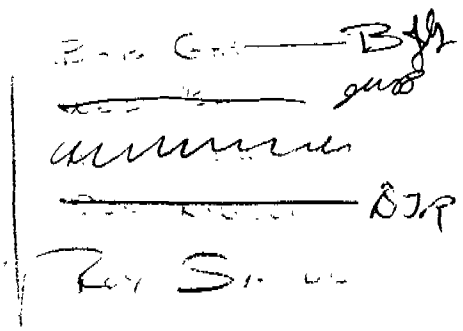
File: Vapor Detectors

PPG Industries, Inc.
Chemical Divison - U.S.
Lake Charles, Louisiana

LD-1873

07-26-1978

ROBERT, G P



Vapor Detection Grid Review (P-823)

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Explosive
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Safety

SL 087351

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APPENDIX

PPG INDUSTRIES, INC.
PROCESS ENGINEERING
G. P. ROBERT

TECHNICAL REPORT LD-1873
July 26, 1978

VAPOR DETECTION GRID REVIEW
(P-823)

ABSTRACT

The present vapor detector system in Plant B has not been reviewed for several years. There have been numerous plant changes which have hindered the operation of some of the vapor detectors, thereby decreasing the efficiency of the entire vapor detection system. In accordance with PPG's program of improving safety, the entire Plant B vapor detection grid has been analyzed. Results are presented in this report on a unit-by-unit basis, with discussions of potential areas of concern.

INTRODUCTION

Because of the possible formation of explosive organic vapor clouds in the Plant B complex, vapor detectors have been installed in key locations to detect these vapor clouds and alert operating personnel to hazardous conditions. An automatic system exists to initiate a water sprinkler network to dissipate the cloud should a vapor detector indicate its presence.

There have been numerous developments in Plant B which have hindered the operation of some of the vapor detectors, thereby decreasing the efficiency of the entire vapor detection system. This report discusses the present vapor detection system in Plant B.

Results are presented here on a unit-by-unit basis, with discussions of potential ar as of concern.

DISCUSSION

Because of the possible formation of explosive organic vapor clouds in the Plant B complex, vapor detectors have been installed in key locations to detect these vapor clouds and alert operating personnel to existing hazards.

The operating principle of the vapor detector units is as follows: The atmosphere surrounding the remote detector unit circulates through the flame arrestor screen by diffusion and convection and is brought in contact with the active platinum filament. The identical adjoining reference filament is shielded from the sample and compensates for changes in ambient temperature, voltage and resistance. The two filaments form two adjacent legs of a Wheatstone Bridge,with the other two legs located in the amplifier-demodulator assembly. The resistance increases in proportion to the temperature and to the amount of gas in the sample. This increase produces an imbalance in the bridge. This imbalance is converted into a signal which is amplifed, demodulated and tramsitted back to the analyzer module. Response is indicated on the meter, which reads percentage of the lower explosive limit. When the preset alarm levels are reached, internal electronic circuits are energized, which, in turn, trip the alarm relays. The relays then lock in and energize the panel alarm or warning lights, and also the terminals for external signals.

The vapor detectors are referenced to a calibrated ethylene-air standard. When the detectors indicate that the monitored environment contains a mixture of organic vapors, which are 20% of the environment's lower explosive limit, a warning alarm will sound and an amber light will be displayed on the panel cabinet in the control room. When any vapor detector indicates that 40% of the lower explosive limit has been reached, it will sound an alarm and display a red light on the panel cabinet. At this alarm point, some of the vapor detectors can automatically activate water sprinkler systems, unless the associated water sprinkler system is bypassed from the vapor detectors.

The water acts to dissipate the vapor cloud to prevent an explosion. Vapor clouds can be detonated by any number of conditions, such as static charges or ignition sources.

In the vinyl chloride plant there is a system which will shut down the vinyl furnaces if two detectors in the furnace area indicate that 40% of the lower explosive limit has been reached. However, these alarms must be two of the fourteen detectors which comprise the furnace shutdown system.

