

PLAINTIFF'S
EXHIBIT

ETCO-92

Report of Survey Done by Medical on
Plants 1 and 3 and the Salt Cake --
Hydrogen Chloride Plant of Ethyl
Chloride

E-05865

Sept. 1947

REPORT OF SURVEY DONE BY MEDICAL ON
PLANTS 1 AND 3 AND THE SALT CAKE -
HYDROGEN CHLORIDE PLANT OF ETHYL
CHLORIDE

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Sept. 1947.
By W. K. Smith

REPORT OF SURVEY DONE BY MEDICAL ON PLANTS 1 AND 3 AND
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Ethyl chloride is manufactured here by reacting the basic chemicals, ethylene and hydrogen chloride, in the presence of a catalyst. The catalyst used in C sections of No. 1 and No. 3 plant is either anhydrous aluminum chloride dissolved in ethyl chloride or the metal aluminum. At No. 2 plant (Frei), however, the ethyl chloride is produced by reacting vaporized ethyl alcohol and hydrogen chloride in the presence of zinc chloride. No polymer is formed in this reaction.

Raw materials are obtained as follows:

Hydrogen chloride produced by:

1. Reaction of H_2 and Cl_2 at Section No. 3 Plant.
2. Manufactured at Salt Cake - Hydrogen Chloride plant (Mannheim).

Ethylene:

1. Produced at B section No. 1 Ethyl Chloride plant by cracking a light petroleum fraction, chiefly propane.
2. Purchased from Standard Oil Company.

Catalyst:

Purchased in form of anhydrous aluminum chloride or aluminum metal.

Hydrogen:

Purchased from the Hydro plant of Baton Rouge, Refinery of Standard Oil.

Chlorine:

Normally supplied by Sodium Plant by electrolysis of fused sodium chloride.

B SECTION PLANT NO. 1

Ethylene, C_2H_4 , is obtained by cracking light petroleum fraction, chiefly propane, by heat and pressure. After cracking the propane, the next step is to take the aromatic distillates off by low pressure fractionization. These aromatic distillates remain liquid at atmospheric temperature and pressure. The removal of the aromatic hydrocarbons leaves hydrocarbons of C_4 and lighter.

These remaining hydrocarbons are then compressed and further cracking is done. Refrigerants are used here with different temperatures at different levels. In this process a split is made between ethane and butane; subsequently between ethane and methane, and this process goes on until the last one where there is a split between ethylene (C_2H_4) and ethane (C_2H_6). The ethylene then goes to the compressors and is delivered to C section. The butanes and propanes are used in recycling and when stabilized as liquids at atmospheric temperature and pressure are mixed with the aromatic distillates and sent to Standard Oil Company. The hydrocarbons lighter than ethylene are vented to flare stack and burned.

SALT CAKE - HYDROGEN CHLORIDE PLANT
(MANNHEIM)

Hydrogen chloride is obtained at Ethyl Chloride by two methods. One process involves the chemical reaction between sodium chloride and sulfuric acid in Mannheim furnaces giving hydrogen chloride and sodium sulfate (known as salt cake) as the products of this reaction.

Sodium chloride is received in railroad cars, is conducted by elevator conveyor and conveyors to three salt storage bins, each with 100 ton capacity. From the storage bins it is again conducted by conveyor system to the salt feed bin, thence to salt weighing scale, thru salt seal conveyor to the furnace.

Sulfuric acid, 98%, is conducted from sulfuric acid storage to constant feed tank (overflow back to storage) thence to acid scale, and thru a rotameter, and then to the furnace.

The furnace is maintained at 1000 at atmospheric pressure by seven gas burners. Within the furnace four opposing arms revolve about a hub. The sodium chloride and sulfuric acid are added at this hub and are kept molten near the hub. Each revolving arm has shoe-like paddles which constantly force the salt cake to the periphery. When the salt cake forms around the walls and when it is necessary to change the sleeves on furnace arms, a considerable exposure to HCl is present. At the sides of the furnace there are four outlets and as the salt cake is moved to the periphery it falls thru these openings periodically. It then goes to a macerator, through 2 coolers, thence to elevator and by elevator and conveyor system to salt cake storage

building. After it has cooled a bulldozer pushes it thru an opening in the floor into the crusher.

Soda ash (sodium carbonate) is added to the salt cake at this step of the operation to neutralize the excess sulfuric acid which may be present up to 3%. The soda ash is added by two men who break the sack and shake it over the salt cake. The entire operation is exceedingly dusty and as a consequence offers particularly a dermatological hazard since sulfuric acid, salt cake, and soda ash are primary irritants. From the crusher the salt cake is taken by conveyor system and chute to box cars. It now contains from 0.3 to 1.0% sulfuric acid.

The hydrogen chloride formed in the furnace comes off as a gas and passes thru a cyclone separator where the heavy material drops. It then goes to the cooling tower, to the cooler-absorber where it is mixed with water forming hydrochloric acid, and then to the stripper where it is boiled and vaporized. Thereafter it goes to No. 3 plant where it passes through a sulfuric acid scrubber after which it joins the common line to plants Nos. 1, 2 and 3.

A SECTION NO. 3 PLANT

The other process for the production of hydrogen chloride is the combustion reaction of hydrogen and chlorine. The combustion products, consisting of hydrogen chloride, air, and small amounts of moisture, leave the reaction chamber at an elevated temperature and are cooled, dried and compressed for use in the ethyl chloride manufacturing process. The portion of the No. 3 plant where these operations are carried out is designated as "A" Section.

Hydrogen is supplied from the Hydro Plant of the Baton Rouge Refinery of the Standard Oil Company of Louisiana where it is produced by passing methane and steam over a catalyst. The impurities are principally nitrogen, carbon monoxide, small quantities of unsaturated, low boiling hydrocarbons, carbon dioxide, methane and oxygen. The hydrogen stream is metered at 225* psi g. At this pressure the hydrogen is delivered to the reaction chambers (called burners) thru a hydrogen manifold.

Chlorine is normally supplied by the Sodium Plant where it is produced by the electrolysis of fused sodium chloride. The chlorine from the electrolytic cells is scrubbed with water to remove silicon tetrachloride, followed by * pounds pressure

scrubbing with sulfuric acid to remove water vapor and is delivered thru a pipe line to No. 3 plant, "A" Section (at 18 psi g.) where it passes thru a flame trap to the burner manifold. At the northwest corner of the burners chlorine tests are run off the feed line. Pressure here is 20 - 25 pounds.

The chlorine stream from the electrolytic cells is 95% pure, the impurities being nitrogen and oxygen. When the production of chlorine is greater than the immediate demand the excess is liquified and stored at Sodium Plant where it is subsequently revaporized as needed. The revaporized chlorine is 100% pure. When Sodium Plant cannot meet the No. 3 Plant requirements, the deficiency is met by use of chlorine (1) produced at Solvay Process Company and supplied by pipe line to No. 3 Plant.

The formation of hydrogen chloride by the combustion of chlorine in hydrogen is carried out in 5 du Pont type burners. These are lined with refractory brick to withstand the high temperature. The metered hydrogen and chlorine are fed to the burners in a hydrogen chlorine mol feed ratio slightly greater than one to insure complete conversion of the chlorine and to minimize the presence of free chlorine in the reactor feed since the presence of free chlorine causes formation of undesirable by products in the reactors. The heat of the reaction is removed by a continuous water flow over the outer surface of the burner and by radiation. The exact temperature of the exit gas is not known but has been estimated at 1000 - 1500° F. The impurities are the inert gases in the hydrogen and chlorine feed streams.

