop flashing. But, until the trouble is corrected, the light will show either red or amber depending upon the nature of the trouble. When the correction is made it will change back to green.

CHECKING ALARMS

A failure in the alarm system could result in serious trouble. For this reason, the alarm system should be checked periodically to be sure it is functioning properly. To check it, pull out on the acknowledgement button and turn it to the high alarm. Check all warning lights to see if they show red. If they do not, there is either a burned-out bulb or a defect in the circuit - either of which should be corrected immediately.

Repeat this procedure for both the normal and low alarm position. Make this check at least once per shift. Safe operation depends upon this system's functioning properly.

RECORDER-CONTROLLER OPERATION

The recorder-controller instruments are Taylor Transcope Recording Receivers and are provided with manual and automatic operation. Under normal conditions, these will be operated on automatic control, but during start-up or shutdown, or possibly in the case of trouble, the manual control can be used. When on manual control, the process valve can be operated from the panel board by regulating the output pressure to the control valve with the set point adjusting knob on the lower right hand corner of the instrument facing.

The automatic valves go from full open to full close (or vice versa in the case of an air pressure closing valve) at an output air pressure variation of 15 to 3 psig. This pressure is indicated on the scale at the top of the controller (on the instrument facing at the panel board). The approximate opening of the valve is indicated by this scale, i.e. 9 psig output is half open, 6 psig and 12 psig are 1/4 and 3/4 open or vice versa depending on valve action. The output pressure will remain at the value set by the set point adjusting knob while the instrument is on manual control, and the valve opening will not vary.

When the instrument is on automatic control, the set point is adjusted to the desired control point by the set point adjusting knob. The instrument will then attempt to regulate the process to this control point by opening or closing the automatic valve. At proper control, the set point and the indicator pen will remain opposite each other. The opening or the closing of the automatic valve to maintain this condition will be shown by the variation in output air pressure.

The recorder-controllers can be readily switched from manual to automatic, or from automatic to manual control, but care must be exercised when doing this. If the indicated control point and the instrument set point do not correspond when the switch is made, a snap action of the automatic valve will occur. This will serve to upset the system as well as being hard on the instruments. The following procedures should be followed when making the transfer to avoid "bumping" the system during the change-over.

Manual to Automatic

1. Set the transfer lever at the "Seal" position. This isolates the control valve from the controller air circuits and seals the pressure that is on the control valve at that time.

2. Adjust the set point adjusting knob until the set pointer indicates the same output pressure as the output gauge.

3. Set the transfer lever to the "Automatic" position. The process is now on automatic control.

Automatic to Manual

1. Note the output pressure and then set the transfer lever at the "Seal" position.

2. Adjust the set pointer with the set point adjusting knob until it corresponds to the same pressure as noted in step one.

3. Set the transfer lever to the manual position. The process is now on manual control.

SET POINT CHANGES

The number one rule for operation of this type of plant is smooth steady control. The purpose of automatic instruments is to provide this control and they should be handled with this in mind.

The instrument set point can be set at the desired control point, and the instrument will regulate the control valve until this point corresponds to what is actually occuring in the process. By raising or lowering the set point, the control point is changed accordingly. It must be remembered though, that when a set point change is made, the instrument will attempt to correct for this change immediately. If a large change is made, this could result in complete opening or closing of the automatic valve which could be severe enough to upset the system. Use small stepwise adjustments and give the system time to "catch-up" before making the next step. This will result in a smooth change and little cycling of the process.

ELECTRICAL SYSTEM

The electrical ties in the EC plant are fairly straight forward. Dwgs. 62A-7100 shows the ties and typical circuitry necessary for each motor.

The only thing unique about the EC electrical system is the fact that the 13.8 KV source may come from either EDC or Per-Tri. Because of this many different arrangements may be used in feeding the organics area, see Dwg. 20A-901-1.

Normally the power for EC-HC1-VC will come from Per-Tri through breaker 0-408 and disconnect 0-503. The Per-Tri power comes from Powerhouse Bus #1. Air Circuit Breaker 0-309 in the EDC switch room will normally be closed with disconnect 0-502 open, the cable is hot but protected. Never keep the cable hot by opening 0-309 and closing 0-502, as any fault in the cable will cause the EC-HC1-VC plants to come down by opening 0-408. Until the H-138 feeder cable from the powerhouse to EDC is increased in size it will carry only EDC, Per-Tri, EC-HC1 but not VC. Before any tie that would connect EC-HC1-VC, when VC is operating, to the EDC cable the area supervision will have to determine the relative loads of the plants. In case of an emergency, leave the units down until the proper decision can be made by the area foreman.

Emergency ties may be made by the shift engineers until the VC plant if running. Anytime a tie is made, even though it is an emergency, be sure and take your time and do all things in proper sequence. Any omissions from safe practices are forbidden.

When the EC-HC1 bus loses power, the shift engineer should proceed immediately to the EC-HC1 switchroom and take a quick look at the 13.8 system, odor and a visual check of the general area will suffice. If ozone damage is present then finish shutting the plants down. If the trouble appears to be elsewhere:

1. Call Powerhouse Switchboard Operator (417), tell him you are switching load from PH Bus #1 to PH Bus #4.

2. Open disconnect 0-503 (feed from Per-Tri).

3. Close disconnect 0-502 (feed from EDC).

If power is back on the bus and stays on, then start back up the motors. If Power is not back, then nothing can be done. Per-Tri cannot be tied to the EDC bus without considerable delay as disconnect 0-404 is interlocked with the powerhouse OCB, i.e., the OCB in the powerhouse will have to be opened and the key removed and used to open disconnect 0-404. The same thing is true with the EDC disconnect 0-301.

Normal switching of the power source for EC-HCl-VC will be done by maintenance with the co-operation of operations. Although operations will never make this switch, it is well that they know how and serve as a double-check. The procedure is as follows:

1. Close 0-309 (in EDC) momentarily (be sure 0-502 is open), if it doesn't drop out, the cable from EDC to EC has no fault. Be sure 0-309 is open before proceeding.

2. Close 0-502 (in EC).

3. Call Powerhouse Switchboard Operator (417). Notify him that load is going to be switched from PH Bus #1 to PH Bus #4. The operator is to check and see that the synchronous tie breakers are closed. Then the powerhouse operator is to equalize the voltages on the two buses. The voltage meters that must be equal are the ones on the EDC and the EC buses in the respective switchgear rooms.

4. After voltages are equal, close 0-309 (in EDC).

5. Open 0-408 (in Per-Tri).

6. Open disconnect 0-503 in EC.

There are many other combinations of operating and switching that may be done. Each procedure is similar to the one given above. It is best to remember that all of this switching is done with 13.8 KV present and therefore any ties made into a faulted bus will cause some damage. Anytime a tie is made into a bus that might have a fault the consequences of the arcing damage must be weighed against the dangers of the plant having only emergency power.

LABORATORY PROCEDURES

HCl ANALYSIS (ORSAT)

1. Test: Total Impurities in HCl Product.

2. Apparatus:

   a. 500 ml. sample bottle connected to 1000 ml. levelling bottle.
   b. Fisher orsat.

3. Reagents:

   a. Dilute aklaline arsenite.
   b. Diphenyl carbazone - "chloride indicator".
   c. 0.3419 N $Hg(NO_3)_2$.
   d. Phenolphthalein indicator.
   e. 2.5 N H_2SO_4.
   f. Oxsorbent - O_2 determination.

4. Sampling and Procedure:

   a. Procedure for obtaining sample.

      1. Fill both tubes of sample bottle completely with alkaline arsenite.
      2. Purge sample line approximately 2-4 minutes.
      3. Connect sample line to tubing that runs to the bottom of sample bottle.
      4. Allow gas to bubble slowly into bottle, until at least 150 mls. of residual have been caught. (Mark on sample bottle.)
      5. Allow sample to reach room temperature before analyzing.

   b. Orsat procedure.

      1. Charge slow combustion pipette with 90 mis. of air.
      2. Connect sample bottle to orsat and raise levelling bottle above sample bottle.
      3. Lower levelling bulb on orsat and open stopcock of measuring burette first, then open stopcock on sample bottle. Then, by pinching the tube on the levelling bulb, transfer approximately 20 mis. of residuals to orsat and record as Reading "A". Discard through manifold. This will remove air from manifold system.
      4. Then transfer exactly 100 mls. of residuals to measuring burette and record as Reading "B". Transfer the 100 mls. to the oxsorbent pipette for storage.
      5. Measure remaining residuals and record as Reading "C". Discard through manifold. <u>Close off stopcock above slow manifold and the manifold from the atmosphere</u>. This step is important, in order to prevent contaminating sample with air. Readings A + B + C = Total Mis. Residuals ("D").

6. Return gas from oxsorbent pipette to measuring burette 2-3 times or until consecutive readings are obtain d. Record as Reading "E". Reading "B" - Reading "E" - Mis. O_2.
7. Turn on filament in slow combustion pipette.
8. Return all gas to oxsorbent pipette except 10 mls., which will be burned for H_2 determination.
9. After getting exactly 10 mls., pinch off tubing on levelling bulb and open stopcock slowly to slow combustion pipette and then the measuring burette. Very slowly allow gas to pass over hot filament until the 10 mis. have been introduced. Then, slowly run gas back and forth across filament 2-3 times. Turn off filament and allow gas and filament to cool before returning gas to measuring burette. Return and record as Reading "F". 100 - Reading "F" x 2/3 x Reading "E" - "G" (mls. H_2). Reading "E" - "G" - Mis. N_2.

IMPORTANT: If Reading "F" should exceed 15 mls., orsat should be checked for leaks and combustion step repeated.

c. Titration of HCl.

1. Drain alkaline arsenite from 500 ml. sample bottle to 1000 ml. levelling bottle. Wash sample bottle with distilled H_2O and drain into levelling bottle.
2. Pinch off tubing at exit of levelling bottle; dilute with distilled H_2O to the 1000 ml. mark. Stopper and shake.
3. Pipette 100 mls. of this dilution into a 250 ml. beaker. Add approximately 50 cc's of distilled water and 5-10 drops phenolphthalein indicator.
4. Titrate to clear end point with 2.5 N H_2SO_4.
5. Add 5-10 drops diphenyl carbazone bromphenol blue indicator and titrate to canary yellow end point with 2.5 N H_2SO_4.
6. Titrate to wine colored end point with 0.3419 $Hg(NO_3)_2$.
7. Mis. 0.3419 $Hg(NO_3)_2$ x 83.140 = Mis. HCl at 25°C for 100 ml. sample.

5. Calculations:

Per 100 mls. of 700 1000 dilution

Density HCl vapor at 25°C = 0.001501 g/cc "From Handbook of Physics"

$$\frac{\text{Titer} \times 0.3419 \times 0.0365 \times 700}{0.001501 \times 100 \times \frac{700}{1000}} = T \times 83.140 = \text{Mls. HCl at } 25^{\circ}\text{C ("H")}$$

A + B + C = D (Total mls. of residuals)
B = 100 ml. aliquot
E = Reading after O_2 absorbed
F = Reading after burning H_2
G = Mis. H_2 in 100 ml. aliquot
H = Mis. HCl
B - E = Mis. O_2 in 100 ml. aliquot

$$100 - \text{Reading F} \times 2/3 \times \text{Reading} \frac{E}{10} = \text{G Mls. } H_2 \text{ in 100 ml. aliquot}$$

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Reading E - G = Mls. N_2 in 100 ml. aliquot

To correct mls. of O_2, H_2 and N_2 found back to total volume residuals caught multiply mls. of each by:

$$\frac{\text{Total mls. Residuals (D)}}{\text{Mls Aliquot (100 mls.) (B)}} = D/B$$

Mls. O_2, H_2 and N_2 found x D/B = $\frac{\text{Total Mls. of Constituent x 100}}{\text{Total Mls. of Sample (D + H)}}$

= % Constituent

DATA SHEET

100 ml. sample.

*Mls. $Hg(NO_3)_2$ x 83.140 = ________ $\frac{\text{Mls. HCl (H)} \times 100}{D + H}$ = ________ % HCl

A + B + C = D ________ Total Mls. Residuals

D + H ________ Total Mls. Sample

** Aliquot: 100 Mls.

Use 10 mls. of aliquot for H_2 determination and 90 mls. of air.

$B - E = \text{Mls. } O_2 \times D/B = \frac{\text{Mls. } O_2 \times 100}{D + H} = \%\ O_2$

$100 - \text{Reading F} \times 2/3 \times \frac{\text{Reading E}}{10} = \text{Mls. } H_2\ (G) \times D/B = \frac{\text{Mls. } H_2 \times 100}{D + H} = \%\ H_2$

Reading E - G Mls. N_2 x D/B = $\frac{\text{Mls. } N_2 \times 100}{}$ = $\frac{\%\ N_2}{***100.00\%}$

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* This factor is good only when 700 mls. alkaline arsenite were used initially, diluted to 1000 mls. and 100 mls. of this dilution used to determine HCl.

** To correct mls. of O_2, H_2 and N_2 found back to total volume of residuals caught, multiply mls. of each found by D/B.

*** If total is more or less than 100.00%, add or subtract difference from % HCl.

Volume of HCl at 25°C

Mls. 0.3419 $Hg(NO_3)_2$

For 100 ml. sample - T x 83.140 = Mls. HCl at 25°C

Mls. Titer	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	8.314	16.628	24.942	33.256	41.570	49.884	58.198	66.512	74.826
1	83.140	91.454	99.768	108.082	116.396	124.710	133.024	141.338	149.652	157.966
2	166.280	174.594	182.908	191.222	199.536	207.850	216.164	224.478	232.792	241.106
3	249.420	257.734	266.048	274.362	282.676	290.990	299.304	307.618	315.932	324.246
4	332.560	340.874	349.188	357.502	365.816	374.130	382.444	390.758	399.072	407.386
5	415.700	424.014	432.328	440.642	448.956	457.270	465.584	473.898	482.212	490.526
6	498.840	507.154	515.468	523.782	532.096	540.410	548.724	557.038	565.352	573.666
7	581.980	590.294	598.608	606.922	615.236	623.550	631.864	640.178	648.492	656.806
8	665.120	673.434	681.748	690.062	698.376	706.690	715.004	723.318	731.632	739.946
9	748.260	756.574	764.888	773.202	781.516	789.830	798.144	806.458	814.772	823.086
10	831.400	839.714	848.028	856.342	864.656	872.970	881.284	889.598	897.912	906.226

For 50 ml. sample - T x 116.289 = Mls. HCl

Mls. Titer	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	16.629	33.258	49.887	66.516	83.145	99.773	116.402	133.031	149.660
1	166.289	182.919	199.548	216.177	232.806	249.435	266.064	282.693	299.322	315.951
22	332.578	349.209	365.838	382.467	399.906	415.725	432.354	448.983	465.612	482.241
3	498.867	515.499	532.128	548.757	565.386	582.015	598.644	615.273	631.902	648.531
4	665.156	681.789	698.418	715.047	731.676	748.305	764.934	781.563	798.192	814.821
5	831.445	848.079	864.708	881.337	897.966	914.595	931.224	947.853	964.482	981.111
6	997.734	1014.369	1030.998	1047.627	1064.256	1080.885	1097.514	1114.143	1130.772	1147.401
7	1164.023	1180.659	1197.288	1213.917	1230.546	1247.750	1263.804	1280.433	1297.062	1313.691
8	1330.312	1346.949	1363.578	1380.207	1396.836	1413.465	1430.094	1446.723	2463.352	1479.981
9	1496.601	1513.239	1529.868	1546.497	1563.126	1579.755	1596.384	1613.013	1629.642	1646.271
10	1662.890	1679.529	1696.158	1712.787	1729.416	1746.045	1762.674	1779.303	1795.932	1812.561

HCl ANALYSIS (H_2 ONLY)

1. Test: Percentages of HCl and H_2 in HCl Product.

2. Apparatus:

   a. 500 ml. gas burette with leveling bottle.
   b. Fisher Orsat (with slow combustion unit).

3. Reagents: Confining solution.

4. Sampling & Procedure:

   a. Sampling

      1. Place approximately 700 ml. of confining solution in the leveling bottle. Change confining solution once per week (Tuesday).
      2. Fill connecting tube by running small amount of confining solution into burette.
      3. Connect water bubbler tube and sample line to burette. Purge for about 5 minutes.
      4. Close stopcocks and sample valve so as to leave a slight pressure in burette.
      5. Vent burette to atmospheric pressure by rotating stopcock on small end until no "HCl fog" comes from burette.
      6. Allow confining solution to enter burette and absorb the HCl. Do not shake. Rock burette several times to bubble residual gas in confining solution.

   b. Orsat Procedure

      1. Transfer exactly 70.0 ml. of air into the slow combustion unit.
      2. Fill rubber connecting tube on burette and orsat sample tube with confining solution.
      3. Transfer all of residual gas to the measuring burette by bringing confining solution from 500 ml. gas burette into the orsat sample tube.
      4. Measure volume of residual gas and record as Volume A - (V_a).
      5. Turn on slow combustion unit filament and SLOWLY transfer residual gas into slow combustion unit. Make three more passes to and from combustion unit. Do not allow confining solution to come in contact with hot part of filament support column.
      6. Turn off filament and allow to cool to room temperature. KEEP CONFINING SOLUTION BELOW HOT PART OF FILAMENT COLUMN.
      7. Transfer entire volume of gas to the measuring burette. Allow liquid to drain from burette walls (about 30 seconds). Read and record as Volume B (V_b).