There have been numerous developments in Plant B which have hindered the operation of some of the vapor detectors, thereby decreasing the efficiency of the entire vapor detection grid. This report discusses the potential areas of concern in each operating unit.

EDC. Currently, there are no vapor detectors present in the EDC plant. How ver, locations exist in the plant where EDC and ethylene can form explosive vapor clouds. Ethylene has a high likelihood of forming an explosive vapor cloud, wh reas an EDC vapor cloud is much less likely to explode. Nearby hazardous areas which offer ignition sources are the main Plant B road to the south, Parish Road and the "Tri-Ethane" II expansion to the north, and to the east, Columbia-Southern Road and the air compressor station containing nonexplosive-proof devices.

The ethylene metering station is not equipped with any vapor detectors. Ethylene has the potential of forming a highly explosive vapor cloud. The ethylene metering station is immediate to Parish Road to the north, which offers a nearby source of ignition. Th prevailing winds from the south increase the probability that a vapor cloud formed here would cross Parish Road. Vapor detectors located here could help alert operating personnel to a hazardous condition.

VDC. There are many vapor detectors which are not going to be necessary when the "Tri-Ethane" II plant starts up. At that time some of the vapor detectors could be relocated to monitor areas which are marginally protected.

One location which is not protected by vapor detectors is the north VDCM day tank. Otherwise, the VDC plant appears to be well protected. The water sprinkler systems are usually bypassed from the vapor detectors because of erroneous alarms which have sounded due to instrument malfunction or because of detection of vapors from releases to the atmosphere during sampling. Standard operating procedure is to investigate vapor detector alarms when they sound and manually trip the water sprinkler system based on operator judgment.

EC. Ethyl chloride is one of the most flammable chlorinated organics in Plant B. There have been occasions in the past where vapor clouds containing EC have formed which have not been indicated by the vapor detectors. (See appendix - Reports of Abnormal Operating Incidents.) Traffic on Parish Road, located on the north boundary of the EC unit, is a potential ignition source. The prevailing winds out of the south increase the probability that a vapor cloud could cross Parish Road undetected. A perimeter vapor detection system would add protection to the EC unit from this hazardous condition.

SL 087355

VC. The VC process area has a large number of vinyl chloride monitoring devic s for personnel protection as well as vapor detectors for protection against unobserved vapor clouds. The only direction which appears not to be well monitored is the west side of the process area. The west side of the process area has traffic and a maintenance shop as readily available ignition sources.

The three nearby vinyl furnaces are possible ignition sources. Any vapor cloud moving toward the furnaces could be drawn into the air intake section and would contact the direct fire from the burners or the high temperatures within the furnaces which are above the auto-ignition temperature of the vapor cloud. There is one unprotected entry to the furnaces. A vapor cloud could conceivably form at the segregated sewer sump from a process spill which is not detected elsewhere or not believed to have advanced to the segregated sewer sump. With the winds out of the east, a vapor cloud could reach the furnace from here without being detected.

VC/EC Storage. There have been modifications in both the VC and EC storage areas. The area beneath the day tanks has been separated with concrete dividers to direct spills or burning EC or VC out of the area to limit fire or potential fire exposure to a minimum number of day tanks. Previously, the vapor detectors were located along the perimeter of the day tank storage area. Due to the present arrangement, a leak or spill of VC or EC could go undetected for some time. Due to the high specific gravities (SG = 2.2, air = 1.0) of VC and EC, the vapors from an unprotected compartment would have to overflow into an adjacent equipped compartment in order to be detected. Vapor detectors should be located within the individual compartments or in the common drainage systems.

EC/VCM Dock Storage. The two EC spheres and the No. 3 VCM sphere at the dock are protected by vapor detectors located at the bottom around the spheres and at the loading pump pads. Detection of flammables in the dock storage area causes an alarm to be sounded in the tank area and in the VCM control room. The alarm circuit to the control room has historically been very troublesome and is out of service much of the time. Even if the alarm does function in the control room, several minutes could lapse by the time the lead operator could get to the dock to investigate the situation. In addition to improving the alarm circuit, consideration should be given to vapor detector activation of the water deluge systems at the dock.