The burners are sampled for purity every one half hour. If an excess of chlorine is present there might be a small chlorine exposure although no cases have required medical care. The operator on Section "A" is called a "Burner" or "A" Section Operator. He operates the burner, checks area including the cooler side and sulfuric acid drying processes. He drains knock out drums once each shift and drains off concentrated HCl solution and at this time a certain amount of hydrogen chloride comes off giving an exposure. Here too no reportable cases. After leaving the burners the hydrogen chloride is air cooled by passing thru a steel cooling section, a pyrex glass cooling section and a rubber lined flame trap. The gases are cooled to about 150° F. in the steel trombone section by a water drip flowing across the pipes. Although this temperature is below the dew point composition, very little corrosion takes place because a coating of silica from the chlorine is formed over the surface of the steel coolers. The gases

are further cooled to 110° F. in pyrex glass double pipe heat exchangers.

Each burner is equipped with a cooling section and flame trap so that it can be operated independently of the other burners. The discharge from the flame traps are manifolded and the cool gases delivered to the drying section.

If a burner is repaired the gas is cut out of the flame trap into an injector which has a stream of water running through it causing a partial vacuum and absorbing the HCl.

The greatest chance for exposure is in the event of equipment failure, particularly if on the chlorine side.

In the drying towers, the moisture present in the stream is removed by counter current scrubbing with concentrated sulfuric acid (88 - 98%) in two series operated towers packed with ceramic Raschig rings. The HCl flowing up the tower is scrubbed by a downward flow of sulfuric acid which lowers the moisture content of the exit gas to less than 0.65 wt. %. A knock down drum, following the last drying tower, removes entrained sulfuric acid from the dried hydrogen chloride before it is compressed. The knock down drums are changed about once each shift and a chlorine or hydrogen chloride exposure may occur when the bleeders are opened.

The sulfuric acid is changed about once each shift; when it gets down to 91%. The operator who adjusts the valves wears full acid equipment. (Hood - coat, pants and gloves). As pressure is about two pounds, no one has yet been burned by acid who has followed the safety code. The HCl then goes to the compressors.

COMPRESSOR HOUSE

The compressor house is not a part of "A" Section. In the three stage compressor (i.e. compressed, cooled, compressed, cooled, and compressed and cooled) the gas is compressed from 2 psi g. pounds to 150 psi g. pounds and 100° F. Four Ingersole-Rand gas engine compressors are used. (Three in operation while the fourth is serviced.)

The HCl that has gone thru the three stage compressor is delivered to "C" Section Plant No. 3. Another portion of the HCl from "A" Section undergoes one stage compression and is then delivered to Plant No. 1.

C SECTION PLANTS 1 & 3

The synthesis and purification of ethyl chloride is performed in that portion of Plants 1 and 3 known as "C" Section.

The synthesis itself can be reduced to the following operations:

- (1) Mixing the reactants.
- (2) Bringing them in contact in the presence of catalyst.
- (3) Removing the ethyl chloride produced.
- (4) Maintaining a sufficiency of active catalyst to sustain efficient conversion.

The reactants (dilute ethylene, concentrated ethylene and hydrogen chloride) are delivered individually to "C" Section but are combined into a mixed feed before being charged to the reactors. There are two reactors in "C" Section, Plant No. 3 and one reactor in "C" Section, Plant No. 1. The reaction between the ethylene and hydrogen chloride takes place in two reaction vessels consisting of steel shells partially filled with a 3 - 4% aluminum chloride - ethyl chloride reactor solution. The reactors are packed with ceramic Raschig rings to provide contact surface for dissolving the reactants.

The anhydrous aluminum chloride is supplied as needed by manually emptying the drums in which it is received into a mixer known as "cat mixer" which has been blown out with ethylene gas, after being locked. While still closed, it is flushed with an inert gas purchased from Standard Oil and which is probably nitrogen or carbon dioxide. The base plate is then opened and the anhydrous aluminum chloride poured in. Workers doing this are supposed to wear goggles, gloves, body protection and respirators as a potential hazard exists for when anhydrous aluminum chloride comes in contact with moisture it breaks down into hydrochloric acid and aluminum hydroxide, releasing in the reaction an enormous amount of heat. When skin or mucous membrane is exposed to this compound, its action is intensely caustic. It is claimed that the substance sublimates and that the resultant vapor also causes caustic burns.

The reactants, entering through feed distributors, are dissolved in the reactor solution and react to form ethyl chloride. With a sufficient amount of active catalyst in the solution, the reaction is almost instantaneous. The effectiveness of the catalyst solution is determined qualitatively from the concentration of unreacted ethylene and hydrogen chloride in the gases leaving the reactors. A constant temperature is maintained to hold the converter fluid

level and the rest, all condensable gases and vapors go off overhead. The reaction forming ethyl chloride evolves approximately 610 Btu/lb ethyl chloride and a portion of this heat is used to vaporize the product. The remainder is removed by heat loss through the reactor shell and by circulation of reactor solution thru water cooled heat exchangers. Everything but polymer which is a complex aluminum chloride-ethylene compound goes off. With normal and efficient operation the reactor overhead gas stream contains from 1.5 to 2.5 mole% hydrogen chloride and 0.0 to 1.5 mole % ethylene. The excess of hydrogen chloride in the reactor overhead gas results from the fact that an excess of hydrogen chloride is maintained in the reactor feed to minimize catalyst consumption polymer formation and isopentane formation.

By-products other than polymer are formed in small amounts during the reaction, during the solution of the catalyst and during the removal of the polymer. The impurities, principally isobutane and isopentane and smaller amounts of related hydrocarbons and chlorinated hydrocarbons, pass overhead together with the product.

The ethyl chloride and heavier materials plus a few light ends are condensed. The remaining non-condensable gases are scrubbed with H_2O and caustic and returned to the refinery. The condensed ethyl chloride is put thru a stabilizing tower where light ends are returned to the reactor. The stabilizer bottoms are fed to the re-run still where heavy ends are removed for disposal and ethyl chloride is taken off overhead, condensed and put in product tanks for use. For purposes of reference, a more detailed description will be found in the subsequent indented paragraphs.

The recovery and separation of the ethyl chloride from the reactor overhead vapors is performed in the residual gas tower system which is composed of reactor gas exchanger, reactor gas precooler, the residual gas tower, the residual gas condenser, and the residual gas tower reflux drum.

The overhead vapors from the reactor at 100 - 125°F. are manifolded and partially condensed by cooling, first in the reactor gas exchanger which cools them to 95° F. and second in the propane cooled reactor gas precooler which cools them to 15° F. At the precooler discharge temperature, most of the ethyl chloride in the reactor overhead vapor is condensed. The vapor-liquid discharge from the precooler is separated in the bottom of the residual gas

tower; the liquid collecting in the bottom portion of the tower and the vapor passing up the tower.

The vapor passing up the tower (composed chiefly of feed diluents) contains some ethyl chloride not condensed at 15° F. This is recovered by rectification of the vapors on 8 bubble cap plates and by cooling the vapors leaving the tower to 100° F. in the ethylene cooled residual gas condenser. The liquid recovered in the condenser is separated from the feed diluents in a reflux drum and is returned to the tower reflux. The ethyl chloride free vapors from the reflux drum are used as cooling medium in the reactor gas exchanger and are heated to approximately 95° F. by the reactor overhead gas. These vapors containing the feed diluents plus small amounts of ethylene, hydrogen chloride and chlorinated hydrocarbons are scrubbed with water and caustic and sent to Standard Oil for fuel purposes.

The liquid collected in the bottom of the residual gas tower contains the ethyl chloride product together with impurities, both those less than volatile and those more volatile than ethyl chloride.

The impurities more volatile than ethyl chloride are (methane, ethane, ethylene, hydrogen chloride and isobutane) removed by a stripping process in a fractionating tower equipped with feed pumps, a steam heated reboiler, and a water cooled condenser.

The ethyl chloride separated from the reactor overhead is pumped from the bottom of the residual gas tower and is charged to the stabilizer thru a nozzle.

The low boiling impurities together with some ethyl chloride are vaporized in the steam heated reboiler and are removed from the column as overhead vapors. The vapors flow to the shell side of a water cooled condenser, part of the ethyl chloride condenses and is returned by gravity flow as reflux to the column. The non-condensed vapors flow from the condenser to the reactors for recovery of their ethylene, hydrogen chloride and ethyl chloride content.