5. Calculations:

   Basis: 500 ml. sample size

a. Percentage of HCl

$$\% \ HCl = 100 - \frac{(V_a \times 2)}{10}$$

or read from Table I

b. Percentage of H_2 (Uncorrected for CO)

1. Contraction Volume = V_c

   V_c =)V_a + 70.0 ml.) - V_b

2. $\% \ H_2 = (V_c \times 2/3) \times 2/10$

   or read from **Table** II

TABLE I

Percentage of HCl

Basis: 500 ml. Sample Size

Volume A (ml.) (Residual Gas)

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
10	98.00	97.98	97.96	97.94	97.92	97.90	97.88	97.86	97.84	97.82
11	97.80	97.78	97.76	97.74	97.72	97.70	97.68	97.66	97.64	97.62
12	97.60	97.58	97.56	97.54	97.52	97.50	97.48	97.46	97.44	97.42
13	97.40	97.38	97.36	97.34	97.32	97.30	97.28	97.26	97.24	97.22
14	97.20	97.18	97.16	97.14	97.12	97.10	97.08	97.06	97.04	97.02
15	97.00	96.98	96.96	96.94	96.92	96.90	96.88	96.86	96.84	96.82
16	96.80	96.78	96.76	96.74	96.72	96.70	96.68	96.66	96.64	96.62
17	96.60	96.58	96.56	96.54	96.52	96.50	96.48	96.46	96.44	96.42
18	96.40	96.38	96.36	96.34	96.32	96.30	96.28	96.26	96.24	96.22
19	96.20	96.18	96.16	96.14	96.12	96.10	96.08	96.06	96.04	96.02
20	96.00	95.98	95.96	95.94	95.92	95.90	95.88	95.86	95.84	95.82
21	95.80	95.78	95.76	95.74	95.72	95.70	95.68	95.66	95.64	95.62
22	95.60	95.58	95.56	95.54	95.52	95.50	95.48	95.46	95.44	95.42
23	95.40	95.38	95.36	95.34	95.32	95.30	95.28	95.26	95.24	95.22
24	95.20	95.18	95.16	95.14	95.12	95.10	95.08	95.06	95.04	95.02
25	95.00	94.98	94.96	94.94	94.92	94.90	94.88	94.86	94.84	94.82
26	94.80	94.78	94.76	94.74	94.72	94.70	94.68	94.66	94.64	94.62
27	94.60	94.58	94.56	94.54	94.52	94.50	94.48	94.46	94.44	94.42
28	94.40	94.38	94.36	94.34	94.32	94.30	94.28	94.26	94.24	94.22
29	94.20	94.18	94.16	94.14	94.12	94.10	94.08	94.06	94.04	94.02
30	94.00	93.98	93.96	93.94	93.92	93.90	93.88	93.86	93.84	93.82

$$\% \text{ HCl} = 100 - \frac{Va \times 2}{10}$$

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TABLE II

Percentage of H_2 (Uncorrected for CO)

Basis: 500 ml. Sample Size

Volume C (Contraction)

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
10	1.33	1.35	1.36	1.37	1.39	1.40	1.41	1.43	1.44	1.45
11	1.47	1.48	1.49	1.51	1.52	1.53	1.55	1.56	1.57	1.59
12	1.60	1.61	1.63	1.64	1.65	1.67	1.68	1.69	1.71	1.72
13	1.73	1.75	1.76	1.77	1.79	1.80	1.81	1.83	1.84	1.85
14	1.87	1.88	1.89	1.91	1.92	1.93	1.95	1.96	1.97	1.99
15	2.00	2.01	2.03	2.04	2.05	2.07	2.08	2.09	2.11	2.12
16	2.13	2.15	2.16	2.17	2.19	2.20	2.21	2.23	2.24	2.25
17	2.27	2.28	2.29	2.31	2.32	2.33	2.35	2.36	2.37	2.39
18	2.40	2.41	2.43	2.44	2.45	2.47	2.48	2.49	2.51	2.52
19	2.53	2.55	2.56	2.57	2.59	2.60	2.61	2.63	2.64	2.65
20	2.67	2.68	2.69	2.71	2.72	2.73	2.75	2.76	2.77	2.79
21	2.80	2.81	2.83	2.84	2.85	2.87	2.88	2.89	2.91	2.92
22	2.93	2.95	2.96	2.97	2.99	3.00	3.01	3.03	3.04	3.05
23	3.07	3.08	3.09	3.11	3.12	3.13	3.15	3.16	3.17	3.19
24	3.20	3.21	3.23	3.24	3.25	3.27	3.28	3.29	3.31	3.32
25	3.34	3.35	3.36	3.38	3.39	3.40	3.42	3.43	3.44	3.46
26	3.47	3.48	3.50	3.51	3.52	3.54	3.55	3.56	3.58	3.59
27	3.60	3.62	3.63	3.64	3.66	3.67	3.68	3.70	3.71	3.72
28	3.74	3.75	3.76	3.78	3.79	3.80	3.82	3.83	3.84	3.86
29	3.87	3.88	3.90	3.91	3.92	3.94	3.95	3.96	3.98	3.99

TABLE II (Continued)

Percentage of H_2 (Uncorrected for CO)

Basis: 500 ml. Sample Size

Volume C (Contraction)

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
30	4.00	4.02	4.03	4.04	4.06	4.07	4.08	4.10	4.11	4.12
31	4.14	4.15	4.16	4.17	4.19	4.20	4.22	4.23	4.24	4.26
32	4.27	4.28	4.30	4.31	4.32	4.34	4.35	4.36	4.38	4.39
33	4.40	4.42	4.43	4.44	4.46	4.47	4.48	4.50	4.51	4.52
34	4.54	4.55	4.56	4.58	4.59	4.60	4.62	4.63	4.64	4.66
35	4.67	4.68	4.70	4.71	4.72	4.74	4.75	4.76	4.78	4.79
36	4.80	4.82	4.83	4.84	4.86	4.87	4.88	4.90	4.91	4.92
37	4.93	4.95	4.96	4.98	4.99	5.00	5.02	5.03	5.04	5.06
38	5.07	5.08	5.10	5.11	5.12	5.14	5.15	5.16	5.18	5.19
39	5.20	5.22	5.23	5.24	5.26	5.27	5.28	5.30	5.31	5.32

$$\% H_2 = \frac{(V_c \times 2/3) \times 2}{10}$$

$$V_c = (V_a + 70.0) - V_b$$

Volume A = V_a = Residual Gas Volume
Volume B = V_b = Volume after Combusti n
Volume C = V_c = Contraction Volume

HCl STRENGTH

1. Test: Acidity as HCl Grams/Liter - Effluent

2. Apparatus:

   a. 250 ml. beaker.
   b. 50 ml. graduated cylinder.
   c. 50 ml. burette.
   d. Stirring rod.

3. Reagents:

   a. 1.0 N NaOH.
   b. Phenolphthalein indicator.

4. Procedure:

   a. Measure 50 mls. of effluent water into 250 ml. beaker and add approximately 100 mls. distilled water.
   b. Add 5-10 drops phenolphthalein indicator and titrate to finest permanent pink color with 1.0 N NaOH.

5. Calculations:

$$\frac{\text{Mls. NaOH} \times 1.0 \times 0.0365 \times 1000}{\text{Sample Size}} = \text{g/l HCl} \quad T \times 0.73 = \text{b/l HCl}$$

SL 009096

HCl STRENGTH

Tentative

HCl Analytical Control Test

50 mls. Sample
1.0 N NaOH
T x 0.73 = g/l HCl
Mls: 1.0 N NaOH

Mls. Titer	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	0.07	0.15	0.22	0.29	0.37	0.44	0.51	0.58	0.66
1	0.73	0.80	0.88	0.95	1.02	1.10	1.17	1.24	1.31	1.39
2	1.46	1.53	1.61	1.68	1.75	1.83	1.90	1.97	2.04	2.12
3	2.19	2.26	2.34	2.41	2.48	2.56	2.63	2.70	2.77	2.85
4	2.92	2.99	3.07	3.14	3.21	3.29	3.36	3.43	3.50	3.58
5	3.65	3.72	3.80	3.87	3.94	4.02	4.09	4.16	4.23	4.31
6	4.38	4.45	4.53	4.60	4.67	4.75	4.82	4.89	4.96	5.04
7	5.11	5.18	5.26	5.33	5.40	5.48	5.55	5.62	5.69	5.77
8	5.84	5.91	5.99	6.06	6.13	6.21	6.28	6.35	6.42	6.50
9	6.57	6.64	6.72	6.79	6.86	6.94	7.01	7.08	7.15	7.23
10	7.30	7.37	7.45	7.52	7.59	7.67	7.74	7.81	7.88	7.96

HCl (FREE CHLORINE)

1. Test: Free Chlorine in HCl

2. Apparatus:

   a. 1 - 32 oz. clear sample bottle (wide mouth).
   b. 1 - 2-hole No. 9 rubber stopper fitted with polyethylene tubing.

3. Reagents:

   a. Ortho-Tolidine.
   b. Carbon Tetrachloride.*

4. Procedure:

   a. Fill 32 oz. bottle approximately half full with distilled water.
   b. Add 1-2 cc's Ortho-Tolidine and shake.
   c. Add carbon tetrachloride until a 1/4 to 1/2 inch layer is present on bottom of bottle.
   d. Insert polyethylene tubing from sample point into carbon tetrachlorine layer.
   e. Regulate flow to approximately 1-2 bubbles a second.
   f. The presence of a yellow color indicates the presence of free chlorine.
   g. If free chlorine is present, notify superviser.

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* Carbon tetrachloride liquid and vapor are hazardous. Avoid Prolonged contact with either. Use only with adequate ventilation.

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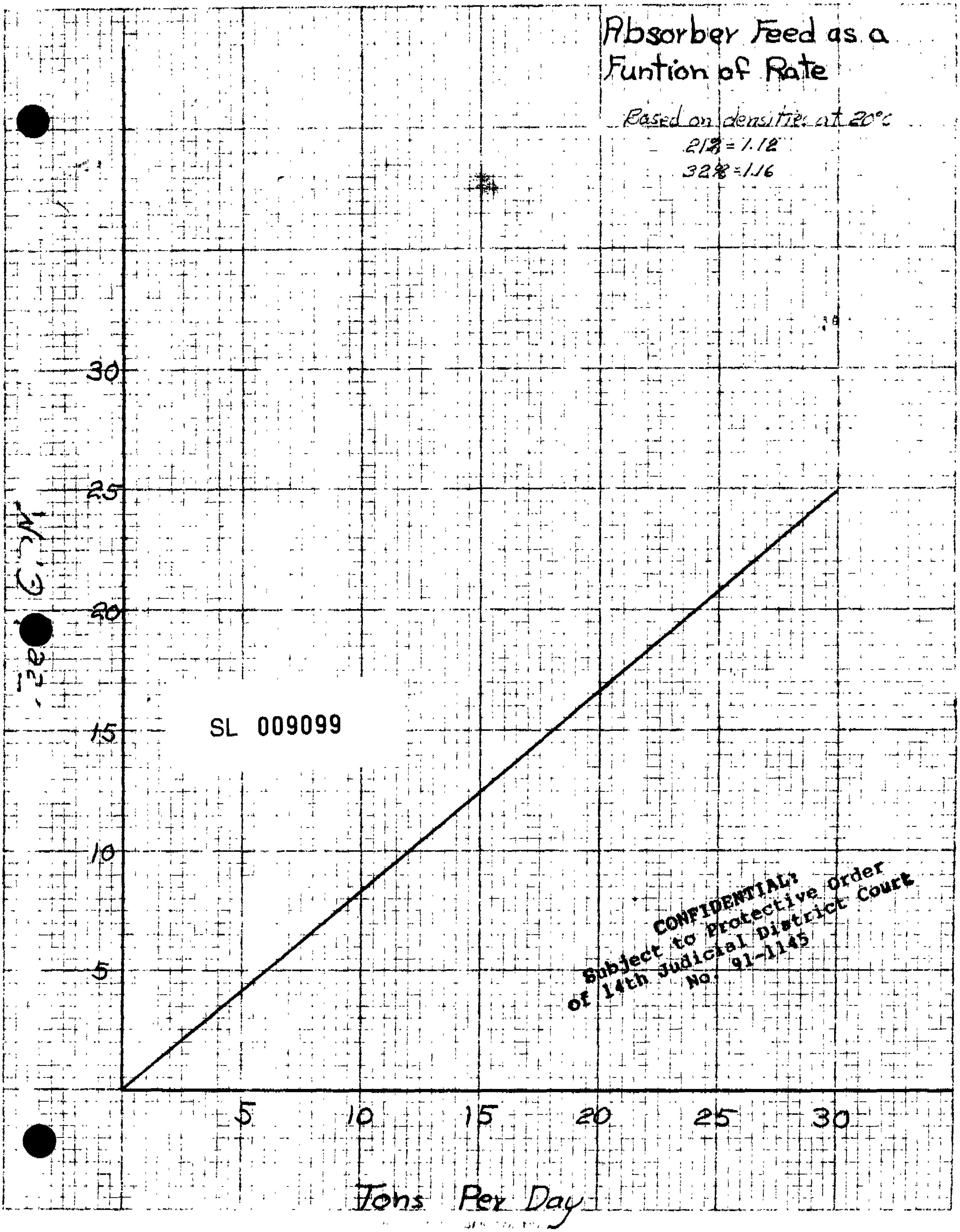
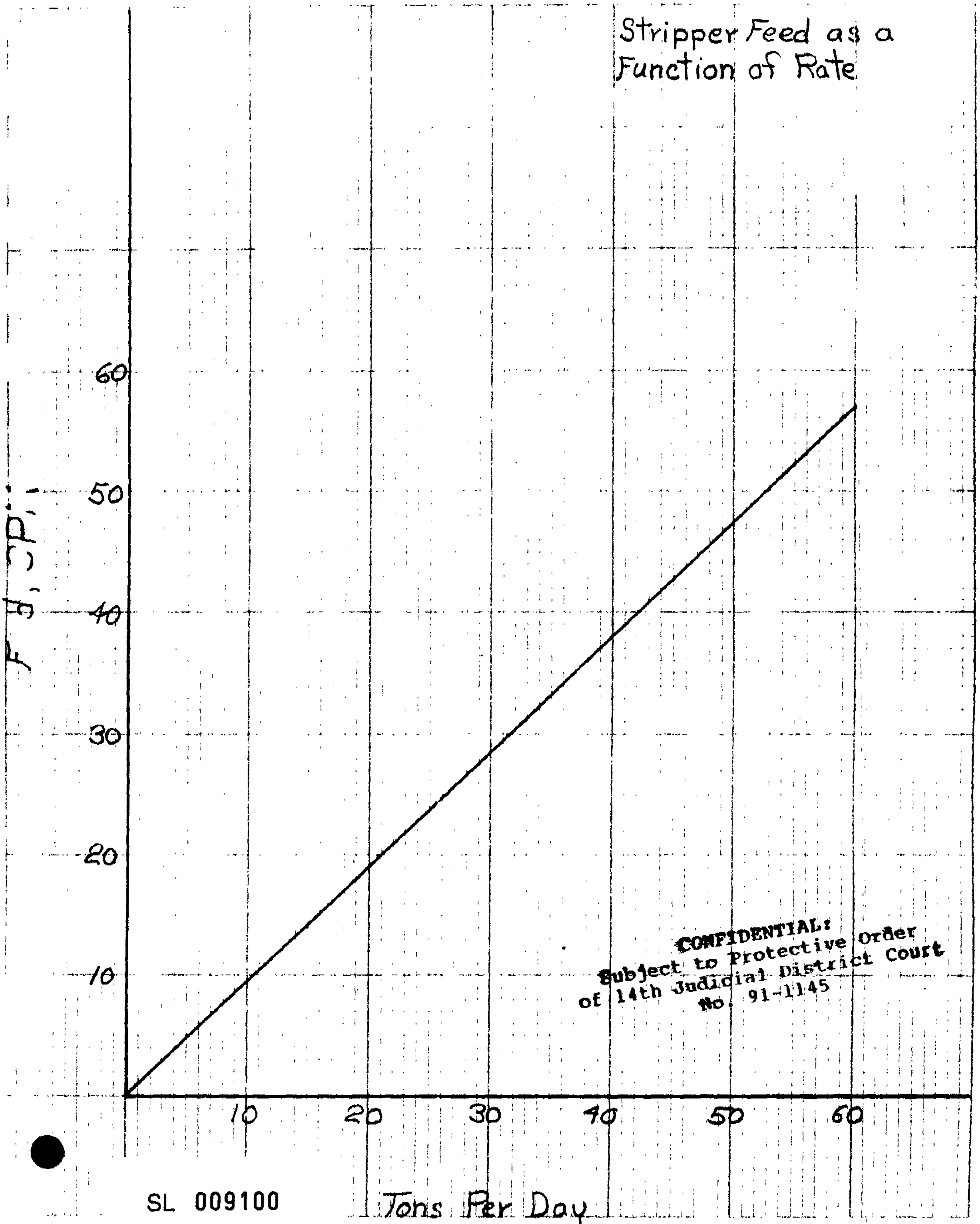
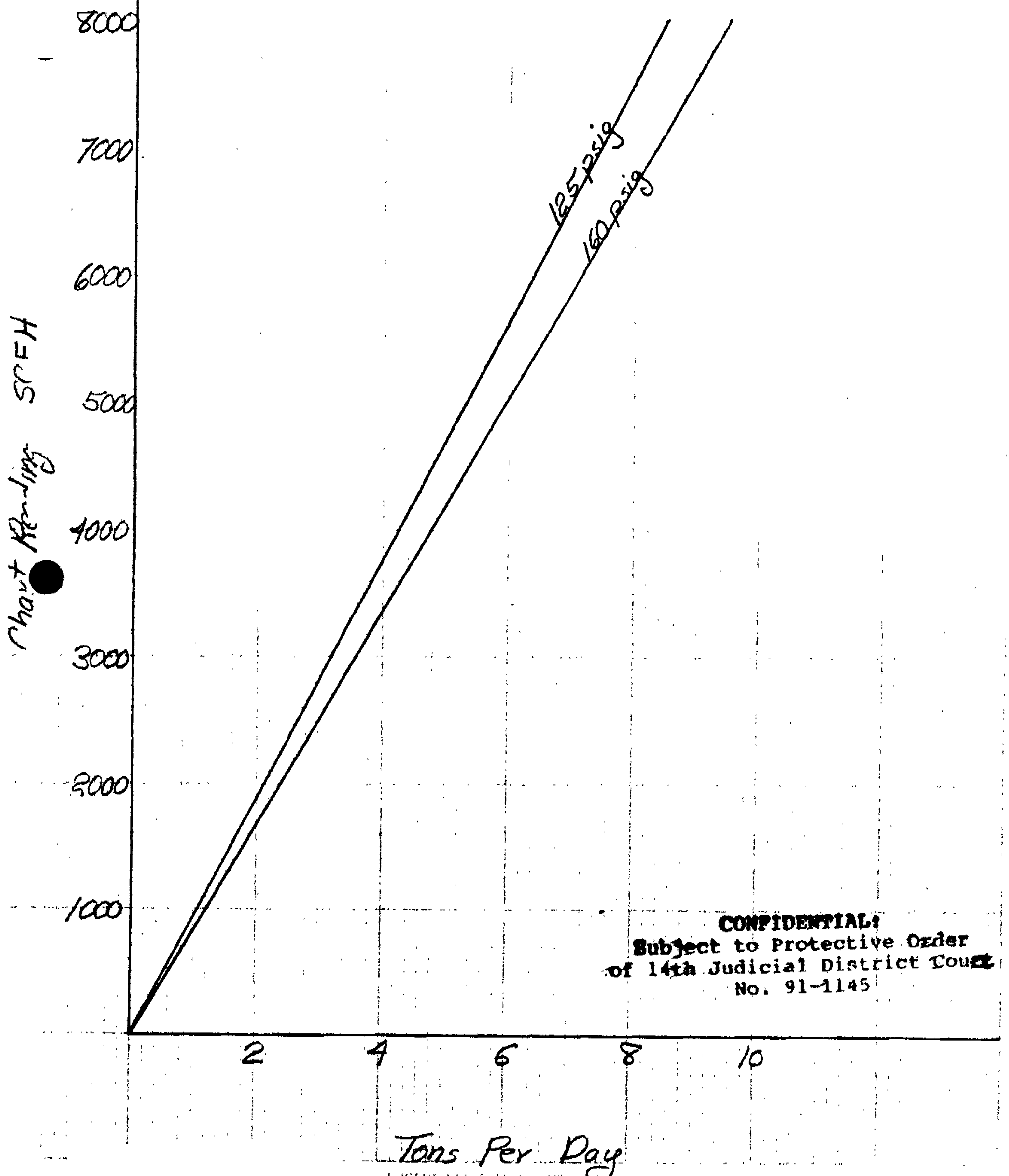