Per/Tri. The only vapor detectors in the Per/Tri plant are located by the Dowth rm h ater and Dowtherm circulating pumps. The Dowtherm heater is an ignition source for a vapor cloud. It is protected by a vapor detector only on the east side. A vapor detector located between the Dowtherm circulating pumps to the south of the Dowtherm heater offers some protection for the heater, in addition to monitoring the environment around the pumps. It is unlikely that a vapor cloud would approach the Dowtherm heater from the north or west. The present protection appears to be adequate, although not foolproof. For instance, there is no water sprinkler that exists near the Dowtherm heater. A vapor cloud approaching the heater would probably approach from the east, due to the location of process equipment. A water shield system on the east side of the Dowtherm heater could prevent an unnecessary explosion or fire from occurring.

There are compounds which exist in the Per/Tri plant, such as EDC and Dowtherm, which can form explosive organic vapor clouds. In some locations they could be released above their flash points. However, these compounds do not readily form vapor clouds and will dissipate before they can be detected. Vapor detectors would be able to discover only excessively large vapor clouds, unless an exorbitant number of vapor detectors were employed.

OHC. The OHC plant is protected by several vapor detectors which are all located 18 inches above ground. EDC vapors (SG = 3.35, air = 1.00) would quickly sink to this elevation. However, ethylene (SG= 0.975) would not sink since it is slightly light r than air. As such, an ethylene vapor cloud would mix with the air and be moved by wind currents toward an ignition source. Vapor clouds which are ethylene rich that occur at elevations above ground may not be detected at all. Ethylene can form one of the more dangerous vapor clouds of all materials in Plant B.

AND CONVEYED IN RELATIVELY FRAGILE HAVEG OR CHEMTITE PIPING?

Tetra. Currently, there are no vapor detectors present in the Tetra plant. However, locations exist in the plant where EDC and ethylene can be released above their flash points, and an explosive EDC or ethylene vapor cloud could conceivably exist.

The Tetra plant is next to a road which offers a nearby source of ignition.

Bottoms. There are no vapor detectors located in the Bottoms plant. There are compounds, mainly EDC, which can exist in the Bottoms plant above their flash points. However, the likelihood of forming an explosive vapor cloud in the Bottoms plant is relatively small due to low pressure operating conditions.

Should a vapor cloud form, it would be difficult to discover without a multitude of vapor detectors.

Incinerator. The incinerator is protected by two vapor detectors which are located to the northeast and northwest. It would be difficult for a vapor cloud to escape both of these detectors if they are operating properly.

CONCLUSIONS AND RECOMMENDATIONS

THEORETICALLY VIA STANDING W.O. --- BUT I'M NOT SURE IT ALWAYS HAPPENS.

1. The vapor detectors in most units are serviced every six months. For more reliable performance, the manufacturer recommends that they be calibrated at least every three months with a standard calibration gas.

2. There are units whose standard operating procedure is to bypass the automatic initiation of the water sprinkler system, thereby preventing unnecessary showers due to instrument malfunctions or detection of vapors released to the atmosphere during sampling. This prevents unwanted rapid cooling of the OHC reactors and keeps the containers dry inside of the MC stabilizer storage shed. However, an unnec ssary vapor cloud explosion may occur without water dissipation. A recommended option to the system would be to operate these sprinkler systems similarly to the vinyl

IS THE ANY OTHE KIND?

furnace shutdown system. If two vapor detectors alarm, thereby indicating that 40% of the lower explosive limit has been reached, then the water sprinkler system would be activated.

3. Detection of ethylene vapor clouds away from direct sources of ethylene release would be more effective if the vapor detectors were located at least six feet above the ground.

4. From the information provided in this report, each individual unit should reassess their vapor detection system and modify it to afford adequate personnel protection from explosive organic vapor clouds.