The stabilizer removes ethylene, hydrogen chloride and impurities more volatile than ethyl chloride. The ethylene and hydrogen chloride are converted to ethyl chloride in the reactors while the more

volatile constituents are eliminated from the system as residual gas. Impurities boiling between hydrogen chloride and ethyl chloride cannot be removed as residual gas due to the low temperature and high pressure of the residual gas tower condenser.

Consequently, the concentration of such impurities in the system increase until their removal cannot be effected in the stabilizer and they appear as product impurities. Non-condensed vapors from the condenser are recycled to the reactor.

In order to maintain right concentration of polymer, a certain amount of converter solution is continuously withdrawn from the reactor and put thru the polymer stills where the ethyl chloride is blanked off and returned to system, and the polymer is removed for disposal.

Catalyst destroyed by polymer formation is replenished by adding additional anhydrous aluminum chloride to the "cat" (catalyst) mixer thru which converter solution is then circulated.

POLYMER SYSTEM Polymer Removal From The Reaction Medium

Polymer, the high boiling complex of aluminum chloride and ethylene, which, as stated previously, is very much less volatile than ethyl chloride. Consequently, it remains in the reactor solution while the product is removed overhead. The accumulation of this by-product in the catalyst solution results in poor conversion, high catalyst consumption, and low product purity.

To prevent this accumulation, the complex is removed from the reaction medium by constantly withdrawing a portion of the reactor solution, as described previously, vaporizing the greater part of its ethyl chloride content, condensing the vaporized ethyl chloride for return to the reactors, and discharging the non-vaporized residue. The equipment used in this process consists of two flashing stills (a high pressure still and a low pressure still) with their auxiliary preheaters, condensers, condensate drums and pumps.

The first polymer still removes (flashes off) the greater portion of the ethyl chloride contained in the reactor solution from the high boiling compounds and the aluminum chloride catalyst. Reactor fluid flows from the reactors thru a pre-heater into the still. The stream is metered and flows under the pressure differential existing between the reactors (at 120 psi g.) and the still (at 90 psi g.). At the first still temperature of 195° F., most of

the ethyl chloride and the volatile compounds are vaporized (flashed off) and pass overhead. This overhead vapor is then cooled and condensed in a water cooled condenser and is discharged into a condensate drum, the liquid being continuously pumped back to the reactors, i.e., returned to the system. The bottoms from the first still are fed to the second polymer still which is a low pressure still for recovery of additional ethyl chloride.

At 125° F. and 90 psi g. of the first still condensate drum, part of the first still overhead is not condensed. This uncondensed portion is exhausted thru a pressure controller to the lower pressure and temperature (35 psi g. and 20° F.) second still condenser where the ethyl chloride in the stream is condensed together with the ethyl chloride in the second still overhead. A portion of the low boiling impurities remains uncondensed and is vented from the second still condensate drum to the atmosphere thru a pressure controller carrying with it a small amount of ethyl chloride.

The second polymer still or low pressure still operates at a lower pressure (35 psi g.) than the first polymer still (90 psi g.) to reduce the ethyl chloride content of the non-volatile residue from the first still to a minimum (3%). The bottom of the first still flows thru a steam heated pre-heater to the second still, where essentially all the ethyl chloride and other volatile compounds are vaporized at 175° F. This overhead vapor is cooled and condensed in a propane cooled condensor and is discharged into a condensate drum. This liquid from the condensate drum is pumped periodically to the slop tank from which it is later returned to the reactors, i.e., returned to the system. The slop tank is used to store impure ethyl chloride.

The bottoms of the second still contain a small amount of ethyl chloride, the high boiling complex impurities, and the aluminum chloride catalyst. This conglomerate is called polymer and is discharged to a storage tank from which it is fed either by pressure or pump to the polymer burner.

One 1st class operator and a helper runs all of "G" Section and one other man runs samples, analyzes various ethyl chloride, ethylene, ethylene and hydrogen chloride streams for purity. In the analyses the Burrel system is used. Bromine is employed in this procedure. If the reagent bottle containing the Bromine should be broken an exposure to that substance would result.

Operators here check levels with bleeders and check the polymer line going to storage. They have possible exposure to polymer and ethyl chloride. There is also an exposure to steam in the whole section when the operator

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checks the steam line.

The worker also analyzes reactor overhead and waste gas.

One worker called "Board Man" watches the instruments in the control room and calls the operator's attention to anything flowing off records data on data sheets.

**ALPHABETICAL LIST OF ACTUAL AND/OR POTENTIAL EXPOSURES
HCl and ETHYL CHLORIDE AREA**

SPECIFIC SUBSTANCES

Anhydrous Aluminum Chloride	Karbate	Thinners
Aromatic Hydrocarbons	Karbate accelerator	Turpentine
Asbestos		
	Lacquer	Varsol
Carbon monoxide	Lead, red	
Catalyst (anhydrous $AlCl_3$)	Lead fumes (oxide)	
Chlorinated hydrocarbons *	Lead, white	
Chlorine	Metal fumes	Zinc fumes (oxide)
		Zinc chloride
Enamels	Oil, crankcase	
Ethyl Chloride	Oil, penetrating	
Ethylene	Oil, soluble cutting	
Ethylene Dichloride	Oxides of nitrogen	
Fluorides	Paints	
Fluorine	Polymer	
	Polymerization products *	
Gasoline	Silicon dioxide	
Grease	Sodium carbonate	
	(Soda ash)	
Havec	Sodium hydroxide	
Hydrogen	(Caustic)	
Hydrogen chloride	Sodium sulfate	
Hydrochloric acid	(Salt cake)	
	Sulfuric acid	
Isobutane		See also Appendix I
Isopentane		

* Complex polymerization products and possibly complex chlorinated hydrocarbons, the exact formulae and numbers of which are not yet known are formed along the lines. Some are definitely irritants and may possibly be toxic and although very improbable, carcinogenic.

MISCELLANEOUS EXPOSURES

Electrical burns and shock (From 13,800 volts down to 400 amps down)	Heat (Mannheim)	Radiation Infra red Ultra violet (Welders)	Steam (When testing lines)
Pneumoconiosis producing dusts			
Silicon dioxide (Sandblasters - negligible)			
Asbestos (Carpenters - negligible)			

POTENTIAL AND ACTUAL EXPOSURES * BY SITES: HCL AND ETHYL
CHLORIDE AREA

PLANT NO. 1

Anhydrous aluminum chloride
Aromatic hydrocarbons
Catalyst
Caustic
Chlorinated hydrocarbons
Ethyl chloride
Ethylene
Ethylene dichloride
Grease
Hydrocarbons
Hydrogen chloride
Hydrochloric acid
Isobutane
Isopentane
Oil
Polymer
Polymerization products
Propane
Varsol

PLANT NO. 2 (Frei)

Chlorine (from Sodium)
Ethyl alcohol, vaporized
Ethyl Chloride
Hydrochloric acid
Hydrogen chloride
Sodium hydroxide
Zinc chloride

PLANT NO. 3

Anhydrous aluminum chloride
Bromine
Catalyst (anhydrous $AlCl_3$)
Chlorinated hydrocarbons
Chlorine
Ethyl chloride
Ethylene
Grease
Hydrogen
Hydrochloric acid
Hydrogen chloride
Isobutane
Isopentane
Oil
Polymer
Polymerization products
Propane
Sulfuric acid
Varsol

Steam

SALT CAKE-HYDROGEN CHLORIDE PLANT

(Mannheim)

Hydrochloric acid
Hydrogen chloride
Sodium Chloride
Sodium Carbonate (Soda ash)
Sodium sulfate (Salt cake)
Sulfuric acid
Heat

REPAIR SHOP

Carbon monoxide
Gasoline
Grease
Oil
Varsol (?)