Absorber Feed as a
Funtion of Rate
Based on densities at 20°C
21% = 1.12
32% = 1.16
30
25
20
15
10
5
5
10
15
20
25
30
Tons Per Day


Stripper Feed as a Function of Rate
60
50
40
30
20
10
10
20
30
40
50
60
Tons Per Day

HCl Gas Recycle Stream
SCFH as a function of TPD



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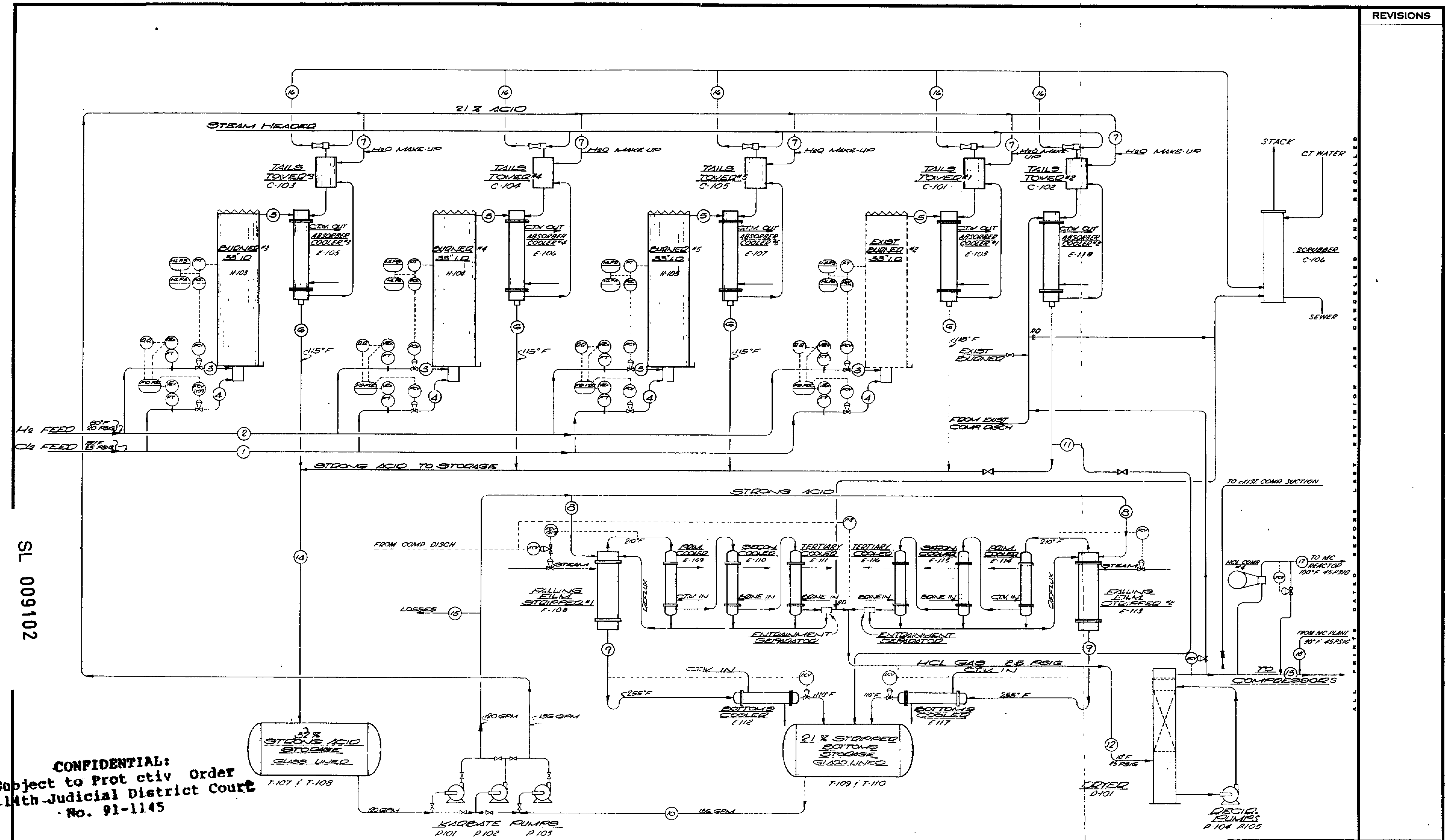

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	(1)		(2)		(3)		(4)		(5)		(6)	
	LBS/HR	MOL %	LBS/HR	MOL %	LBS/HR	MOL %	LBS/HR	MOL %	LBS/HR	MOL %	LBS/HR	WT %
Cl_2	9,415.2	95.75					2353.8	95.75				
CO_2	111.00	1.82					27.75	1.82	27.75	.90		
O_2	39.72	.90					9.95	.90				
H_2	.56	.20	286.08		71.52		.14	.20	4.22	3.01		
N_2	59.60	1.33					12.90	1.33	12.90	.66		
HCL									2420	94.64	5,595	32.10
H_2O									11.17	.89	11,836.17	67.90
STEAM												
TOTAL	9,618.08	100.00	286.08		71.52		2404.52	100.00	2476.04	100.00	17,431.17	100.00
FLOW	371 CFM		398 CFM		234 CFM		250 CFM		1035 CFM		30 GPM	

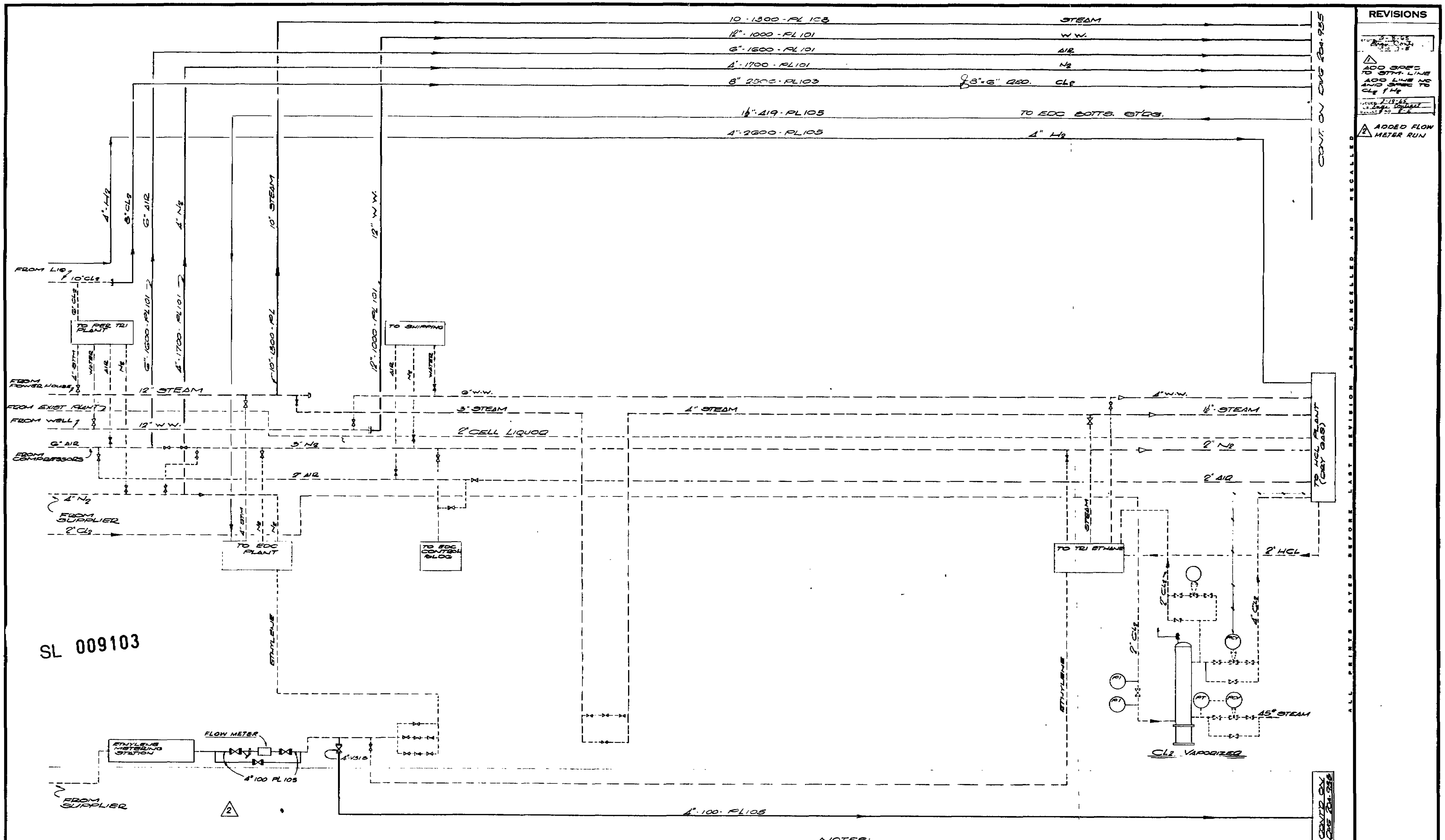
	(7)		(8)		(9)		(10)		(11)		(12)	
	LBS/HR	WT %	LBS/HR	WT %	LBS/HR	WT %	LBS/HR	WT %	LBS/HR	WT %	LBS/HR	
Cl_2												
CO_2												
O_2												
H_2												
N_2												
HCL	5,175	21.17	11,111.5	32.00	6,350	21.17	15,875	21.17	3,175	21.17	9,523	
H_2O	11,825	78.83	23,650.24	68.00	23,650	78.83	59,125	78.83	11,825	78.83	0.48	50 PPM
STEAM												
TOTAL	15,000	100.00	34,761.74	100.00	30,000	100.00	75,000	100.00	15,000	100.00		
FLOW	27.2 GPM		60 GPM		54.4 GPM		136 GPM		27.2 GPM		822 CFM	

	(13)		(14)		(15)		(16)		(17)		(18)	
	LBS/HR		LBS/HR	WT %	LBS/HR		LBS/HR		LBS/HR		LBS/HR	
Cl_2												
CO_2							27.8					
O_2												
H_2							4.22					
N_2							12.9					
HCL	9,523		22,380	32.10	157		10		1150		1980	
H_2O	0.48	50 PPM	47,344.6	67.90	44.20							
STEAM							1500					
TOTAL			69,724.6	100.00	201.20							
FLOW	822 CFM		120 GPM				76 CFM		82.4 CFM		80.3 CFM	

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PROCESS

DRAWN BY MALLETT DATE 12-9-64 SCALE ——
CHECKED BY ______ DATE ______ CHARGE ______
APPROVED BY [signature] DATE 3-17-66 SUB ______
BILL OF MATERIAL ______ DWG. NO. 624-1000



SL 009103

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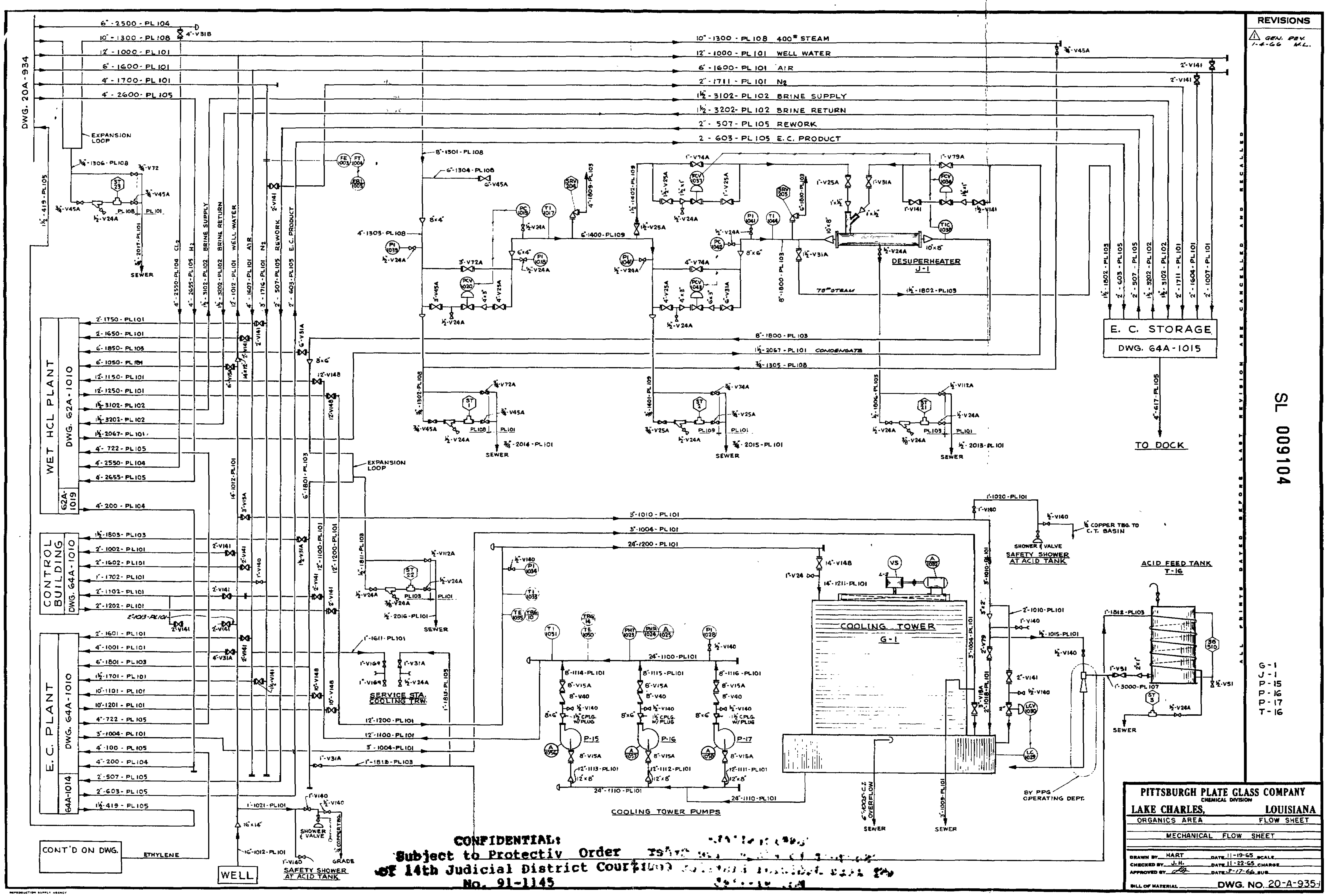
No. 91-1145