5. Perimeter location of vapor detectors should be considered, especially in the EC and VCM units. The estimated cost of installing each vapor detector is $1700. Approximately $800 of the cost is for the equipment and its installation. The remaining $900 is for an average length of 200 feet of conduit necessary to run from the detector to the control room.

Author: Gregory P Robert Date: 7/26/78

Approved: B.D. Reynolds Jr. Date: 7/28/78

Approved: J. Boyd Alleman Date: 8/21/78

edh

SL 087358

APPENDIX

TABLE 1

FLAMMABLE COMPOUNDS IN PLANT B

Compound	(°F.) Boiling Point	(°F.) Flash Point (Open CuP)	(°F.) Auto-Ignition Temperature	(Volume %) Explosive Limits (Lower-Upper)	Vapor Density
Methane	-259		1000	5.3 - 14	0.55
Ethylene	-219		1010	2.75 - 28.6	0.975
Vinyl Chloride (VC)	8	-108		4 - 22	2.15
Ethyl Chloride (EC)	54	- 45	966	3.6 - 12	2.22
Vinylidene Chloride (VDC)	89	50		7 - 16	3.35
Ethylene Dichloride (EDC)	182	65	840	6.2 - 15.9	3.35
Dowtherm	500	255			

OTHER FLAMMABLE COMPOUNDS

Monochloroacetylene (MCA)	Spontaneously flammable in air				
Nitromethane (NRE)	214	112		7.3	2.11
Methyl Ethyl Ketone (BTE)	175			1.8 - 11.5	
Isobutanol (IBL)	226	95	800	1.68	
1,4 Dioxane (DOX)	214			2 - 22	
Tertiary Butyl Alcohol (TBL)	180	60		2.4 - 8	
Tolu ne	231			1.27 - 6.75	
Secondary Butyl Alcohol (SBL)	212				2.56
Tertiary Amyl Alochol (TAL)	215	75			3.04