ETHYL CHLORIDE MAINTENANCE SHOPS

CARPENTER SHOP

Asbestos (negligible)
Karbate
Karbate accclerator
Wood dusts

WELDING SHOP

Acetylene
Fluoride salts, volatile
Flux
Hydrogen fluoride
Lead oxide (if cut painted metals)
Metal fumes
Oxides of nitrogen

"Flash burns"

Radiation

Infra red
Ultra violet

* Principal exposures, potential or actual. Exposures to substances like hydrogen important only from explosion or fire standpoint and is important actually as safety problem and not health.

SPECIFIC EXPOSURES BY CRAFTS*

ETHYL CHLORIDE MAINTENANCE

CRAFT and Job Description	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED (Potential and/or actual exposures)
PAINTERS PAINTER HELPERS Do spray and brush painting. No paint containing lead is sprayed, only brushed All maintenance helpers, third class, are originally assigned as painter helpers. Thus, the group of painter helpers acts as a pool from which other maintenance crafts draw helpers as needed. Should the helper show aptitude in that craft and like the work he is usually assigned there permanently.	14 23	Entire HCl and Ethyl Chloride area When working at Mannheim, exposures are to those substances in exposure column numbered as follows: 1, 3, 4, 5, 6, 7, 8 and 9, and some 2, but very little and for practical purposes may be disregarded. PLANT NO. 1 (Approximately 10% man-hours of exposure.) PLANT NO. 3 (Approximately 40% of man-hours exposure.)	1. Note list of paints and thinners used as listed in Appendix I. 2. Chlorine (very little) 3. Hydrochloric acid 4. Hydrogen chloride 5. Sodium carbonate (Soda ash) 6. Sodium chloride 7. Sodium Sulfate (Salt cake) 8. Sulfuric acid 9. White lead N.B. Approximately 70% of painters and helpers have exposure to the above list about 50% of time. Anhydrous aluminum chloride Aromatic hydrocarbons Ethylene Ethylene dichloride Hydrogen chloride (Does not constitute much hazard) Polymer Propane Complex polymerization products along lines. The exact number and formulae of these are not yet known. Some are definitely irritants. Anhydrous aluminum chloride Chlorine (occasionally a little) Ethylene Hydrochloric acid Hydrogen chloride Polymer Propane Complex polymerization products (see next preceding list)

Specific exposures by operators are not given in these tables as the substances encountered by specific operators are adequately covered in the text of this report. THE ONE EXCEPTION TO THIS IS SHOWN IN A SUBSEQUENT TABLE COVERING OPERATORS EMPLOYED IN T.E.L. AREA. Their jobs are not actually Ethyl Chloride but T.E.L.

ETHYL CHLORIDE MAINTENANCE (p.2)

CRAFT and Job Description of Craft	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED (Potential and/or actual exposures)
PAINTERS (Cont'd.)		Drying area, Plant No. 3 (10% of exposure time) PLANT NO. 2 (Frei.) 2 painters and 2 painter helpers spend all their time in T.E.L. area on outside jobs limited to painting tank cars. Painters and helpers do brush and spray painting in paint shop as necessary. Paint shop is poorly equipped - no exhaust system present.	Sulfuric acid (When working in Drying area workers are required to wear full acid equipment) Chlorine Ethyl alcohol Ethyl chloride Hydrogen chloride (about 30% exposure) Sodium hydroxide (25% solution) Sulfuric acid (Have encountered no trouble) Zinc chloride (Solid or liquid, if liquid, is hot.) Exposure to T.E.L. considered negligible.
CARPENTERS 8 CARPENTER HELPERS 8 INSULATORS 6 INSULATOR HELPERS 6 NOTE: When necessary, carpenters and insulators are used interchangeably. Carpenters do carpentry throughout entire area and carpentry and wood working in carpenter shop. Insulators do neat and frost insulation of cork and asbestos, i.e., insu- lation to maintain tempera- tures of hot and cold sub- stances. They use moulded pipe. Cement is mixed from dry cement. They also saw blocks composed of 85% magnesia and 15% chalk		2 carpenters, 2 carpenter helpers, 1 insulator, and 1 insulator helper are stationed at Mannheim full time. The other 6 carpenters, 6- carpenter helpers, 5 insula- tors, and 5 insulator helpers work at Plants 1, 2 and 3 as needed. They also work at Development Section as needed. Carpenter shop	Exposures are potential- ly the same as those of painters for the same areas. Have potential lead exposure when working at Development Section. Asbestos (Exposure is negligible as far as asbestos is concerned but constitutes a severe nuisance dust due to no exhaust)

ETHYL CHLORIDE MAINTENANCE (p.3)

CRAFT and Job Description of Craft	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED (Potential and/or actual exposures)
CARPENTERS (Cont'd.)			
Two carpenters and two helpers do sandblasting but are alternated as only one machine is available		All over area	Silicon dioxide (sand) Lead (If part blasted had been painted with lead paint.)
Cut KARBATE from block form using circular saws, etc. (Have Karbate in pipe, cylinder and block form. Karbate is used to carry HCl and chlorinated hydrocarbons)		Carpenter shop	KARBATE (Contains graphi impregnated under pressu with binder cement) Whil not a health menace constitutes severe nuisance dust when sawed due to lack of local exhaust.
<u>OUTSIDE MACHINISTS</u> " " " <u>HELPERS</u>	15 35	These workers, in general circulate.	Exposures essentially th same as carpenters and insulators, i.e., plant exposures
Maintain, grease, and oil machinery, pumps, elevators, conveyors, compressors, etc. as well as automotive equipment, tractors, etc.		Greasers work regularly at Plants 1, 2 and 3 unless needed occasionally elsewhere. 2 machinists and 2 helpers on compressors (HCl compressors) 2 greasers and 1 helper work as greasers all over Ethyl Chloride area all the time.	Grease Oil Varsol (Compressors)
2 mechanics and 2 helpers and one greaser, full time, maintain, grease and oil pumps, elevators, and conveyors at		1 machinist and 1 helper work in salvage all the time.	
		1 machinist and 1 helper work on trucks and tractor. Note: Garage at Mannheim is call Repair Shop; has only natural ventilation	Carbon monoxide Gasoline Grease Oil Plus exposures at Mannh. listed immediately belo
		Mannheim	Grease Hydrochloric acid Hydrogen chloride Oil Sodium carbonate Sodium chloride Sodium sulfate Sulfuric acid
		Remainder of outside machinists not specific-ally listed above work all over plant about equally.	Plant exposures
<u>BOTILERMAKERS AND RIGGERS</u> 23 (Work interchangeably) <u>BOTILERMAKER AND RIGGER</u> <u>HELPERS</u> 23 (Work interchangeably)		Over entire area	Plant exposures plus exposures encount in specific jobs such welding, listed below subsequent chart)

ETHYL CHLORIDE MAINTENANCE (p.h)