PITTSBURGH PLATE GLASS COMPANY CHEMICAL DIVISION	
LAKE CHARLES,	LOUISIANA
ORGANICS AREA	FLOW SHEET
MECHANICAL FLOW SHEET	
DRAWN BY HOP DATE 1-22-66 SCALE none	
CHECKED BY DATE CHARGE	
APPROVED BY DATE SUB.	
BILL OF MATERIAL	DWG. NO. 204-934-2



PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
ORGANICS AREA FLOW SHEET
MECHANICAL FLOW SHEET
DRAWN BY HART DATE 11-19-65 SCALE
CHECKED BY J.H. DATE 11-22-65 CHARGE
APPROVED BY DATE 3-17-66 SUB.
BILL OF MATERIAL DWG. NO. 20-A-935-1

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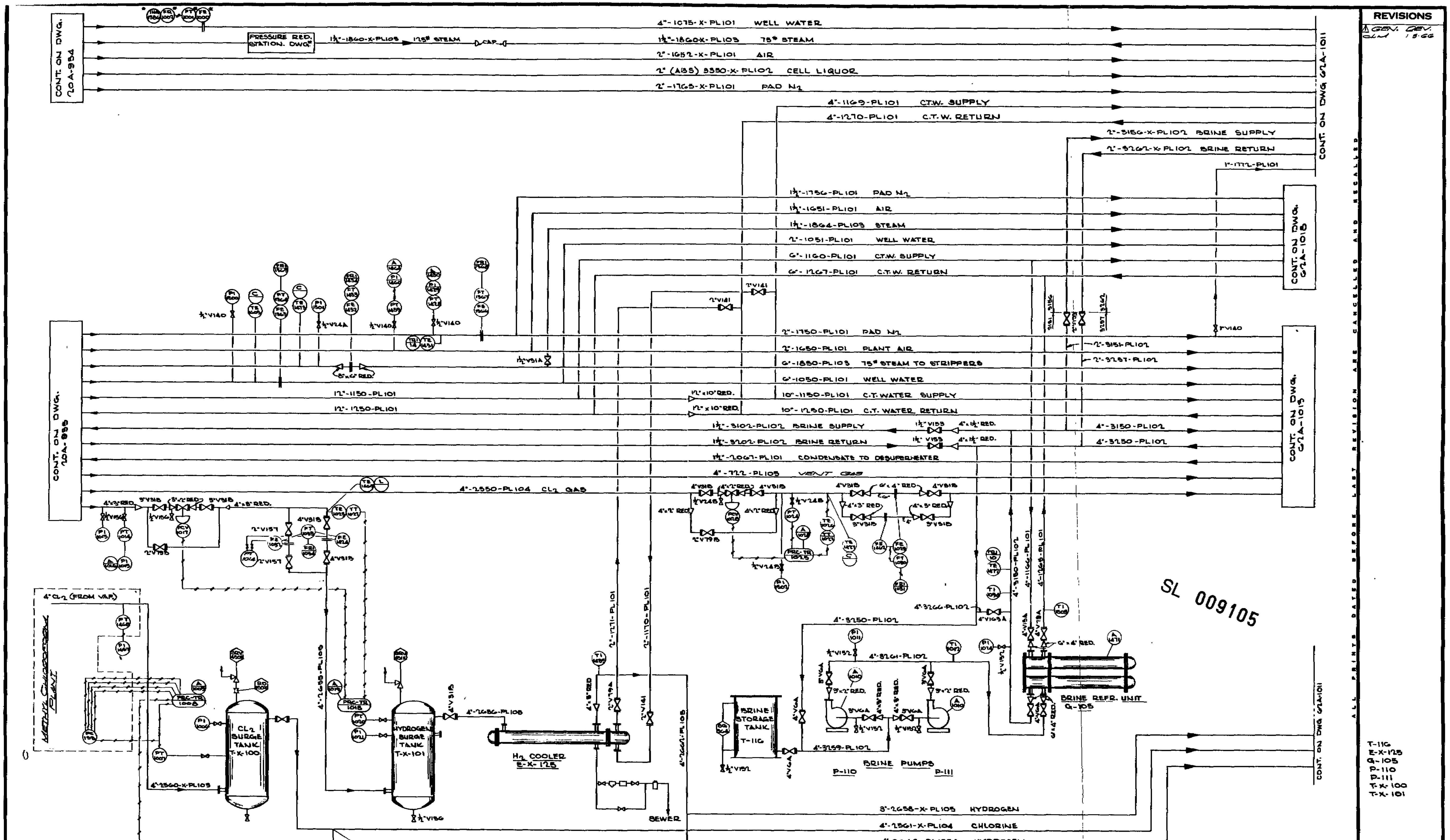
No. 91-1145



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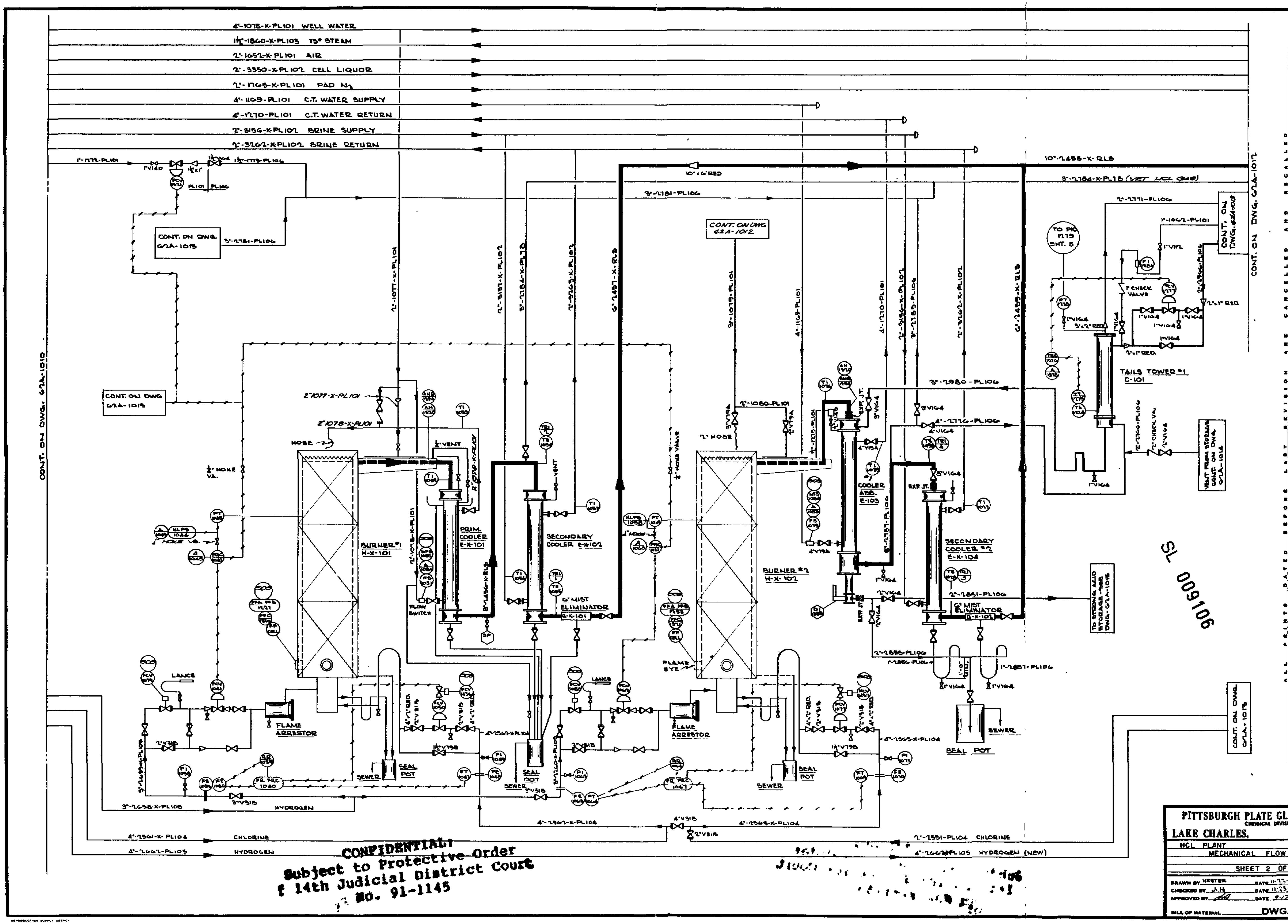
No. 91-1145

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT — FLOW SHEET
MECHANICAL FLOW SHEETS
SHEET 1 OF 10

DRAWN BY HESTER DATE 11-22-65 SCALE NONE
CHECKED BY J.H. DATE 11-23-65 CHARGE
APPROVED BY [signature] DATE 3-17-66 SUB
BILL OF MATERIAL ______ DWG. NO. 62A-1010.1



REVISIONS

GEN. REV. 1-5-66

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT — FLOW SHEET
MECHANICAL FLOW SHEETS

SHEET 2 OF 10

DRAWN BY HESTER DATE 11-22-65 SCALE NONE
CHECKED BY J.H. DATE 11-23-65 CHARGE
APPROVED BY DATE 3-7-66 SUB.
BILL OF MATERIAL — DWG. NO. 62A-1011

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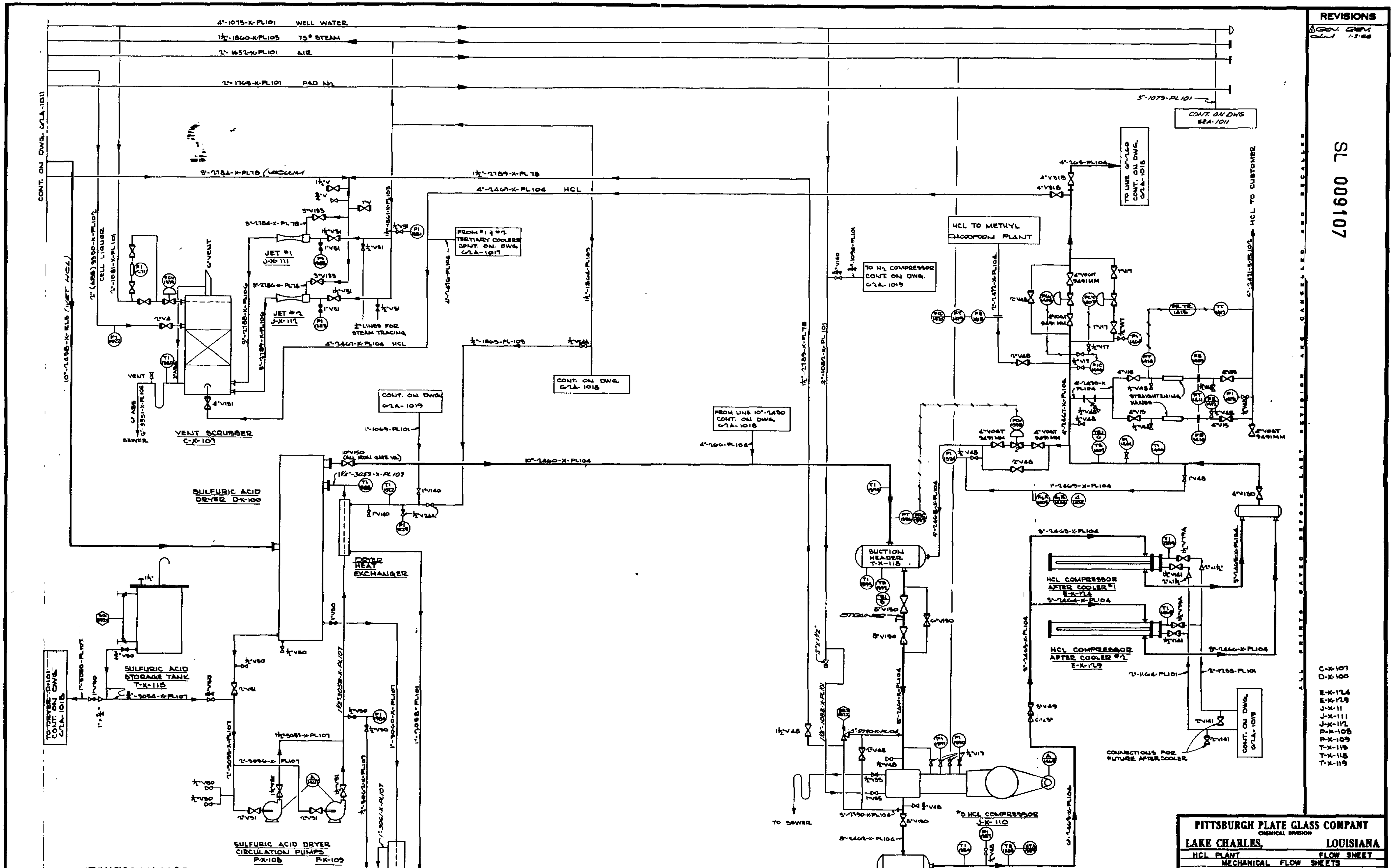
14th Judicial District Court
No. 91-1145

SL 009106



PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT	FLOW SHEET
MECHANICAL FLOW SHEETS	
SHEET 3 OF 10	
DRAWN BY HESTER DATE 11-22-65	SCALE NONE
CHECKED BY J.H. DATE 11-23-65	CHANGE
APPROVED BY DATE 2-17-66	
BILL OF MATERIAL	DWG. NO 62A-1012.1

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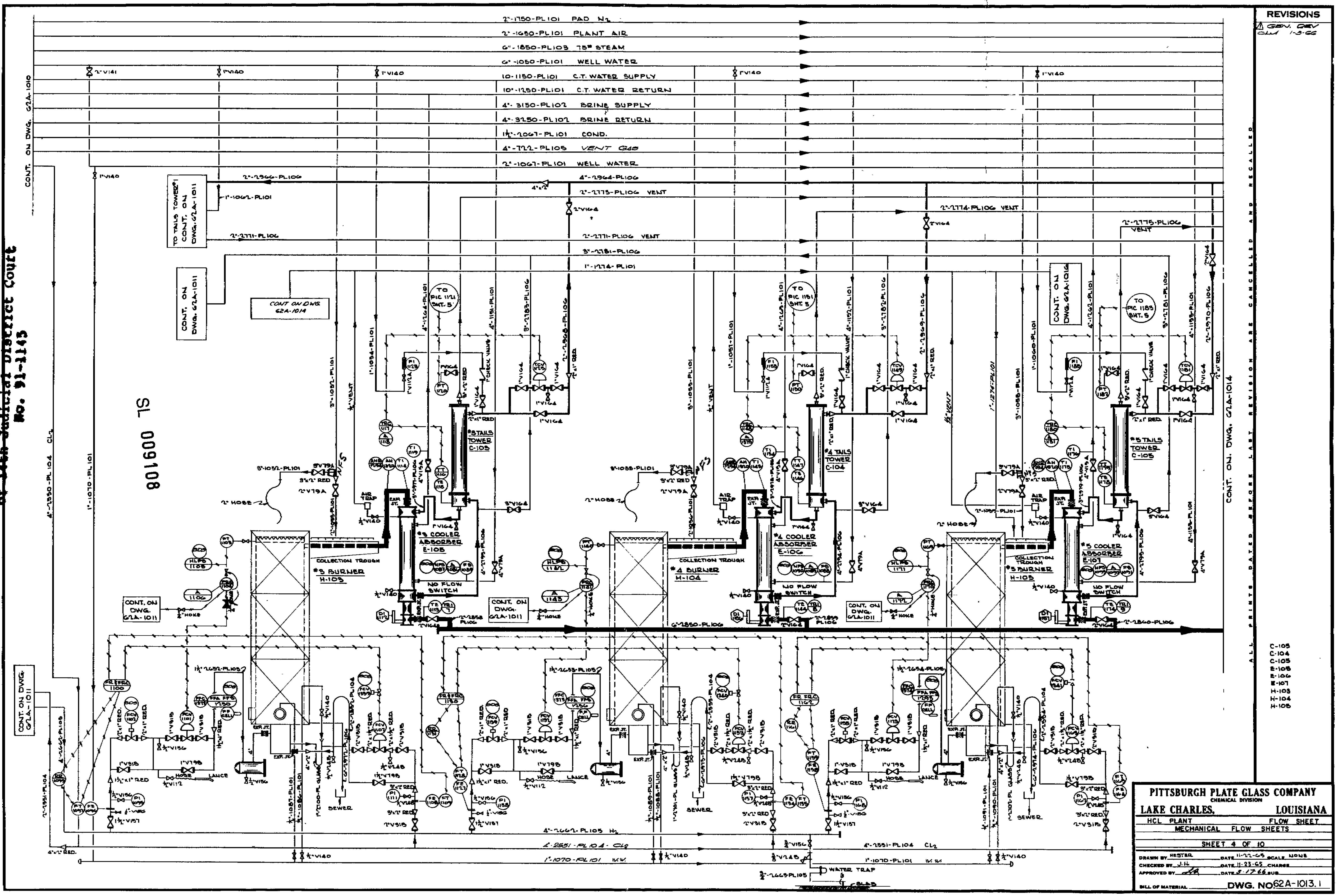
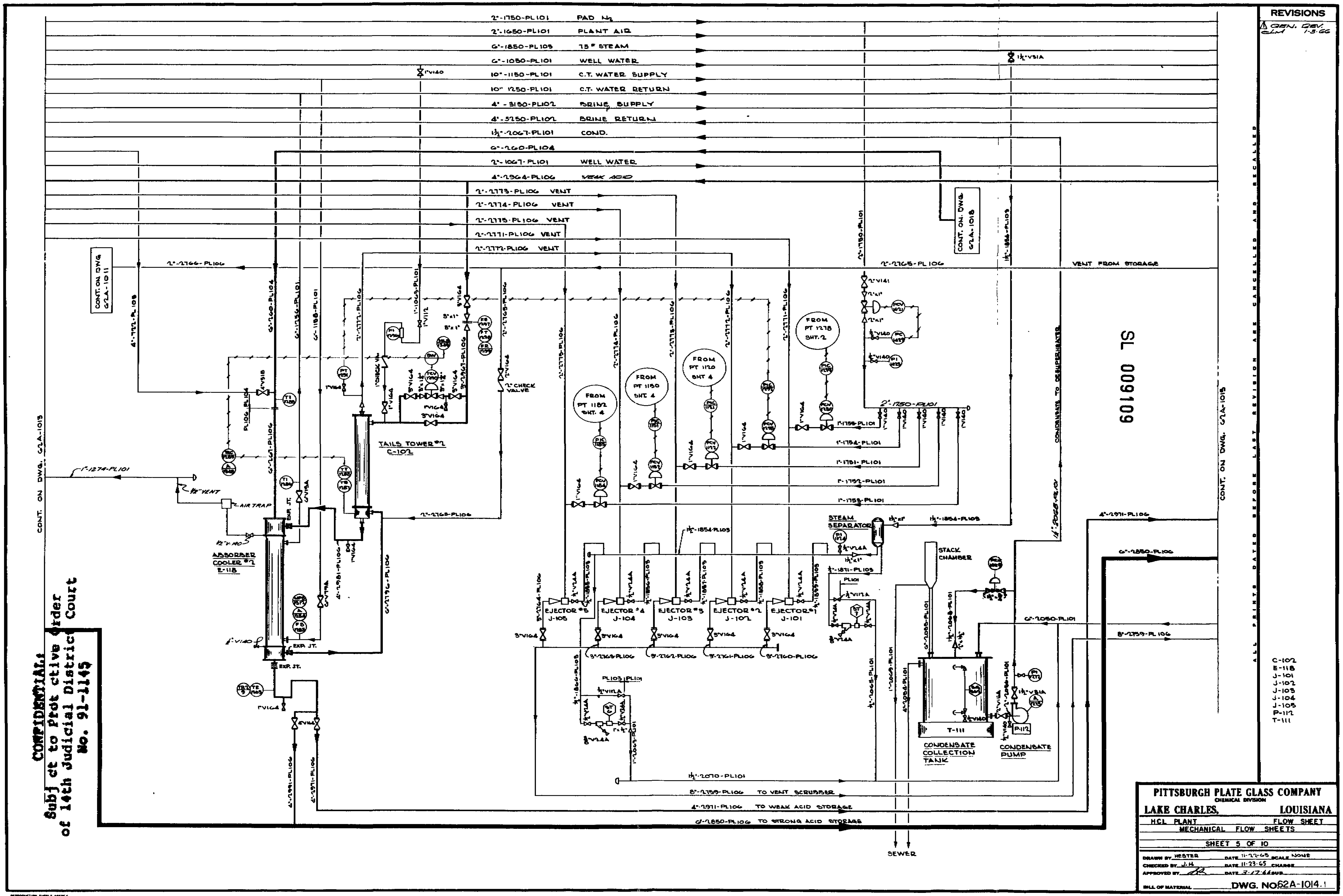
of 14th Judicial District Court
No. 91-1145