GRAPH I - CALIBRATION CURVES

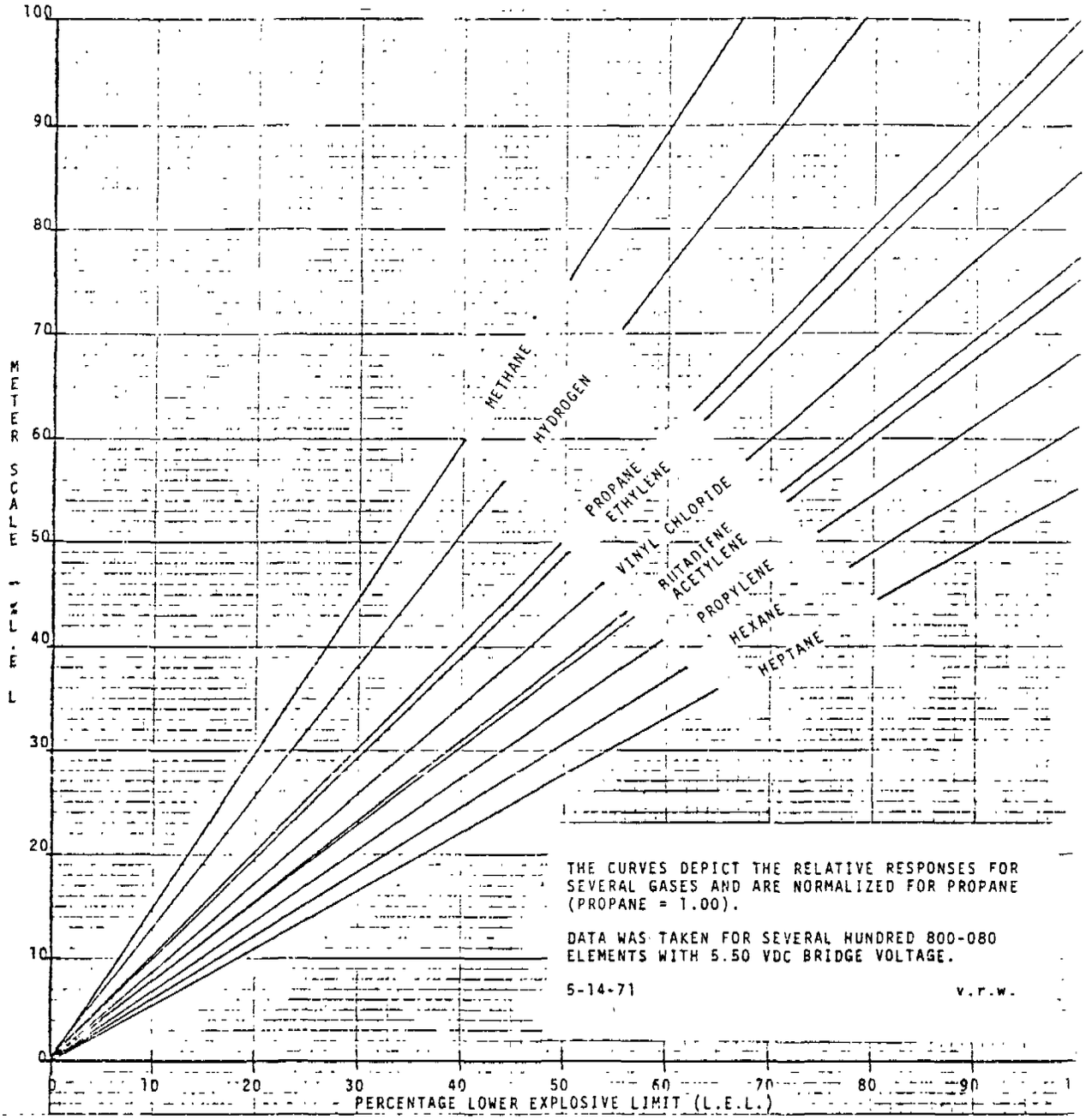


TABLE OF CONVERSION FACTORS

GAS	K	1/K
METHANE	1.50	0.67
HYDROGEN	1.27	0.79
PROPANE	1.00	1.00
ETHYLENE	0.98	1.02
VINYL CHLORIDE	0.86	1.17
BUTADIENE	0.77	1.29
ACETYLENE	0.75	1.33
PROPYLENE	0.68	1.47
HEXANE	0.61	1.64
HEPTANE	0.55	1.82

CONVEPSIONS:

1) IF THE INSTRUMENT IS CALIBRATED FOR PROPANE, MULTIPLY THE METER READING BY THE "K" FACTOR TO DETERMINE THE EQUIVALENT RESPONSE FOR THE OTHER GAS.

2) IF THE INSTRUMENT IS CALIBRATED FOR ANOTHER GAS, MULTIPLY THE METER READING BY "1/K" FACTOR TO DETERMINE THE EQUIVALENT RESPONSE FOR PROPANE.

EXAMPLE:

To use a 50% LEL mixture of Propane to calibrate the instrument to read correctly on Hexane:

a) Multiply the correct propane response (50%) by the 1/K factor for Hexane (1.64)