CRAFT and Job Description of Craft	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED (Potential and/or Actual Exposures)
BOILERMAKERS & RIGGERS (Con't.)			
Boilermakers and Riggers and their helpers work interchangeably and do the same work. One day Riggers may be needed and the next day Boilermakers may be needed. Riggers do bracing, pipe-hanging, stack work, remove and install machinery and parts that have to be rigged. Work is more or less the same as done by steel construction workers. Also install hand railing and do some welding.		Entire HCl and Ethyl Chloride area	See later chart for exposures of welders
Fabrication is done by boilermakers.			
NOTE: See also later chart for boilermaker, helper, and welder who go to T.E.L. area.			
<u>PIPEFITTERS</u>	28	Time fairly equally divided over area (Outside buildings)	Plant exposures plus Graphite and Oil for oiling bolts. White lead for cementing joints and on gaskets.
<u>PIPEFITTER HELPERS</u>	32	When working at Mannheim	Excessive heat
<u>FIRST CLASS WELDERS</u>	4	Over entire HCl and Ethyl Chloride area.	Plant exposures plus exposures peculiar to welding:
<u>SECOND CLASS WELDERS</u>	4	Have welding shop which is open and when coated rods are used local exhaust is used which is not too satisfactory according to the welders.	Acetylene Flux Fluoride salt, volatile Hydrogen fluoride Metal fumes Oxides of nitrogen "Flash burns" Radiation Infra-red Ultra-violet
First class welders do outside welding and weld anything necessary but largely steel and stainless steel with occasionally some brass, bronze and tin. They do both acetylene and electric. When doing acetylene a flux is used. Electric welding: use both coated and uncoated rods.			
Second class welders do cutting and sometimes cut painted metal but none with lead paint.			
<u>ELECTRICIANS</u>	10	Cover entire HCl and Ethyl Chloride area	Exposures essentially the same as those met by painters plus
<u>ELECTRICIAN HELPERS</u>	10		Electrical shock Electrical burns (From 13,800 volts down to 400 amps. down.)
Electricians and helpers do electrical maintenance: Repair, replace, install and inspect electrical equipment such as lights, motors, transformers, fans, vibrators, meters, etc.			
<u>INSTRUMENT MECHANICS</u>	8	About 20% of man-hours spent in shop.	Exposures essentially the same as painters and to any substance in process
<u>" " HELPERS</u>			

ETHYL CHLORIDE MAINTENANCE (p.5)

CRAFT and Job Description of Craft	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED (Potential and/or Actual Exposures)
INSTRUMENT MECHANICS * * HELPERS (Cont'd.) Instrument mechanics install, repair, replace and inspect all recording, indicating instruments and meters and install, repair, replace and inspect all refrigeration units.		About 20% man-hours spent Plant 1.	lines. Only about 10% of entire time are exposed to potential hazards. About 5% of entire time spent at Plant 1 are exposed to 2, 3, 4 & 6. 1. Chlorine - (1% time in area) 2. Ethylene 3. Ethylene dichloride 4. Hydrogen chloride 5. Polymer - (10% of time in area) 6. Propane
		About 10% man-hours spent at Plant 2 (Frei)	Chlorine (From 6 to 25% of time in area) Ethyl Chloride (Have from 10 to 15% of time in area potentially exposed) Hydrogen chloride (Have potential exposure 6 to 25% time spent in area) Sodium hydroxide (Have over 5% time in area w. potential exposure) Zinc chloride (For practical purposes considered as none)
		About 30% man-hours spent at Plant 3	Percent of time spent in area with potential exposures as follows: Chlorine - 20% Ethylene - 10% Hydrogen chloride - 20% Polymer - 10% Propane as refrigerant 1 Sulfuric acid - 5%
		About 20% man-hours spent at Mannheim	Percent of time spent in area with potential exposures as follows: Hydrochloric acid and Hydrogen chloride - 40% Sulfuric acid - 40% Sodium carbonate - none Sodium sulfate - none
LABORERS NOTE: The work done by group classified as laborers is extremely diversified and runs all the way from some employed full time in T.E.L. area to a coffee maker who makes and distributes coffee over entire HCl and Ethyl Chloride area. 10 laborers are assigned to		3 laborers work at T.E.L. blender full time HCl (Mannheim) full time	For exposures see table "Ethyl Chloride personnel who work in T.E.L. area"

ETHYL CHLORIDE MAINTENANCE (p.6)

CRAFT and Job Description of Craft	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED (Potential and/or Actual Exposures)
<u>LABORERS (Cont'd.)</u>			
4 laborers feed hoppers and add soda ash to salt cake in salt cake shed		Salt cake shed, HCl (Mannheim) full time	Hydrochloric acid Hydrogen chloride Sodium carbonate Sodium sulfate Sulfuric acid
2 laborers work as clean up men in furnace and stripper buildings (1 man each in 1 & 2 furnaces and strippers)		Furnaces and strippers Mannheim, full time	See next preceding list
1 laborer acts as porter over entire Mannheim area		Mannheim area, full time	"
3 laborers work on ground as general clean up men		Mannheim area, full time	"
.....			
1 laborer works at general laborer's duties (roustabout)		CP plant, full time	Area exposures
.....			
1 does janitor work in office and shops		Ethyl chloride area	Area exposures when not in office
.....			
1 coffee maker makes coffee in tool room and makes two daily trips over HCl and Ethyl Chloride area distributing it		Entire HCl and Ethyl Chloride area	Plant Exposures
.....			
2 laborers work on 1 truck and another on another truck as roustabouts and help as necessary. Work pretty much over as general clean up men and haul aluminum chloride to Plants 1 and 3		Entire HCl and Ethyl Chloride area	Plant exposures
.....			
2 laborers work in storehouse as porters or handymen		Storehouse	Exposures negligible at storehouse
.....			
8 laborers work as general yard men for any task as needed over entire Ethyl Chloride area with some particularly specified duties as follows:		Ethyl Chloride area	Plant exposures in general plus certain exposures on special jobs noted below:
Wash compressors inside and outside and add oil as well as keep building clean when torn down		Compressor houses, Plants 1 and 3	From practical standpoint exposures not significant
Clean entire section from top to bottom. Dump catalyst (anhydrous aluminum chloride) from drums into catalyst mixer ("cat mixer") and act as clean up men. Polymer spills all the way down		C Sections, Plants 1 & 3	Section and line exposure (See painters) Exposures particularly bad area: Anhydrous aluminum chloride

ETHYL CHLORIDE MAINTENANCE (p.7)

CRAFT and Job Description of Craft	Average Number of Employees	WHERE WORK DONE	SPECIFIC SUBSTANCES ENCOUNTERED Actual and/or Potential exposures
<u>LABORERS (Cont'd.)</u>			
and must be cleaned up carefully. Clean out activated aluminum chloride about once every year.			Hydrogen chloride Polymer
General clean up men and clean up around furnaces. Not as much spill here as in Section A. Clean bubble towers		B Section, Plant No. 1	Section exposures (see carpenters)
General clean up men. In drying area remove rings		A Section, Plant No. 3 Drying area, A Section	Section exposures. Sulfuric acid (laborers wear full acid equipment when working in drying area.
.....			
1 man acts as general clean up man and roust-about. Adds Zinc chloride (about a half hour job) three times a week		Plant No. 2 (Frai)	Chlorine Ethyl alcohol Ethyl chloride Hydrochloric acid Hydrogen chloride Sodium hydroxide Zinc chloride
.....			

NOTE; When any laborer has worked on a job where he may have had a skin or clothes contamination by a toxic or dermatitis producing substance he is sent to change clothes and does not return to work until he has bathed and put on clean clothes.

APPENDIX I

PAINTS AND THINNERS IN USE IN THE HCL AND ETHYL CHLORIDE AREA

1. Red Lead, No. 7900 (Socony)
2. Red, No. 310 Fire Equipment, Machine and Tool
3. Gray, Primer Surfacer (Du Pont) Undercoat
4. Gray, Galvanized Iron Primer
5. White, Interior Primer Sealer
6. Green, Socony No. 280500 (Interior Rubber Base)
7. Green Olive, Brushing Enamel
8. Green Olive, Spraying Lacquer
9. Green Chemical Resistant (Interior Rubber Base)
10. Green Anti Oxide Bronze
11. Green Automotive (Lacquer)
12. Gray Tank Car (Lead Base)
13. Black Marine Hull Finish (Outside Enamel)
14. Black Heat Resistant (Socony No. 2311)
15. Black Automotive (Lacquer)
16. Aluminum (Asphalt Base)
17. White Exterior Gloss (Lead Base)
18. White Flat
19. White Interior Gloss (Enamel)
20. White Lacquer Spraying

THINNERS

1. Thinner No. 7T1 Socony
2. Thinner No. 7T2 Socony
3. Thinner No. 7T1 Socony
4. Thinner Lacquer
5. Thinner No. 3717 Duco - Du Pont
6. Thinner Turpentine

Consolidated
Chemicals Co.
(H_2SO_4)

Aluminum Ore Co.
(Aluminum Co. of
America)

Monte Sano Bayou

U.S. Highway 190

Copolymer Corp.
(Firestone Rubber Co.)