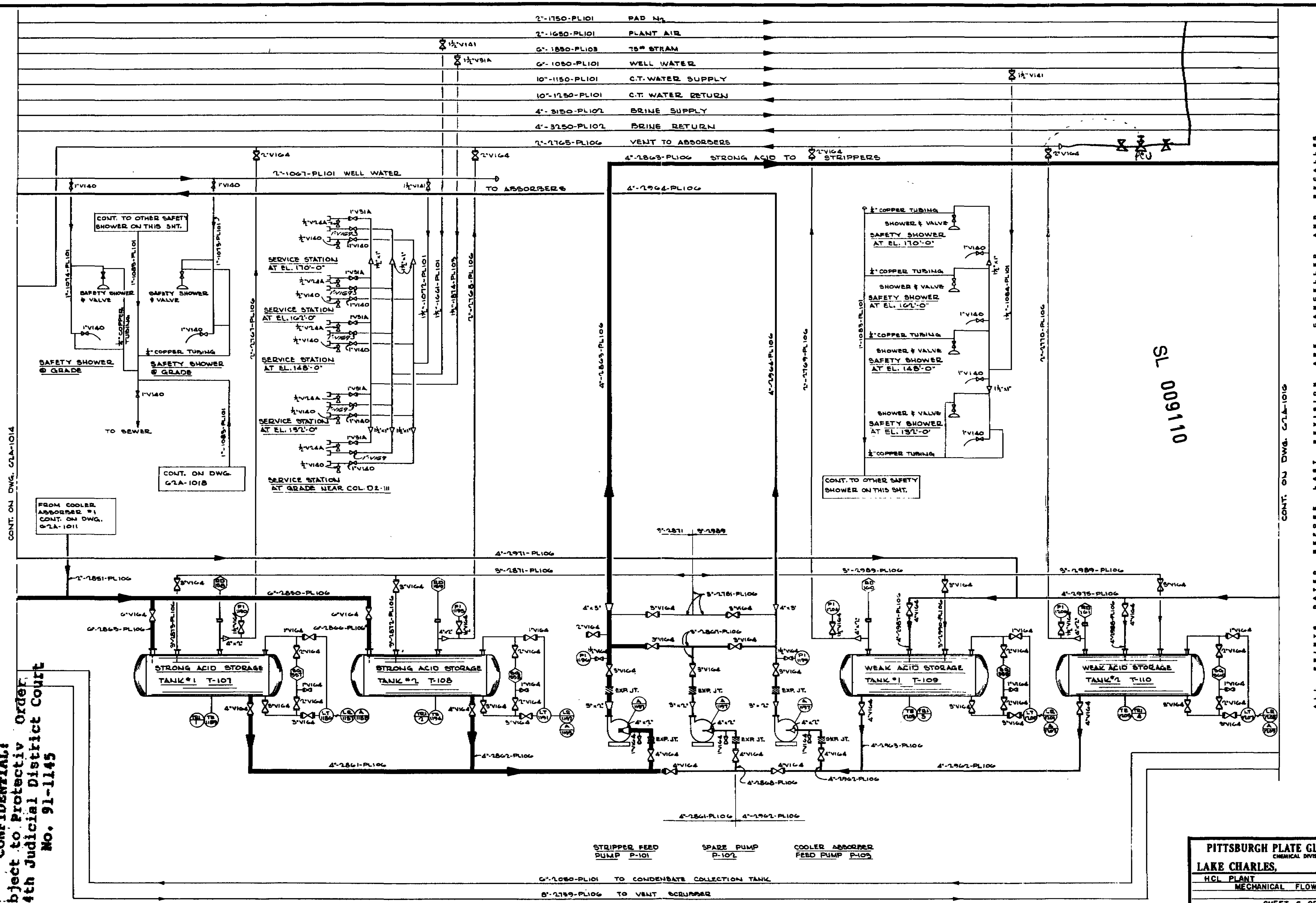
CONFIDENTIAL;
Subject to Protective Order
of 14th Judicial District Court
No. 91-1145

SL 009108





REVISIONS
GEN. REV.
2"-1750-PL101 PAD N2
2"-1650-PL101 PLANT AIR
6"-1850-PL105 75# STEAM
6"-1050-PL101 WELL WATER
10"-1150-PL101 C.T. WATER SUPPLY
10" 1250-PL101 C.T. WATER RETURN
4"-3150-PL102 BRINE SUPPLY
4"-3250-PL102 BRINE RETURN
1½"-2067-PL101 COND.
6"-2260-PL104
2"-1067-PL101 WELL WATER
4"-2964-PL106 WEAK ACID
2"-2773-PL106 VENT
2"-2774-PL106 VENT
2"-2775-PL106 VENT
2"-2771-PL106 VENT
2"-2772-PL106 VENT
CONT. ON DWG 62A-1011
CONT. ON DWG. 62A-1018
VENT FROM STORAGE
CONT. ON DWG. 62A-1015
TAILS TOWER #2 C-102
ABSORBER COOLER #2 E-118
AIR TRAP
½" VENT
CHECK VALVE
EXP. JT.
FROM PT 1182 SHT. 4
FROM PT 1150 SHT. 4
FROM PT 1120 SHT 4
FROM PT 1278 SHT. 2
STEAM SEPARATOR
STACK CHAMBER
EJECTOR #5 J-105
EJECTOR #4 J-104
EJECTOR #3 J-103
EJECTOR #2 J-102
EJECTOR #1 J-101
CONDENSATE TO DESUPERHEATER
CONDENSATE COLLECTION TANK T-111
CONDENSATE PUMP P-112
1½"-2070-PL101
8"-2759-PL106 TO VENT SCRUBBER
4"-2971-PL106 TO WEAK ACID STORAGE
6"-2850-PL106 TO STRONG ACID STORAGE
SEWER
SL 009109
C-102
E-118
J-101
J-102
J-103
J-104
J-105
P-112
T-111
ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED
CONFIDENTIAL:
Subject to Protective Order
of 14th Judicial District Court
No. 91-1145
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
HCL PLANT FLOW SHEET
MECHANICAL FLOW SHEETS
SHEET 5 OF 10
DRAWN BY HESTER DATE 11-22-65 SCALE NONE
CHECKED BY J.H. DATE 11-23-65
DWG. NO. 62A-1014-1



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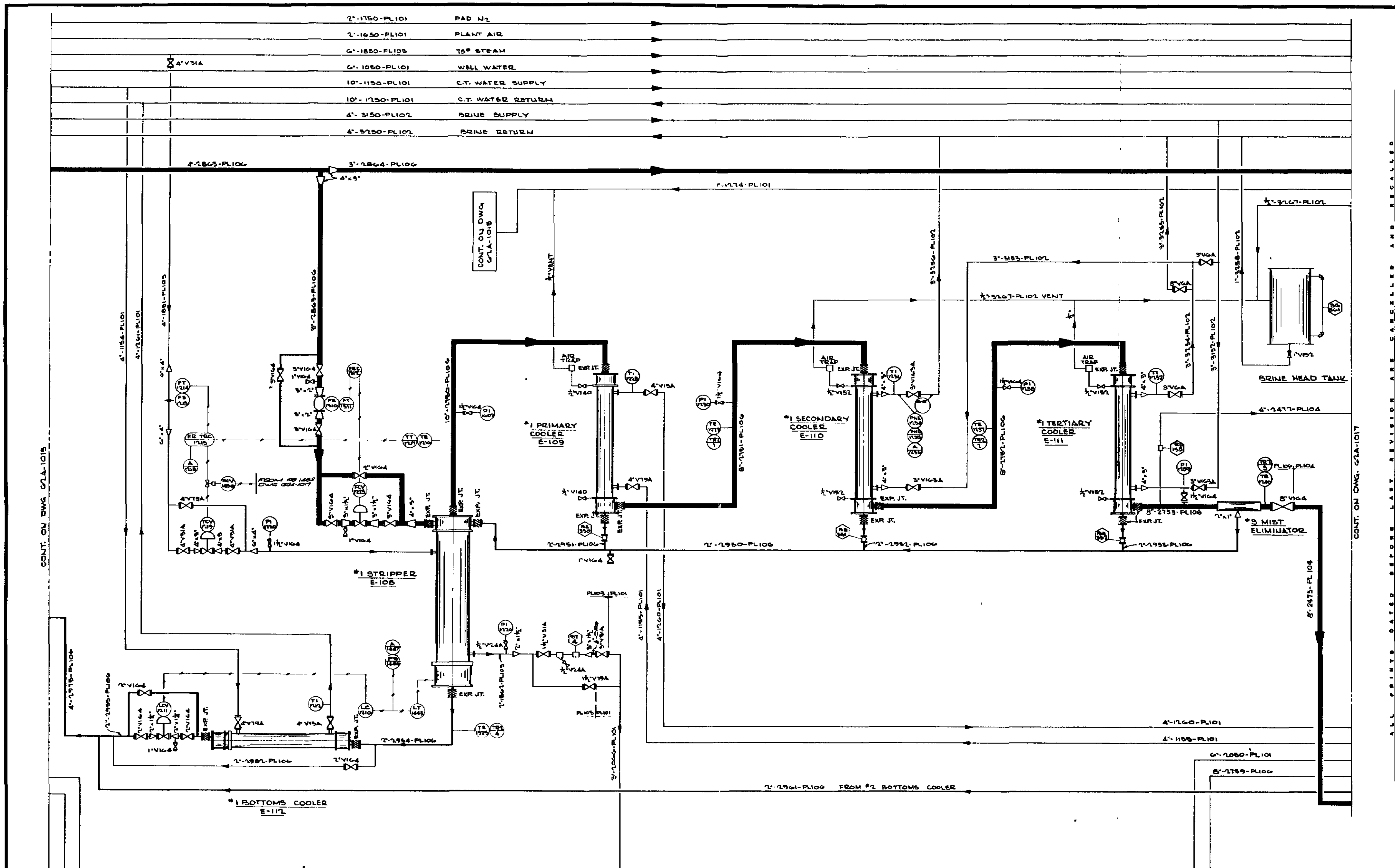
REVISIONS

△ GEN. REV. 1-4-66

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT	FLOW SHEET
MECHANICAL FLOW SHEETS	
SHEET 6 OF 10	
DRAWN BY HESTER	DATE 11-22-65 SCALE NONE
CHECKED BY J.H.	DATE 11-23-65 CHARGE
APPROVED BY	DATE 3-12-66 SUB.
BILL OF MATERIAL	DWG. NO. 62A-1015.1



REVISIONS

GEN. REV. CLM 1-4-66

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

SL 009111

E-108
E-109
E-110
E-111
E-112

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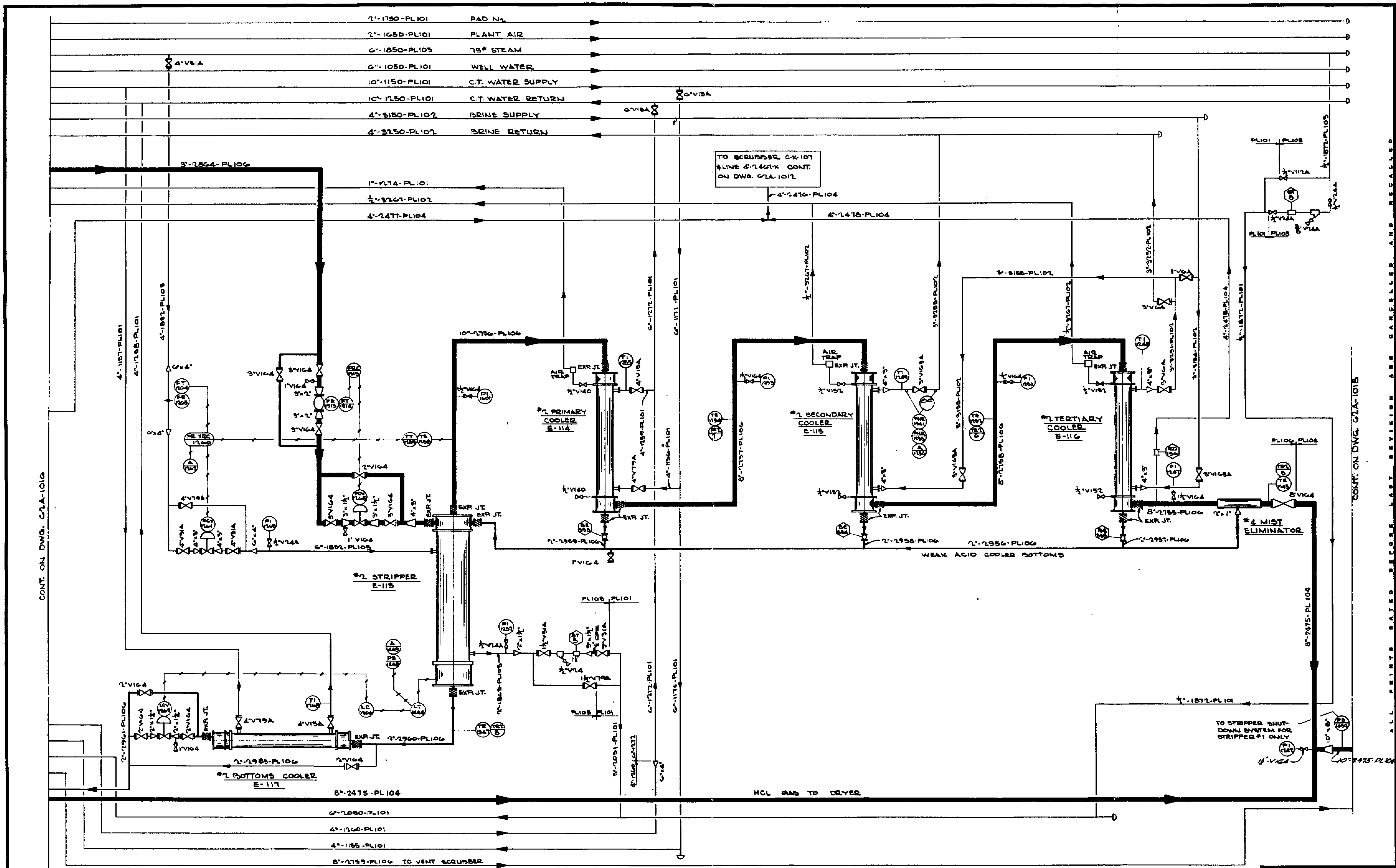
No. 91-1145