50 X 1.64 = 82

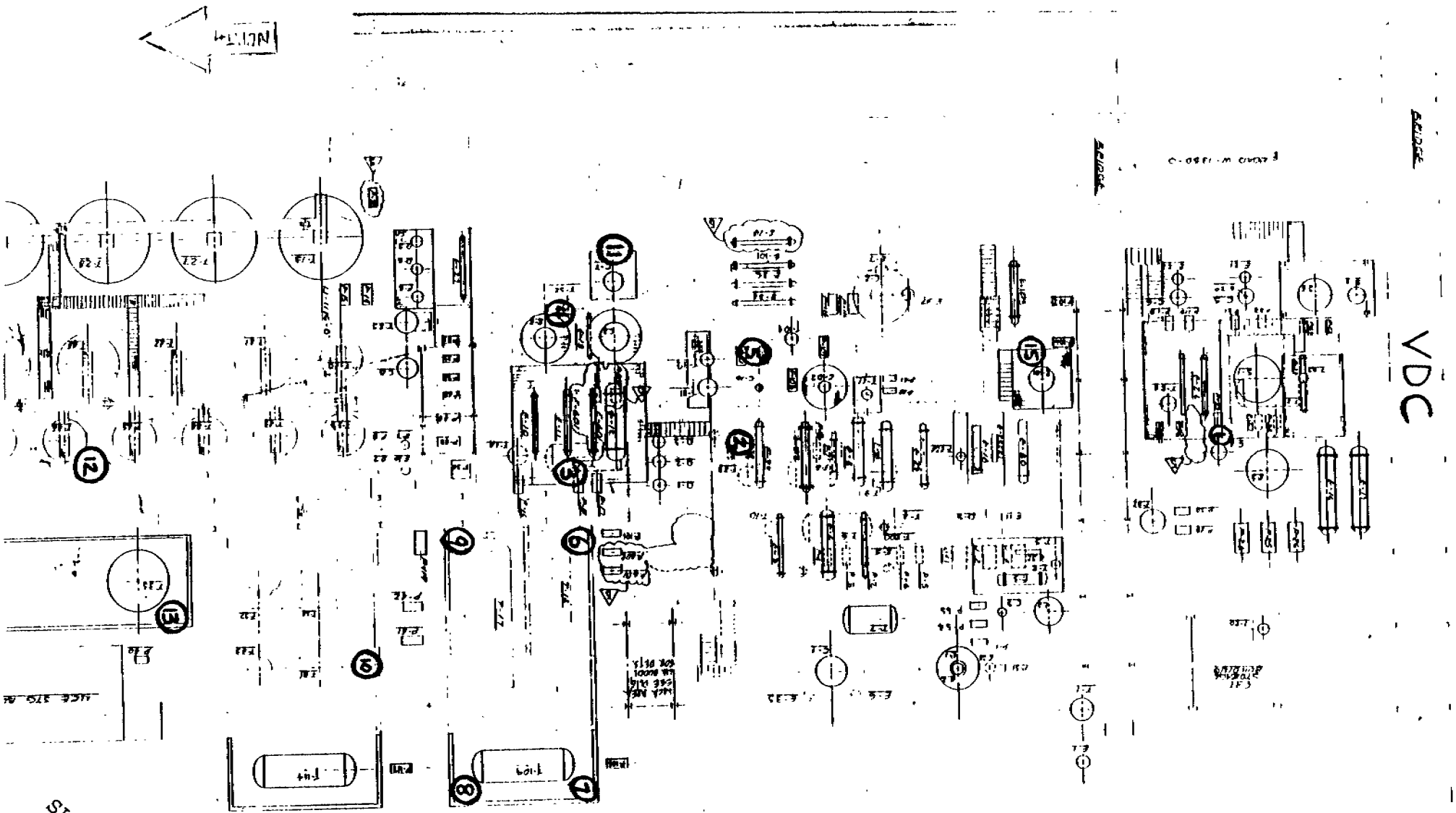
b) Apply the 50% LEL Propane mixture to the detector and adjust the instrument to read 82% on the meter.

SL 087361

VAPOR DETECTOR LOCATIONS

VDC

1	VDC Vaporizer
2	VDC DH Phase Separator
3	VDC Reflux Pump
4	VDC Reactor
5	VDC DH Product Pump
6	Vaporizer Feed Pump
7	Southwest VDCM Storage
8	Northwest VDCM St orage
9	VDC Storage Tank
10	South End Stabilizer Dike
11	Scrubber Seal Pot
12	NRE Dike
13	Southwest DOL/IBL Dike
14	Control Room Sewer
15	VDCM Reactor Heater