Solvay Process Co.
(Chlorine)

Illinois Central RR.

ETHYL CORPORATION

Salt - Cake -
Hydrogen chloride
Plant

T. E. L.
Area

Sodium Plant
(Chlorine)

No.3
Plant

No.2
Plant

No.1
Plant

Louisiana & Arkansas RR.

Chemical Products Division
Standard Oil Co. of La.
(Ethylene)

Private Road

Gulf States
Utilities Co.
(Steam & Electric
Power)

Standard Oil Co. of La.
(Hydrogen & Propane)

SKETCH NO. 1:

Layout of Ethyl Corporation areas
Location of bordering companies

ETHYL CHLORIDE PERSONNEL WORKING IN
T.E.L. AREA

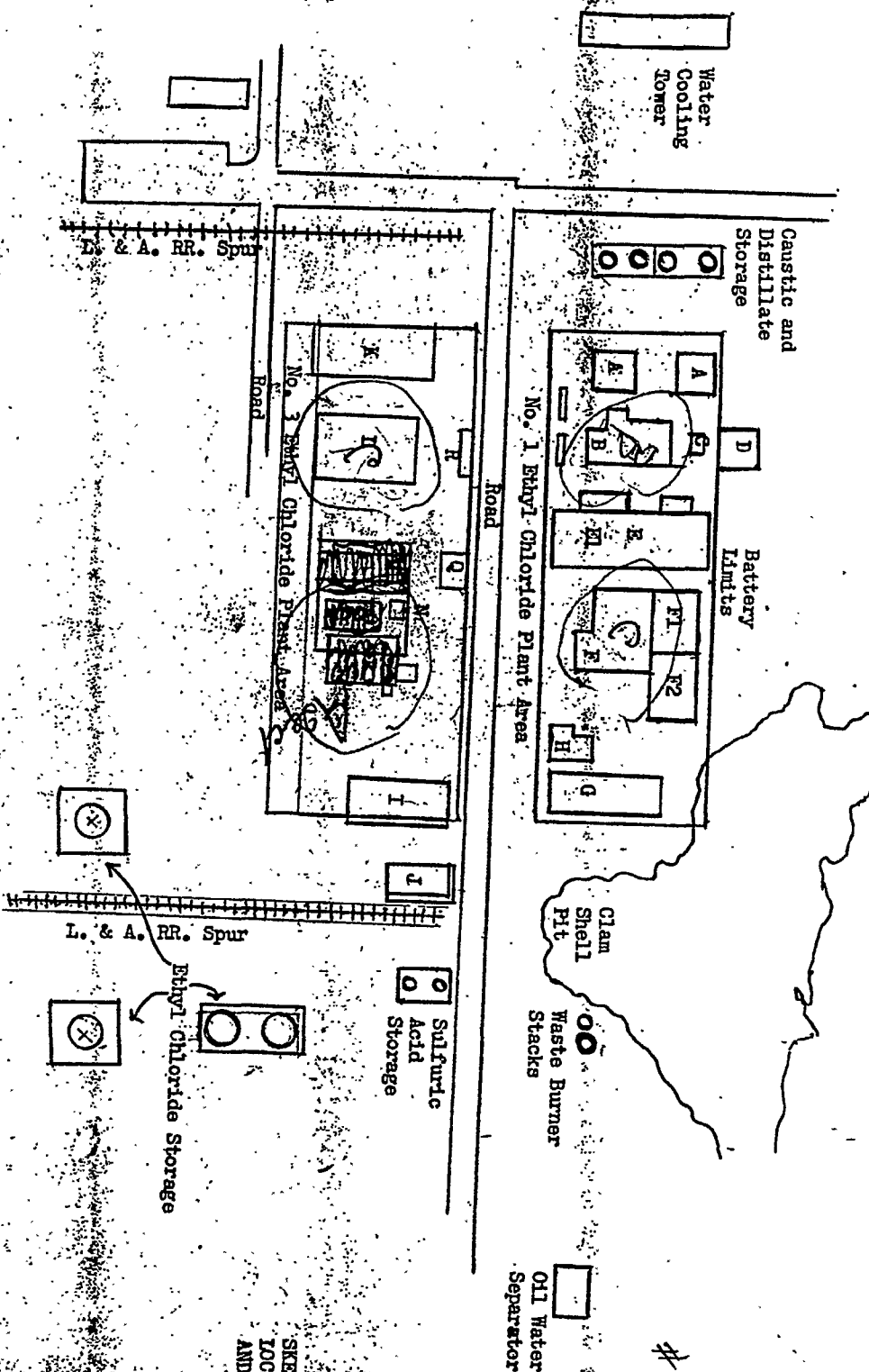
JOB AND JOB DESCRIPTION	NUMBER	SPECIFIC SUBSTANCES ENCOUNTERED Potential and/or actual exposures
<u>ETHYL CHLORIDE MAINTENANCE</u> <u>OUTSIDE MECHANICS</u> (Formerly called millwrights) <u>HELPERS</u>	5 4	No appreciable exposure to T.E.L. if tank cars have been properly prepared first. However, if cars have not been adequately prepared, a marked hazard can be present.
General tank car repairs and interior cleaning. No welding but do riveting and replace broken parts. Clean lead sludge out of tanks. Clean T.E.L. fluid railroad cars only. Repair other railroad tank cars. Employed in T.E.L. area full time.		
1 Boilermaker, 1 helper and 1 Welder go to T.E.L. area from Ethyl Chloride to repair tank cars. Time worked in T.E.L. Area quite variable and may be from a few hours to weeks and may go to T.E.L. area same intervals.	3	See exposures of tank car repairmen in next preceding section this page.
<u>ETHYL CHLORIDE OPERATORS</u> (Referred to usually as "BA Operators" i.e., Bargaining Agency Operators)	3 or 4 depending on the amount of work.	Ethylene Dibromide Ethylene Dichloride Propylene Dichloride Tetra ethyl lead
Hook up and unhook T.E.L. fluid cars only. Handle all raw materials from tank cars to storage.		

LEGEND

A - Gas Cracking Furnaces
 B - Fractionating Group
 C - Gaustic Scrubber
 D - Accumulators
 E - Compressor House
 F - Control Room of plant
 F - Fractionating Group