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT FLOW SHEET
MECHANICAL FLOW SHEETS
SHEET 7 OF 10

DRAWN BY HESTER DATE 11-22-65 SCALE NONE
CHECKED BY J.H. DATE 11-23-65 CHARGE
APPROVED BY [signature] DATE 3-17-66 SUB.
BILL OF MATERIAL DWG. NO 62A-1016.1



REVISIONS

GEN. REV. CLM 1-4-66

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

SL 009112

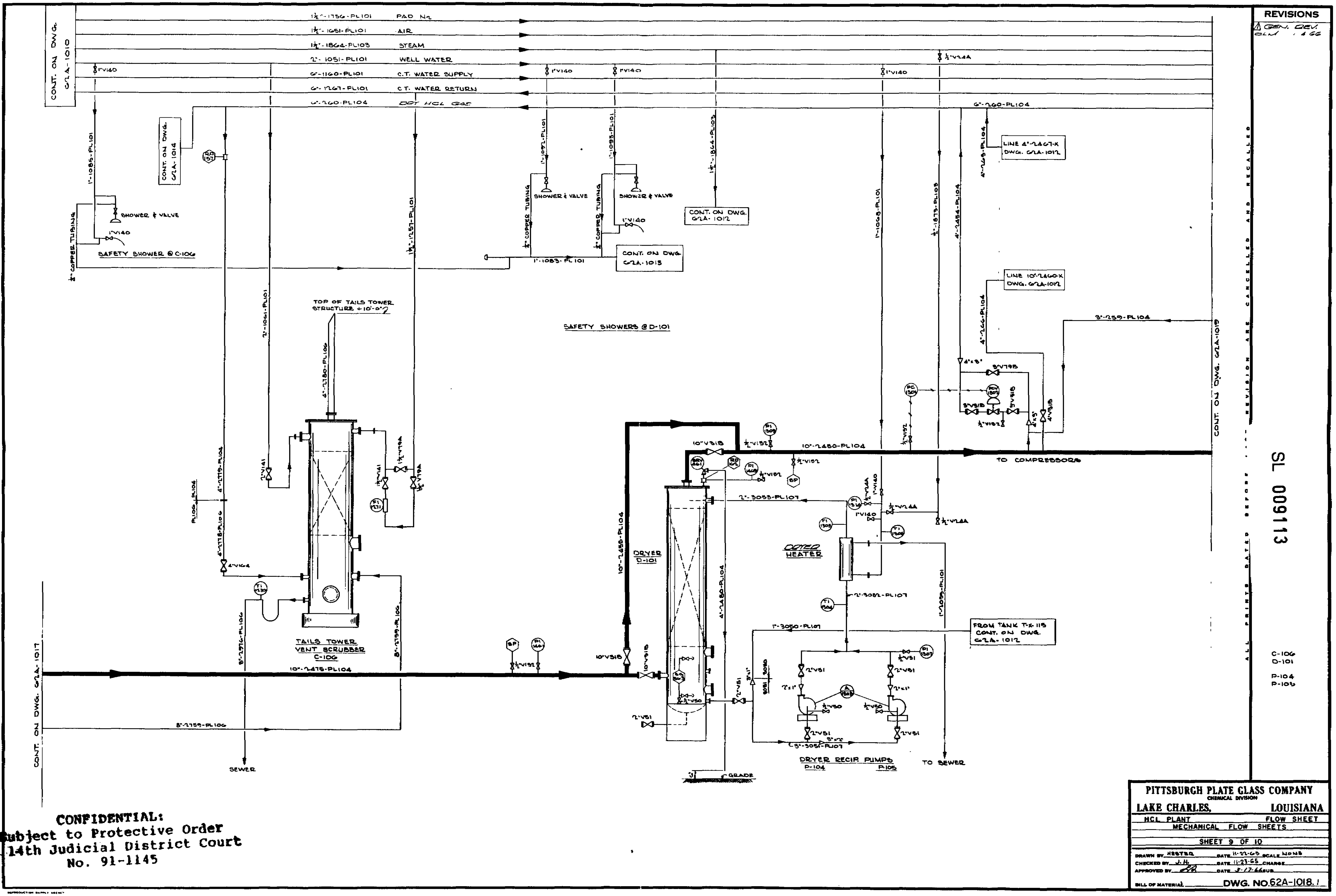
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT — FLOW SHEET
MECHANICAL FLOW SHEETS

SHEET 8 OF 10

DRAWN BY HESTER DATE 11-22-65 SCALE NONE
CHECKED BY J.H. DATE 11-23-65 CHARGE
APPROVED BY DATE 1-17-66 SUB.
BILL OF MATERIAL DWG. NO 62A-1017.1

CONFIDENTIAL:
Subj ct to Prot ctive Order
of 14th Judicial District Court
No. 91-1145



SL 009113

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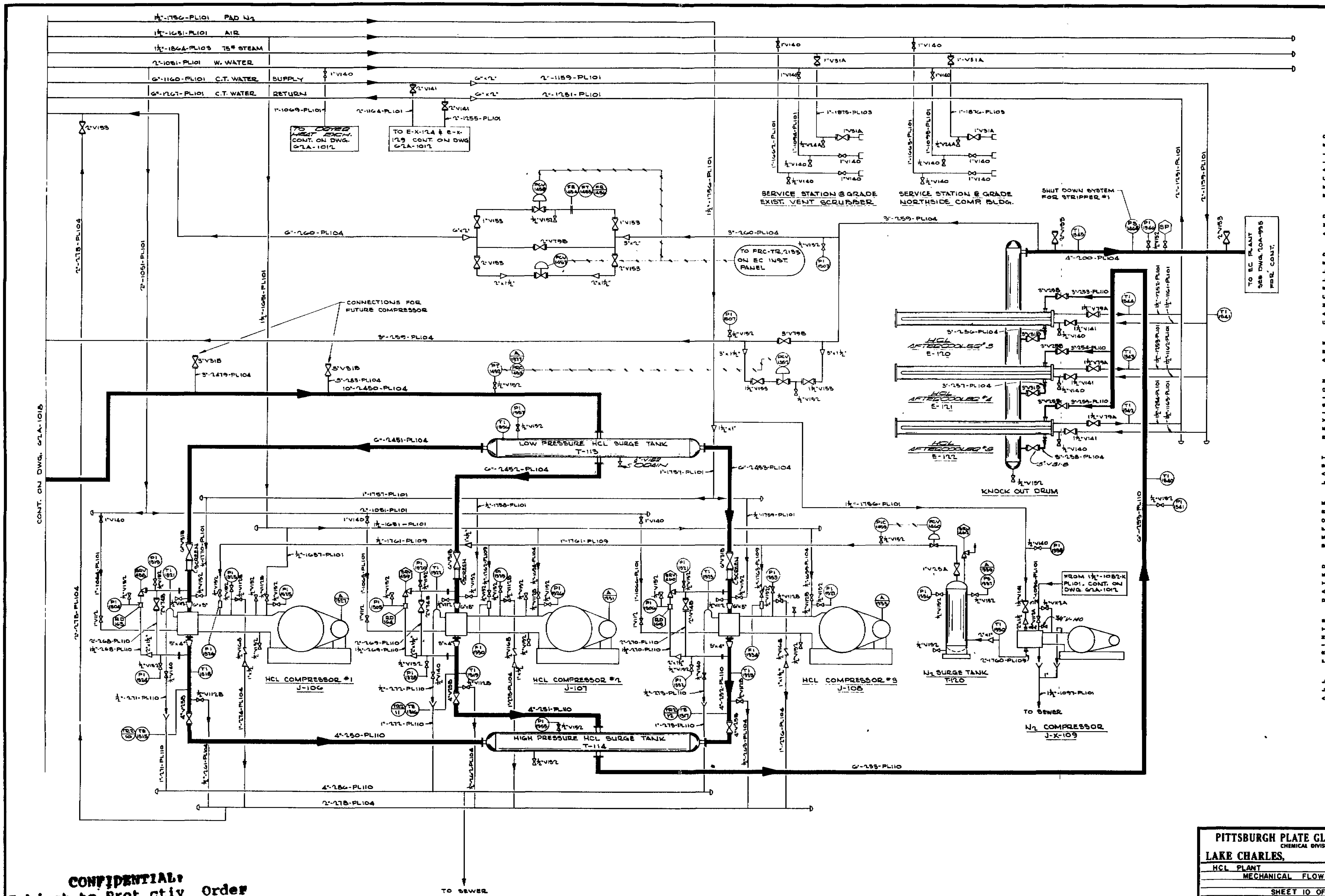
of 14th Judicial District Court
No. 91-1145



REVISIONS

Ⓐ GEN. REV. CLM 1-4-66

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

E-120
E-121
E-122
J-106
J-107
J-108
J-X-109
T-113
T-114
T-120

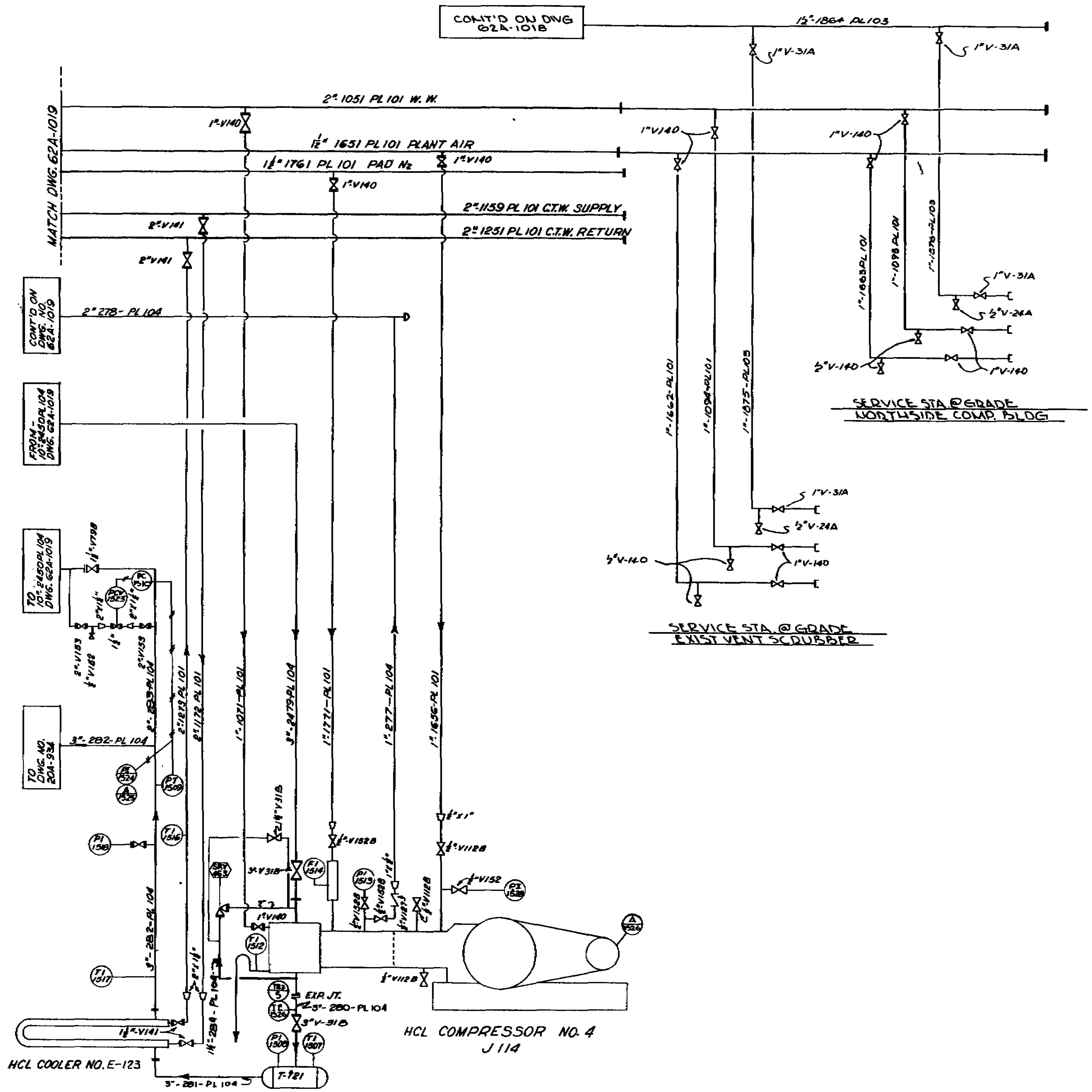
SL 009114

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

HCL PLANT	FLOW SHEET
MECHANICAL FLOW SHEETS	
SHEET 10 OF 10	
DRAWN BY KESTER DATE 11-22-65	SCALE NONE
CHECKED BY J.H. DATE 11-23-65	CHARGE
APPROVED BY [illegible] DATE 3-17-66	SUB.
BILL OF MATERIAL	DWG. NO 62A-1019.1

CONFIDENTIAL:
Subject to Prot ctiv Order
of 14th Judicial District Court
No. [illegible]

REVISIONS
1 GEN REVISIONS 7-20-65
2 GENERAL REVISIONS 8-5-65
3 GENERAL REVISIONS 8-30-65
4 GENERAL REVISIONS 3-22-66 D.T.H.



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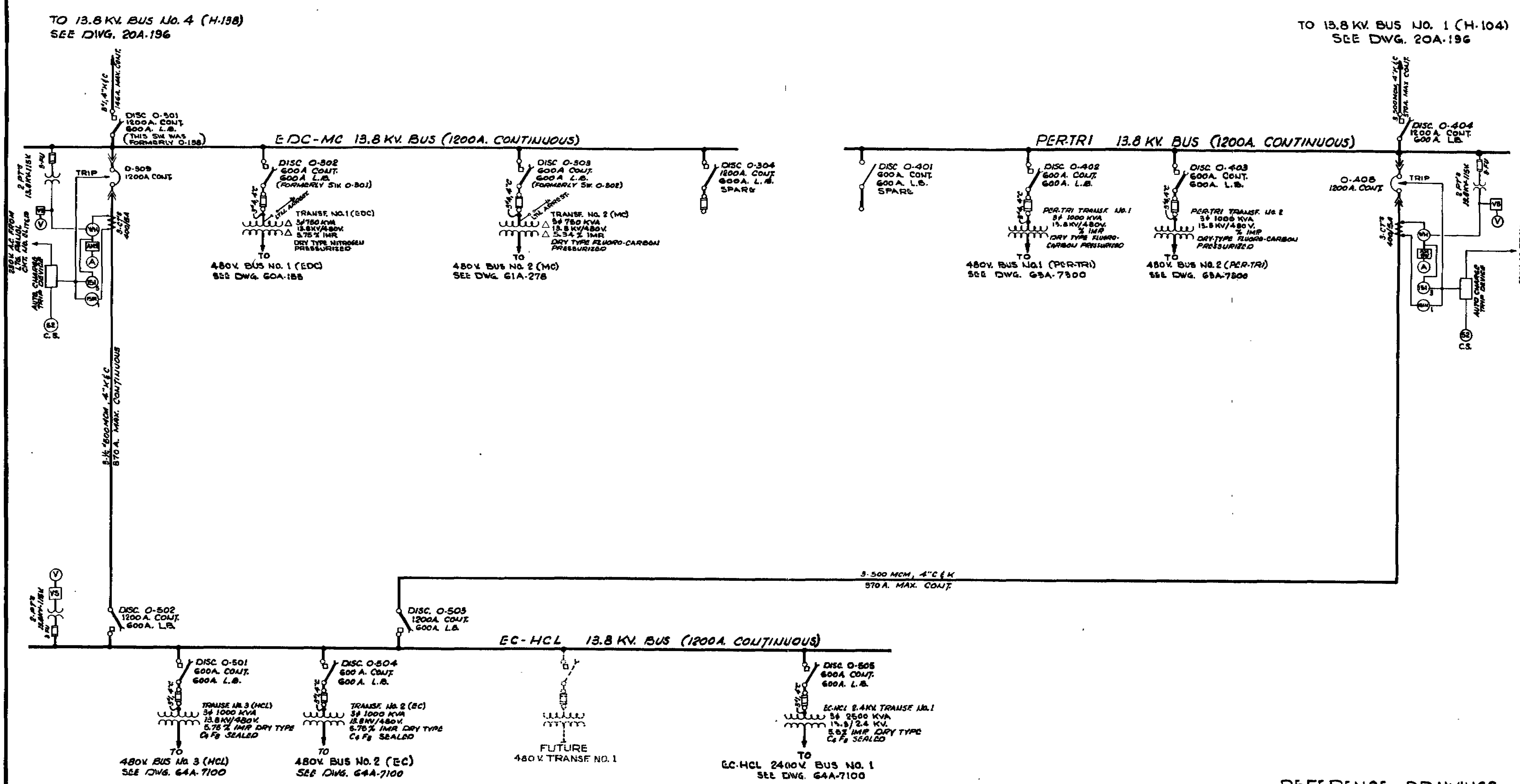
of 14th Judicial District Court
No. 91-1145

ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

SL 009115

PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
HCL PLANT FLOW SHEET
MECHANICAL FLOW SHEETS
#11 OF 11

DRAWN BY H. BROWN DATE 7-7-65 SCALE
CHECKED BY DATE CHARGE
APPROVED BY DATE SUB.
BILL OF MATERIAL DWG. NO. 62A-1020-4



REFERENCE DRAWINGS

20A-196	13.8 KV. ONE LINE DIAGRAM
60A-158	E.D.C. PLANT ONE LINE DIAGRAM
61A-278	TRI-ETHANE PLANT ONE LINE DIAGRAM
62A-200	HCL PLANT ONE LINE DIAGRAM
63A-7300	PER-TRI PLANT ONE LINE DIAGRAM
64A-7100	EC-HCL PLANT ONE LINE DIAGRAM

REVISIONS

THIS DRAWING SUPERSEDES & VOIDS ORIGINAL DWG. 20A-901 & A009 EC-HCL BUS
P-674-932 10-26-65
UG/BM S.D.M.
REF. DWG. 20A-1057

ISSUED 10-27-65
FOR Const.
BULLETIN NO. 135-E

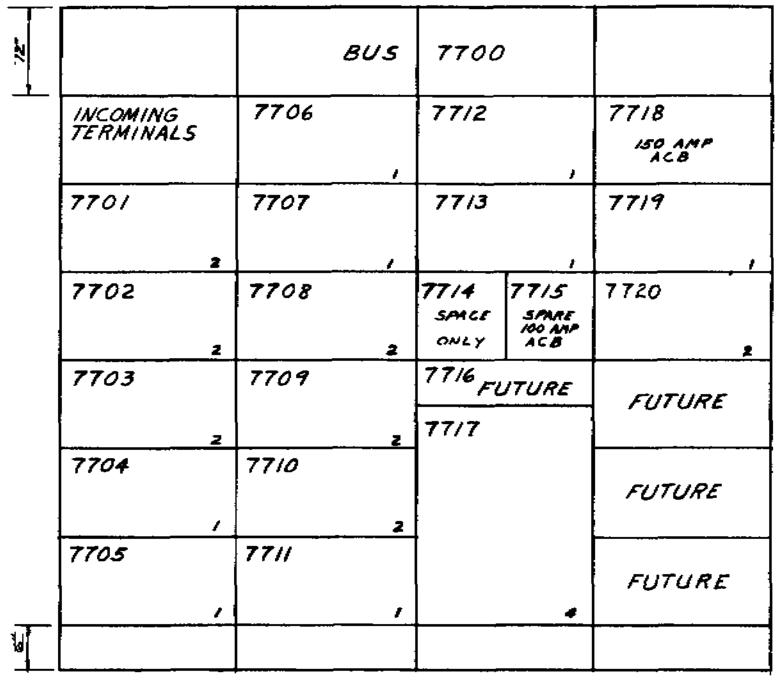
ALL PRINTS DATED BEFORE LAST REVISION ARE CANCELLED AND RECALLED

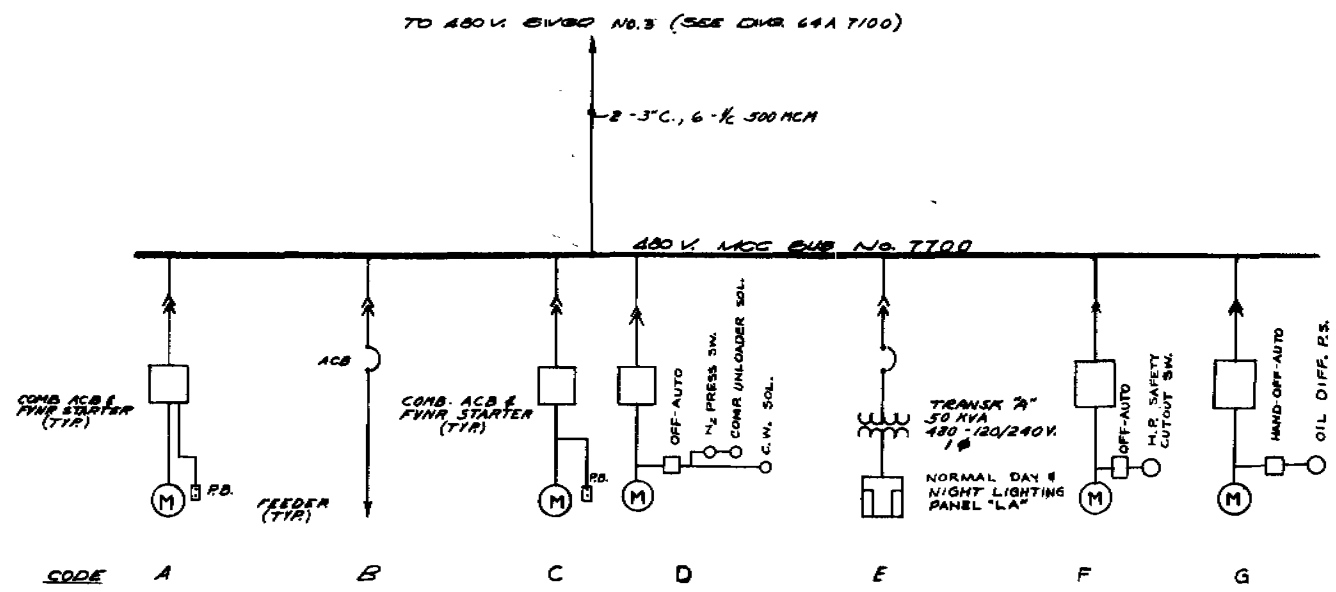
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA

20A ELECTRICAL
ORGANICS AREA COMPOSITE
ONE LINE DIAGRAM

DRAWN BY MC DANIEL DATE 7-6-66 SCALE NONE
CHECKED BY R.J.J. DATE 10-22-65 CHANGE P-674
APPROVED BY [illegible] DATE 10-27-65 SUB.
BILL OF MATERIAL NONE DWG. NO. 20A-901-1

SL 009116





SPECIFICATIONS:

1- MOTOR CONTROL CENTER SHALL BE FABRICATED PER GENERAL ELECTRIC'S SPECIFICATIONS FOR 7700 LINE MOTOR CONTROL CENTERS. VERTICAL SECTIONS ARE TO BE 90" HIGH, 20" WIDE & 13" DEEP FOR PLUG IN STARTERS ON ONE SIDE ONLY.
2- WIRING IS TO BE NEMA CLASS I, TYPE B.
3- ENCLOSURE TO BE NEMA TYPE I.
4- POWER SUPPLY: 480 VOLT, 3 PHASE, 60 CYCLE.
5- CONTROL POWER: 120 VOLT, 60 CYCLE, USE A SEPARATE CONTROL TRANSFORMER FOR EACH STARTER.
6- PROVIDE A 600 AMP GROUND BUS W/EIGHT 5/8" DIAMETER HOLES FOR EACH VERTICAL SECTION OF MOTOR CONTROL CENTER.
7- MAIN HORIZONTAL BUS TO BE RATED 600 AMPS & VERTICAL BUS TO BE RATED 300 AMPS. ALL BUS WORK TO BE SILVER PLATED & SUITABLY BRACED TO WITHSTAND A MAXIMUM OF 30,000 RMS AMPERES SHORT CIRCUIT CURRENT.
8- INCOMING LINE CABLES WILL BE TOP FED W/TWO 500 MCM CABLES PER PHASE.
9- OUT GOING CABLES FROM STARTERS, ETC. WILL LEAVE THE CONTROL CENTERS FROM THE TOP.
10- PHYSICAL ARRANGEMENTS OF STARTERS AND BREAKERS ARE TO BE AS SHOWN ON THESE DRWINGS. STARTERS SHALL BE OF THE CIRCUIT BREAKER COMBINATION TYPE.
11- OVERLOAD BIMETALLIC RELAYS (EXTERNAL HAND RESET TYPE AMBIENT COMPENSATED) ARE TO BE PROVIDED IN ALL THREE PHASES. HEATER ELEMENTS ARE TO BE PURCHASED & INSTALLED BY OWNER AT LATER DATE.
12- ONE EXTRA NORMALLY OPEN AUXILIARY CONTACT IS TO BE PROVIDED W/EACH MOTOR STARTER CONTACTOR.
13- LAMACOID NAMEPLATES: LETTER HEIGHT OF CIRCUIT NUMBER TO BE 1/2". LETTER HEIGHT OF CIRCUIT DESCRIPTION TO BE 1/4". LETTER HEIGHT OF BUS NUMBER TO BE 1/2". LETTERS TO BE WHITE ON BLACK BACKGROUND.
14- VENDORS NAMEPLATE TO BE LOCATED TOP AND CENTER OF MOTOR CONTROL CENTERS W/A LAMACOID NAMEPLATE SHOWING THE BUS NUMBER DIRECTLY BELOW.
15- INSTALL LAMACOID NAMEPLATES DESIGNATING INCOMING FEEDER SPACES & ALL CUBICLES.
16- MOLDED CASE BREAKERS FOR FEEDER USE ONLY ARE 30,000 AMP INTERUPTING (100 A. FRAME ARE THEF - 225 A. FRAME ARE TYPE THFK). BREAKERS USED IN COMBINATION MOTOR STARTERS SHALL BE 15,000 ASYM. AMPS INTERRUPTING (100 A FRAME ARE TYPE TEF - 225 AMP. FRAME ARE TYPE TFJ).

SEE DATA BELOW FOR DETAILED INFORMATION

CODE	C/O No.	UNIT SPACE	STARTER SIZE	HEATER No.	BKR. TRIP	H.P. (OR KVA) NAMEPLATE CON.	NAMEPLATE SPARE	CONSU. LOAD	DESCRIPTION	R.P.M.	CONDUIT & WIRE SIZE	NAME PLATE ENGRAVING
C	7701	1	2	CR 123-C22.8B	50A	15		13	PUMP NO. P101 MOTOR NO. M101	1800	1½"C., ¾, 4#8 & 3#12	CKT #7701 STRIPPER FEED PUMP NO. 1
C	7702	1	2	CR 123-C22.8B	50A		15	0	PUMP NO. P102 MOTOR NO. M102	1800	1½"C., ¾, 4#8 & 3#12	CKT #7702 STRIPPER FEED PUMP NO. 2
C	7703	1	2	CR 123-C22.8B	50A	15		13	PUMP NO. P103 MOTOR NO. M103	1800	1½"C., ¾, 4#8 & 3#12	CKT #7703 ABSORBER FEED PUMP
C	7704	1	1	CR 123-C3.01A	15A	1½		1.2	PUMP NO. P104 MOTOR NO. M104	1800	TRAY, 1"C., ¾ #12	CKT #7704 H_2SO_4 CIRCULATION PUMP NO. 1
C	7705	1	1	CR 123-C3.01A	15A		1½	0	PUMP NO. P105 MOTOR NO M105	1800	TRAY, 1"C., ¾ #12	CKT #7705 H_2SO_4 CIRCULATION PUMP NO. 2
C	7706	1	1	CR 123-C9.35B	20A	5		4.5	PUMP NO. PX 108 MOTOR NO. MX 108	1800	TRAY, 1"C., ¾ #12	CKT #7706 H_2SO_4 CIRCULATION PUMP NO. 3
C	7707	1	1	CR 123-C9.35B	20A		5	0	PUMP NO. PX 109 MOTOR NO. MX 109	1800	TRAY, 1"C., ¾ #12	CKT #7707 H_2SO_4 CIRCULATION PUMP NO. 4
D	7708	1	2	CR 123-C22.8B	50A	15		13	COMPRESSOR NO. JT-109 MOTOR NO. M 114	1800	TRAY, 1½"C., ¾, 4#8 & 3#12	CKT #7708 HCL COMPRESSOR N_2 PAD
C	7709	1	2	CR 123-C22.8B	50A	15		12	PUMP NO. P110 MOTOR NO. MX 115	3600	TRAY, 1½"C., ¾, 4#8 & 3#12	CKT #7709 BRINE PUMP NO. 1
C	7710	1	2	CR 123-C22.8B	50A	15		12	PUMP NO. P111 MOTOR NO. MX 116	3600	TRAY, 1½"C., ¾, 4#8 & 3#12	CKT #7710 BRINE PUMP NO. 2
F	7711	1	1	CR 123-CL.81A	15A	¾		¾	PUMP NO. G106 MOTOR NO. M 118	1800	TRAY, 1"C., ¾ #12	CKT #7711 REF. UNIT PURGE RECOVERY
C	7712	1	1	CR 123-C3.79B	15A	2		2	PUMP NO. P112 MOTOR NO. M119	1800	1"C., ¾, #12	CKT #7712 DESUPERHEATER FEED PUMP
G	7713	1	1	CR 123-CL.94A	15A	1		.75	PUMP NO P113 MOTOR NO M120	1800	TRAY, 1"C., ¾, #12	CKT #7713 HCL REF. COMP. OIL PUMP
	7714	½							FUTURE SPACE ONLY			CKT #7714 FUTURE
B	7715	½			100A	0		0	100 AMP FR. 100 AMP TRIP TYPE THEF			CKT #7715 SPARE ACB
	7716	½				0		0	FUTURE SPACE ONLY			CKT #7716 FUTURE
A	7717	2½	4	CR 123 F194C	175A	100		95	PUMP NO. P-17 MOTOR NO. M-17	1800	TRAY, 3"C., ¾-3#⅔ & 1#4 TRAY, ¾"C., ¾ #12	CKT # 7717 COOLING TOWER PUMP #3
E	7718	1			150A	50		30	OPERATES CONTINOUSLY		TRAY, 2"C., 2#⅔	CKT #7718 DAY & NIGHT LIGHTING TRANSF. "A"
	7719	1	1		40A	0		0	SPARE			CKT #7719 SPARE SIZE 1
C	7720	1	2	CR 123 C33.0B	70A	25		21	COMPRESSOR NO. J114 MOTOR NO. M-121	1800	TRAY, C., 7/c 4#8 & 3#12	CKT #7720 HCL COMPRESSOR NO 4

LOAD SUMMARY DATA	K.V.A. (OR) H.P.	AMPS *
ACTUAL CONSUMED LOAD (MEAS. OR EST. AVG. WITH PLANT AT 100% PRODUCTION)	218.20	273
TOTAL CONNECTED NAMEPLATE	281.75	353
RUNNING NAMEPLATE	260.25	325
SPARE NAMEPLATE	21.5	27

* AMPS = KVA (OR) HP x 1.25 ~

FOR HCL PLANT DRAWING INDEX PLOT PLAN SEE DWG 62A-7000

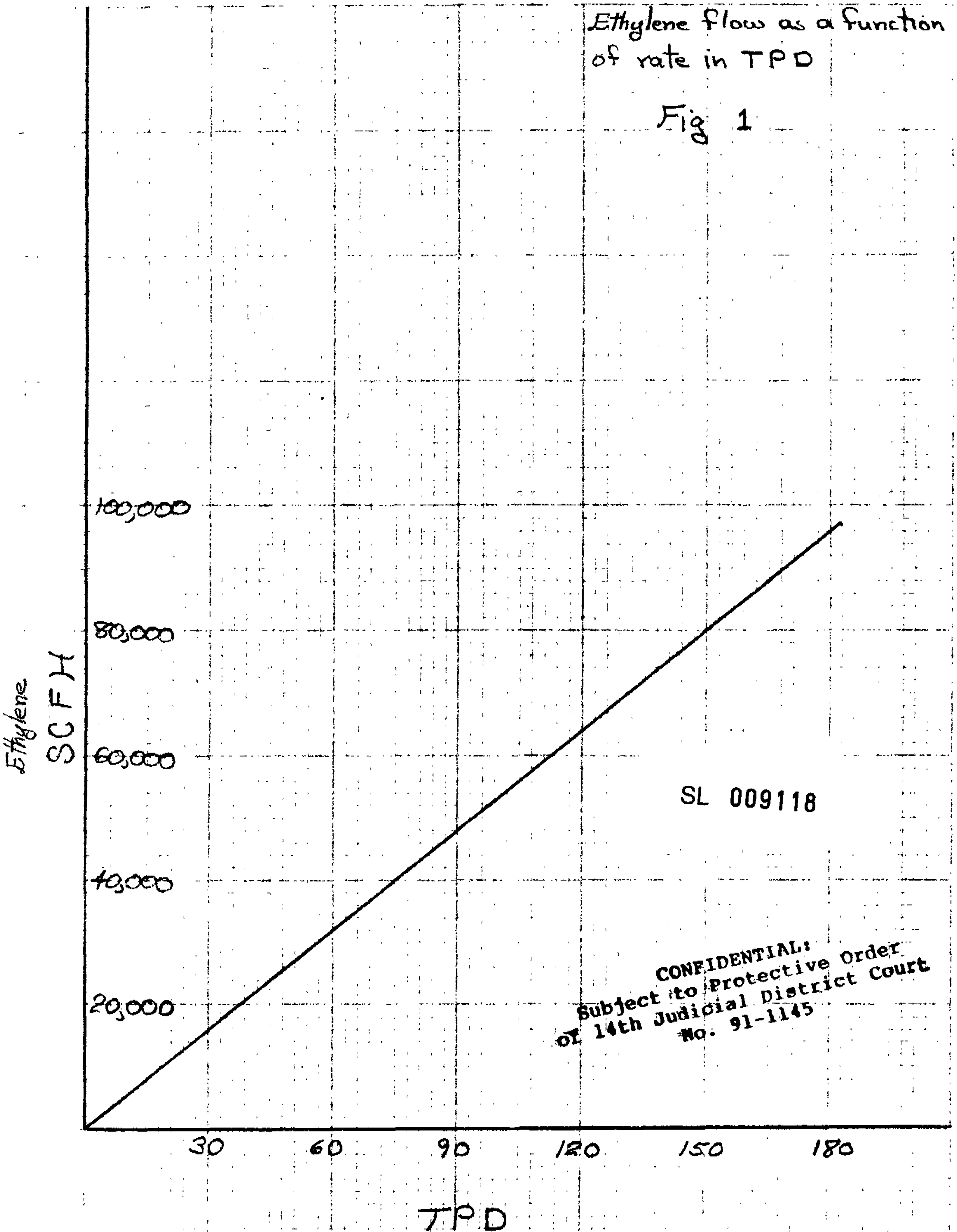
REVISIONS

1 ADDED BKR. TRIPS & MISC. CORRS. 7-8-65
2 ADDED CKT # 7720 8-8-65
3 ADDED TO 1 LINE & MISC. MEP 10-7-65
ISSUED 10/18/65 FOR [illegible] BULLETIN NO. 1265
ISSUED 11-4-65 FOR [illegible] BULLETIN NO. 1321E
ISSUED 11/22/65 FOR [illegible] BULLETIN NO. 1458
4 ADDED HEATER NO. TO SCHEDULE 11-29-65 J.K.G.
ISSUED 12-30-65 FOR [illegible] BULLETIN NO. 168-E