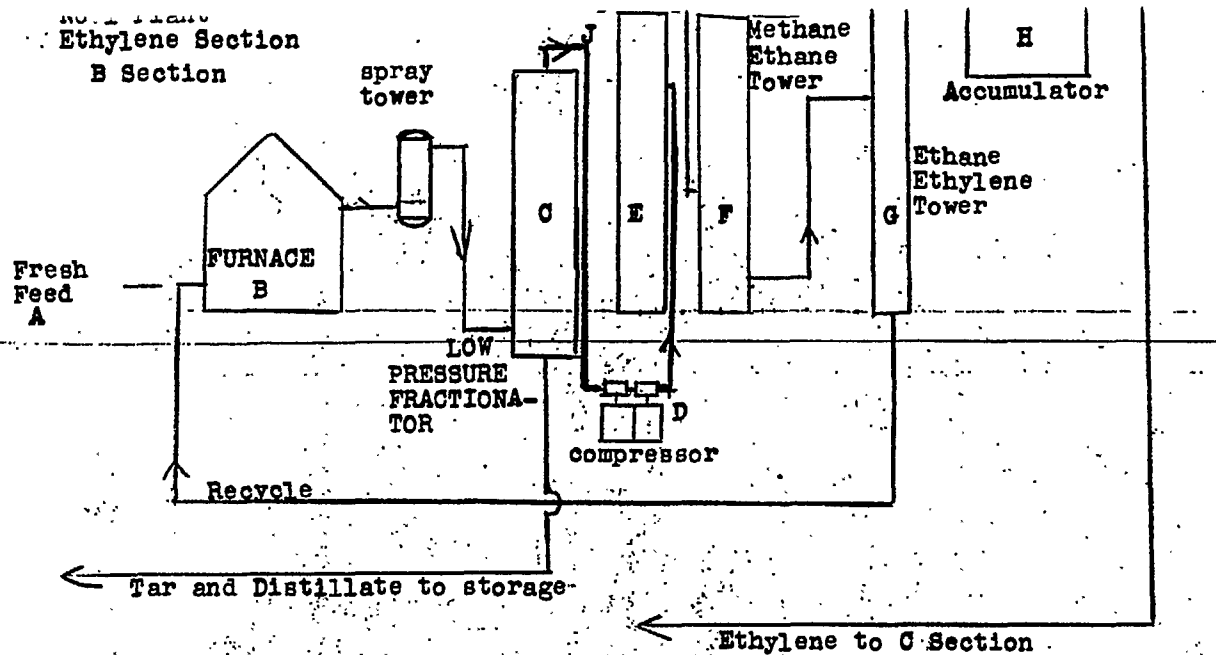
F1 - Refrigeration Group
 F2 - Accumulators
 G - Burner Building
 H - Hydrogen Chloride Section
 I - Drying Group
 I - Store House

K - Storage Drums
 L - Fractionating Group
 M - Compressor House
 N - HCL Liquidation Unit
 O - HCL Drying Towers
 P - HCL Burners & Coolers
 Q - Control Room



SKETCH NO. 2
 LOCATION OF IMPORTANT INSTALLATIONS
 AND BUILDINGS OF PLANTS NOS. 1 & 2

Hand
Chang
Hong



"A" Ethylene is produced in B Section by thermal cracking of a light petroleum fraction, chiefly propane at "B"

"C" After cracking the propane, the next step is the removal of the AROMATIC DISTILLATES. This is accomplished by taking the aromatic distillates off by LOW PRESSURE FRACTIONIZATION at "C". These distillates remain liquids at atmospheric temperature and pressure.

"J" Hydrocarbons of C_4 and lighter go over.

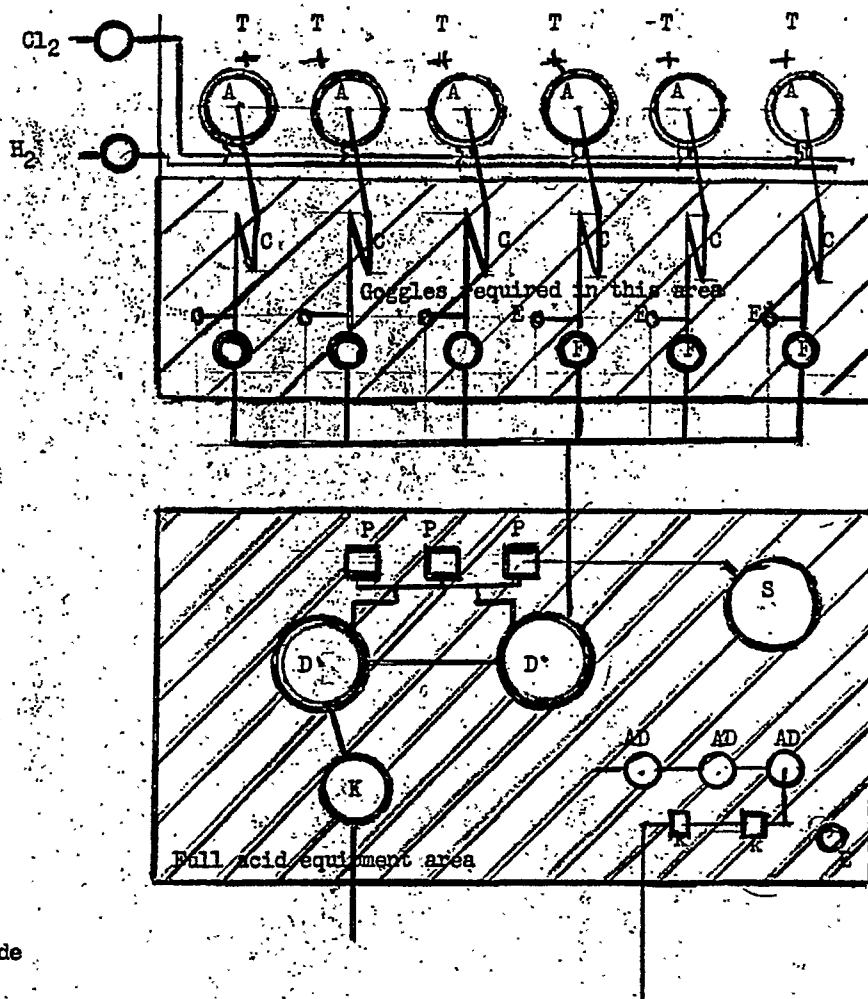
"E" Have split between ETHANE and BUTANE here. Refrigerant is used here with different temperatures at different levels.

"F" This process goes on until the last one where there is a split between Ethylene C_2H_4 and Ethane C_2H_6

Butanes, Propanes, etc., used in recycling and when stabilized as liquid at atmospheric temperature and pressure are mixed with aromatic distillates and sent to Standard Oil.

Hydrocarbons lighter than ethylene are vented to flare stack and burned.

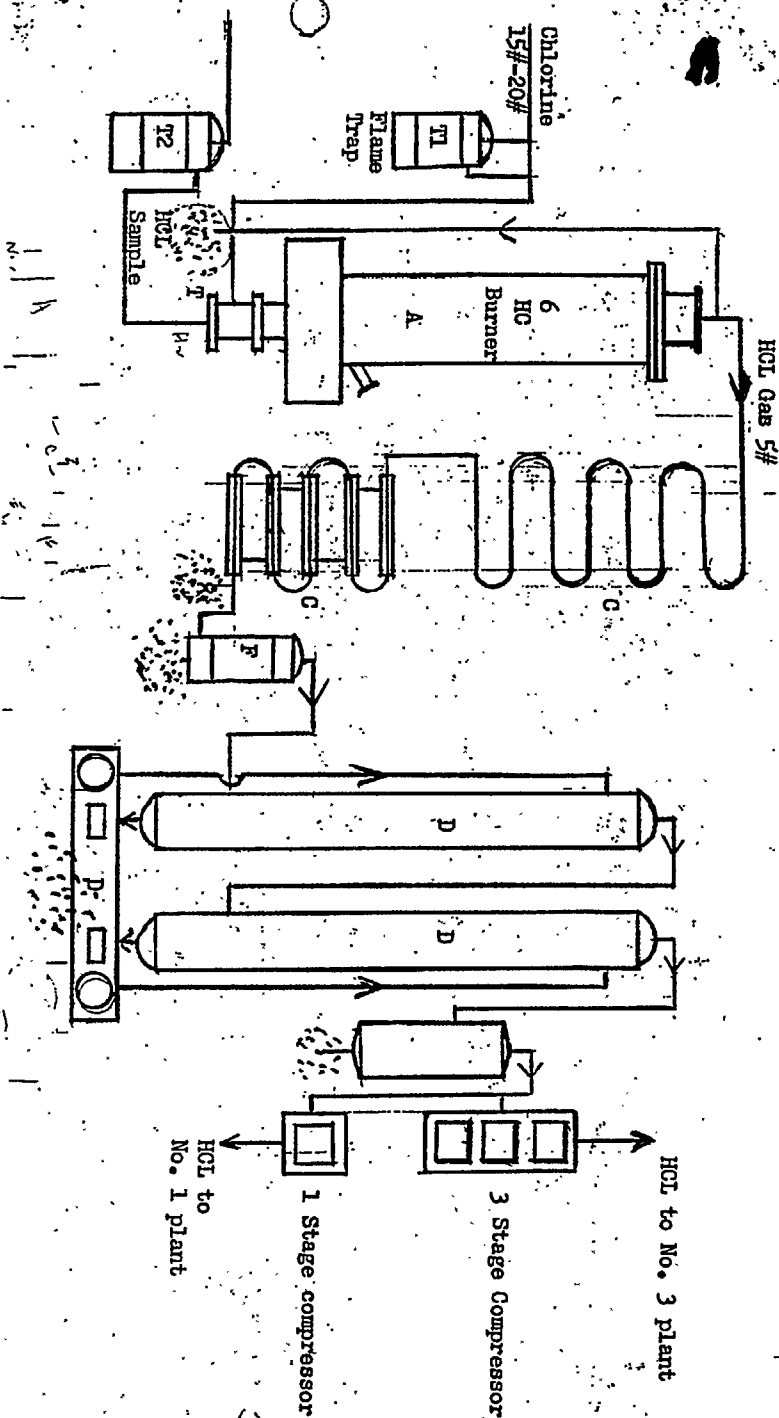
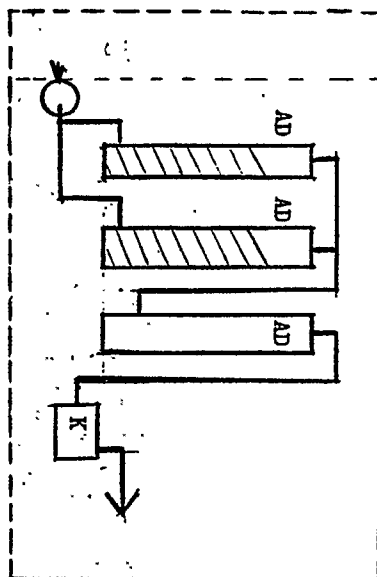
DIAGRAMATIC
SKETCH OF
ETHYL CHLORIDE
A SECTION
PLANT NO. 3