SL 009117

Ford, Bacon & Davis
Construction Corporation
NEW YORK MONROE, LA.
APPROVED [illegible] 5-28-65

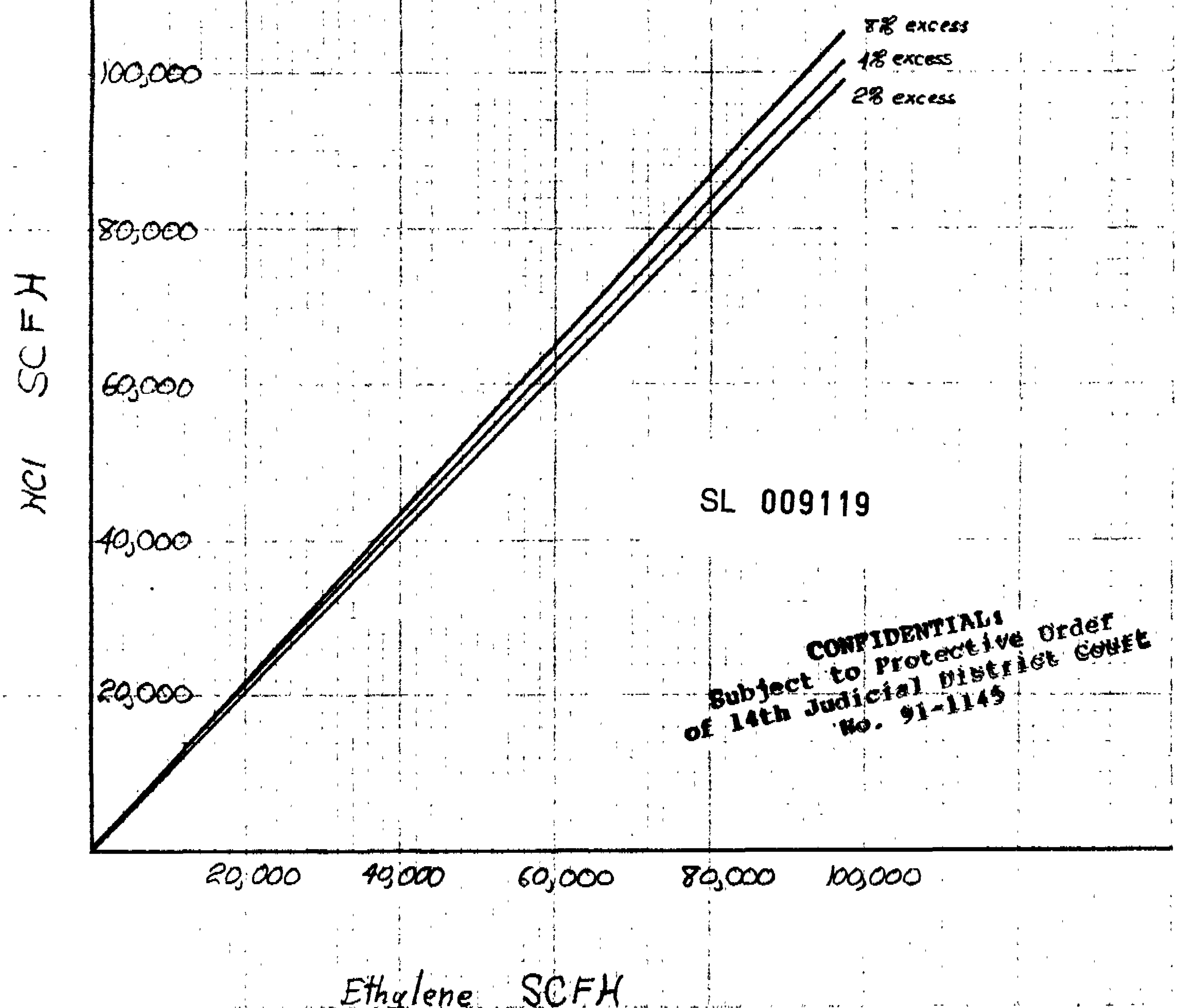
PITTSBURGH PLATE GLASS COMPANY
CHEMICAL DIVISION
LAKE CHARLES, LOUISIANA
HCL PLANT ELECTRICAL
480 VOLT MOTOR CONTROL CENTER
ONE LINE DIAGRAM & FRONT LAYOUT
BUS No. 7700
DRAWN BY OSTERLAND DATE 6/24/65 SCALE NONE
CHECKED BY [illegible] DATE 6/29/65 CHARGE P-674
APPROVED BY [illegible] DATE [illegible] SUB.
BILL OF MATERIAL NONE DWG. NO. 62A-7100.4


Ethylene flow as a function of rate in TPD
Fig 1
Ethylene
SCFH
100,000
80,000
60,000
40,000
20,000
30
60
90
120
150
180
TPD

SL 009118

HCl flow as a function of ethylene flow

Fig. 2



SL 009119

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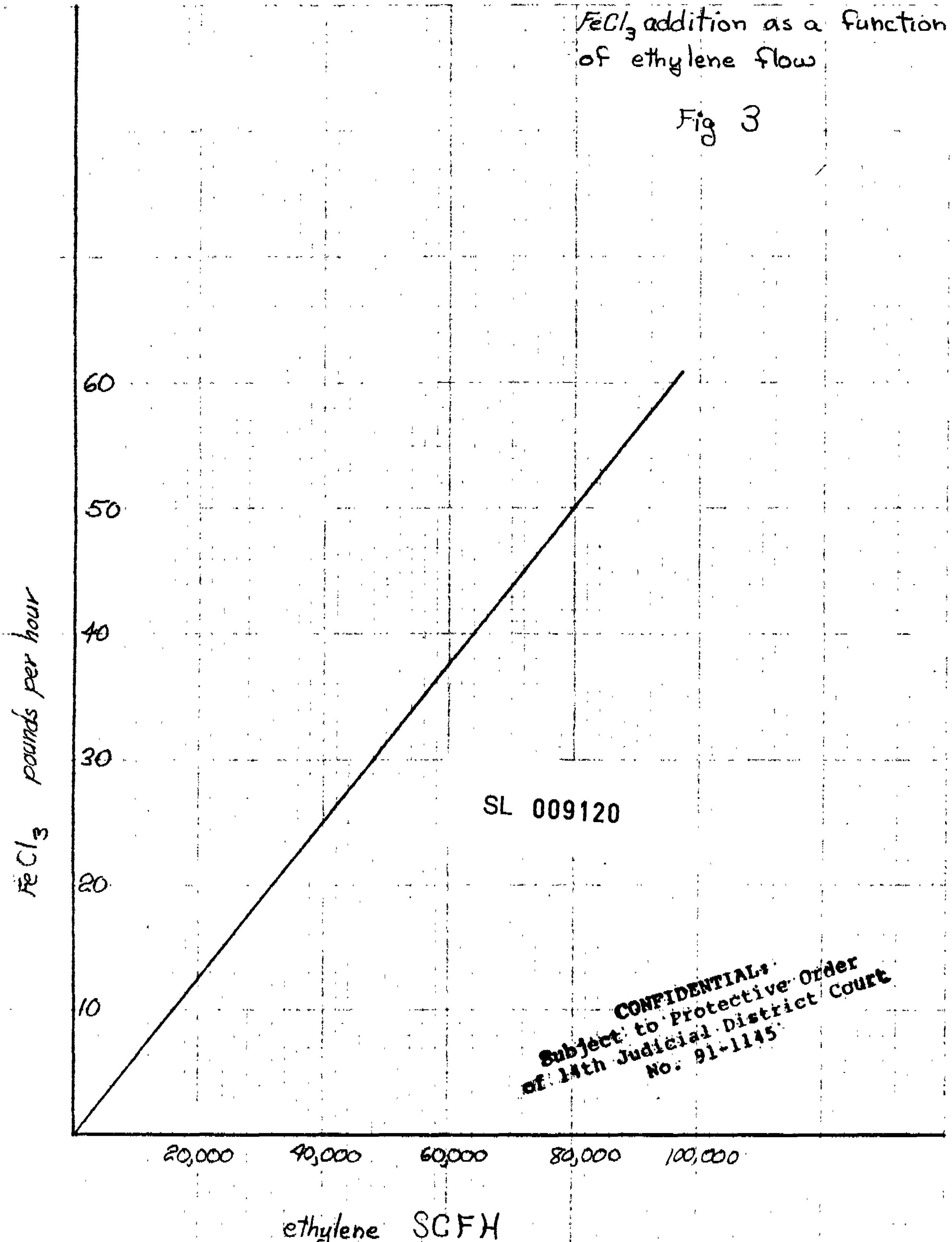
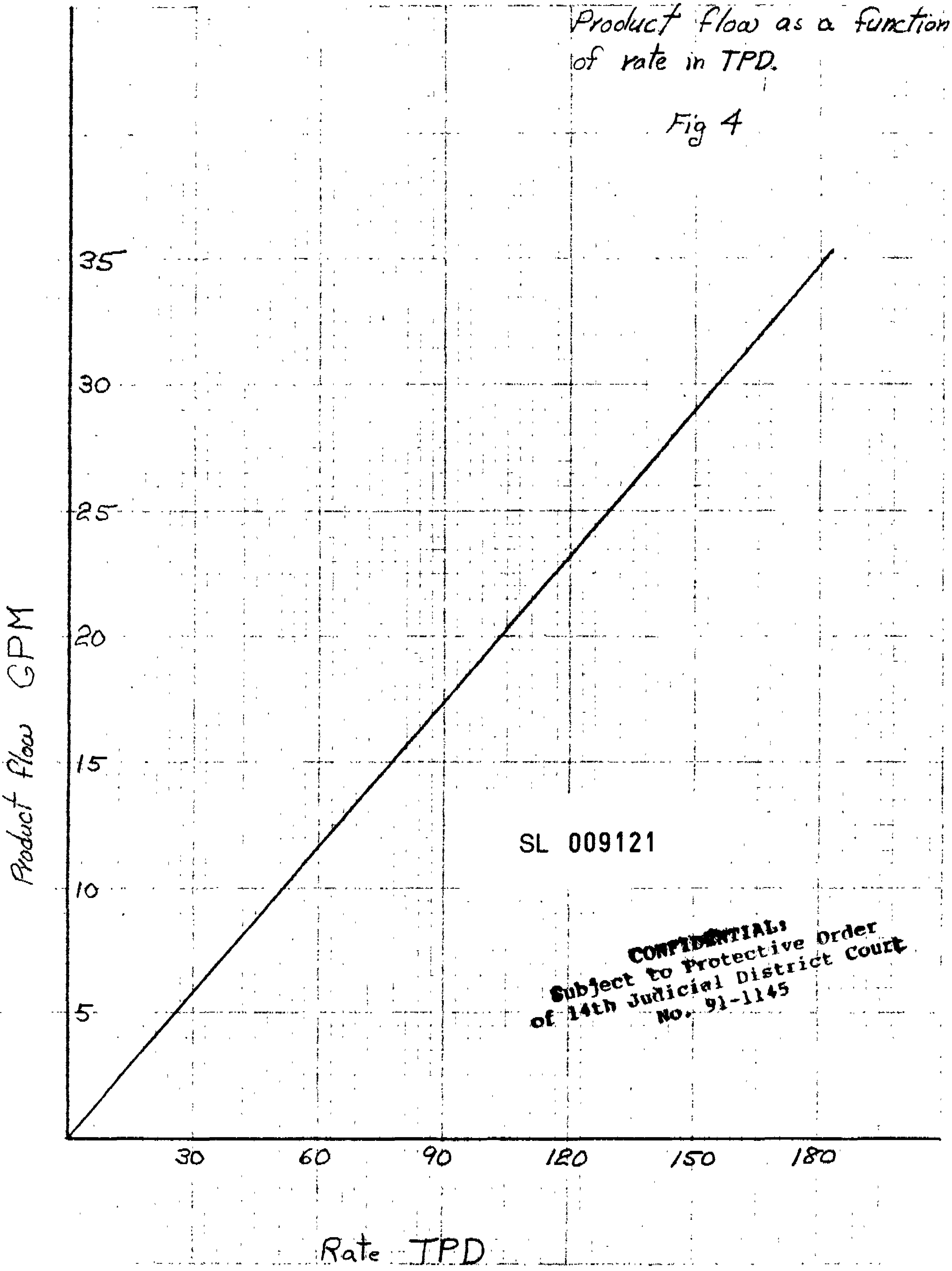


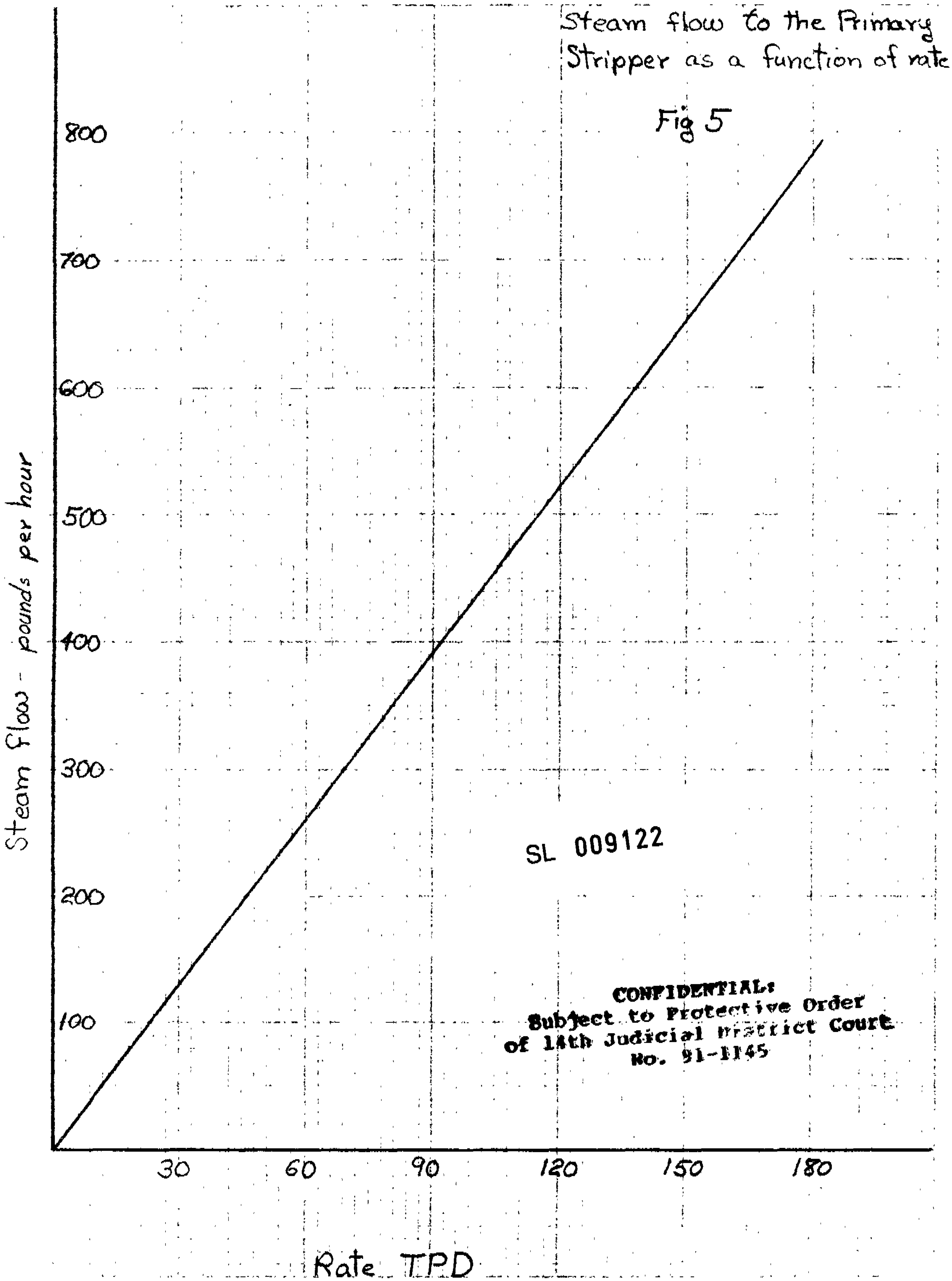
Fig 3

SL 009120



Product flow as a function of rate in TPD.

Fig 4


Steam flow to the Primary Stripper as a function of rate
Fig 5
800
700
600
500
400
300
200
100
Steam flow - pounds per hour
30
60
90
120
150
180
Rate TPD

SL 009122

Steam flow to the Secondary Stripper as a function of rate

Fig 6