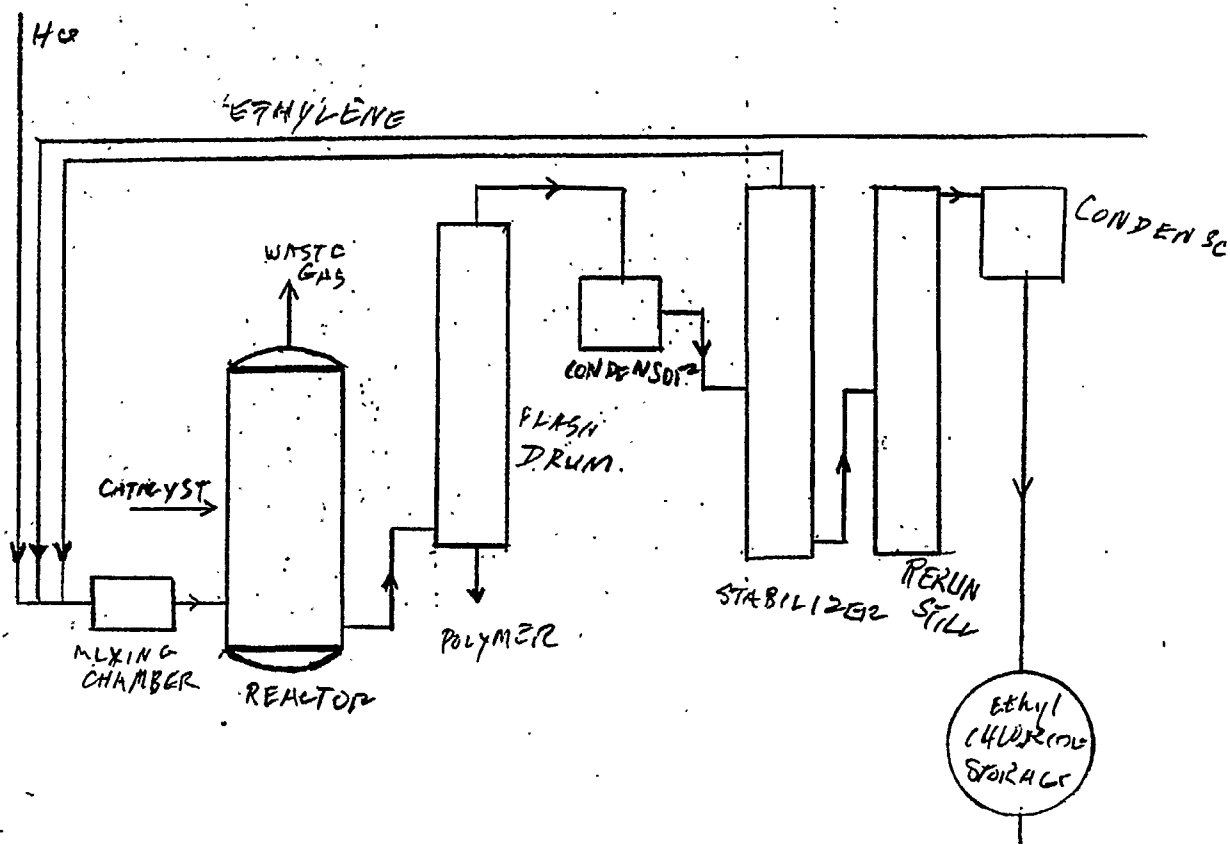


Hydrogen
Chlorine
Hydrogen Chloride
Sulfuric Acid

- A - Acid burners
- Cl₂ & H₂ - Chlorine and hydrogen feed lines respectively
- T1 & T2 - Chlorine and hydrogen flame traps respectively
- C - Cooler
- E - Ejectors
- F - Flame traps
- D - Drying tower
- K - Knock out drums
- k - Knock out drums
- P - H₂SO₄ pump
- S - Seal Drum
- AD - Air drying tower
- T - Testing equipment for testing

SKETCH NO.
 Schematic Sketch
 C Section Plant No. 3
 Showing Process Flow and
 Exposures





SIMPLE Schematic Drawing Section .

LEGEND

Ethylene

Propane

Chlorinated Aromatic Hydrocarbons

Hydrogen _____

Chlorine _____

Hydrogen Chloride _____

Sulfuric Acid _____

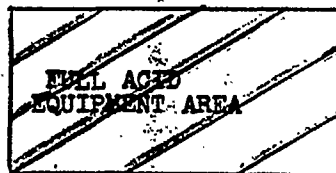
Polymer _____

Sodium Chloride _____

Sodium Sulfate _____

Sodium Carbonate _____

Catalyst (Aluminum Chloride, anhydrous)

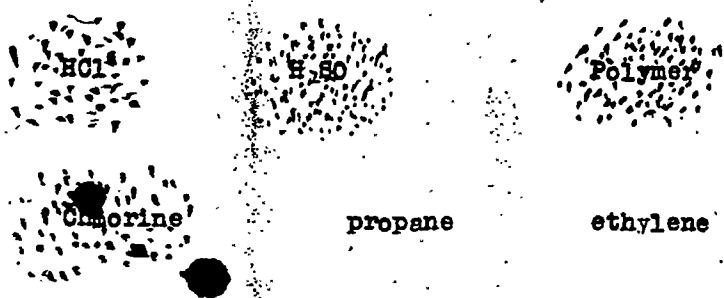


~~XXXXXXXXXX~~

~~Hydrogen~~

~~Chlorine~~

POINTS OF EXPOSURE





- A - Bull dozer pushes soda ash to chute after cooled and mixed with water it becomes sodium carbonate
- B - Sodium carbonate is added to neutralize excess H_2SO_4 . The sacks of soda ash (sodium carbonate) are broken and scattered by 2 men.
- C - Shute to crusher.

LEGEND

Sulfuric Acid
Hydrogen chloride
Soda ash (sodium sulfate)
Soda ash contaminated with H_2SO_4
Sodium Carbonate