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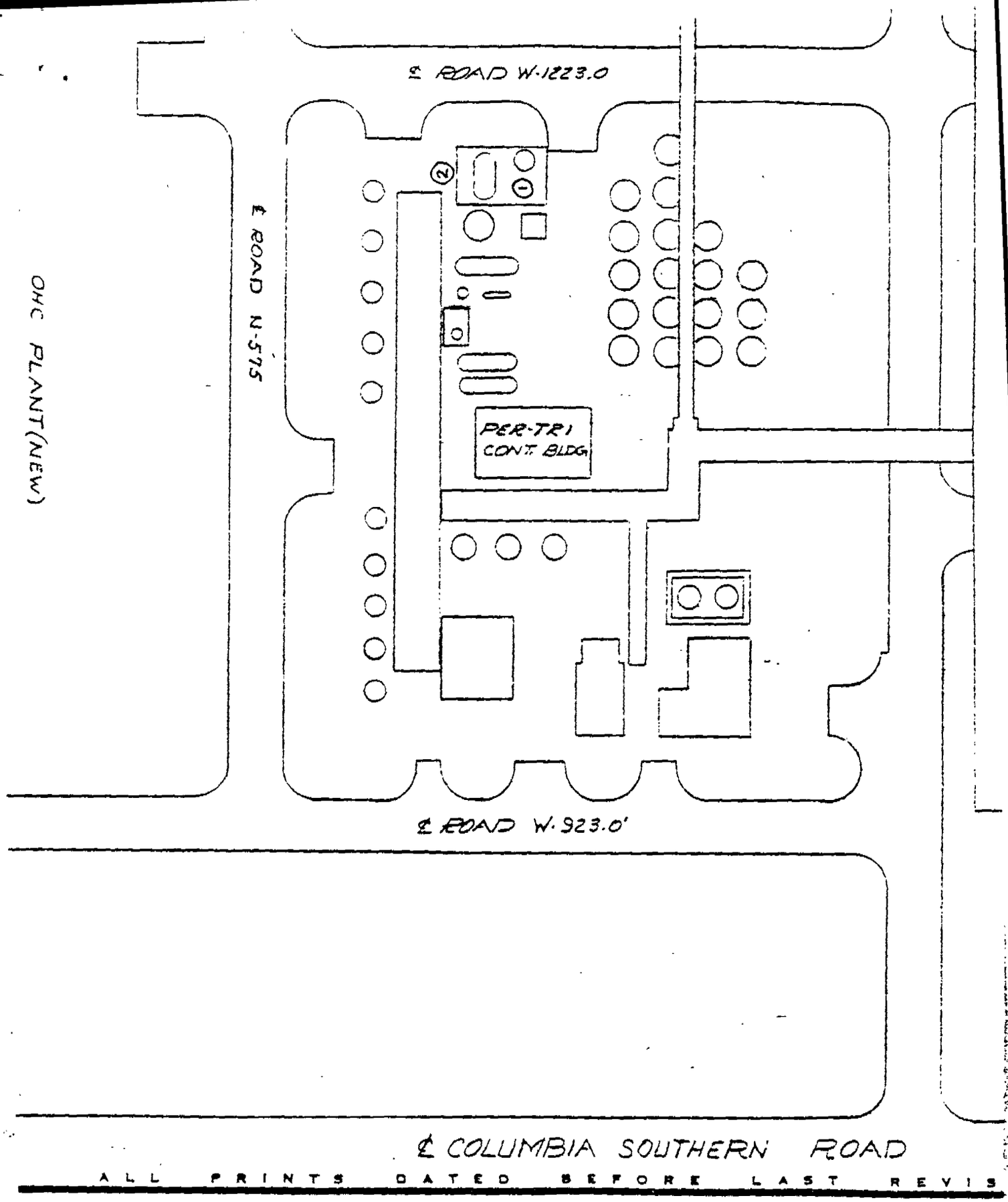
VAPOR DETECTOR LOCATIONS

PER/TRI

1	Dowtherm Heater
2	Dowtherm Pump



ALL PRINTS DATED BEFORE LAST REVIS

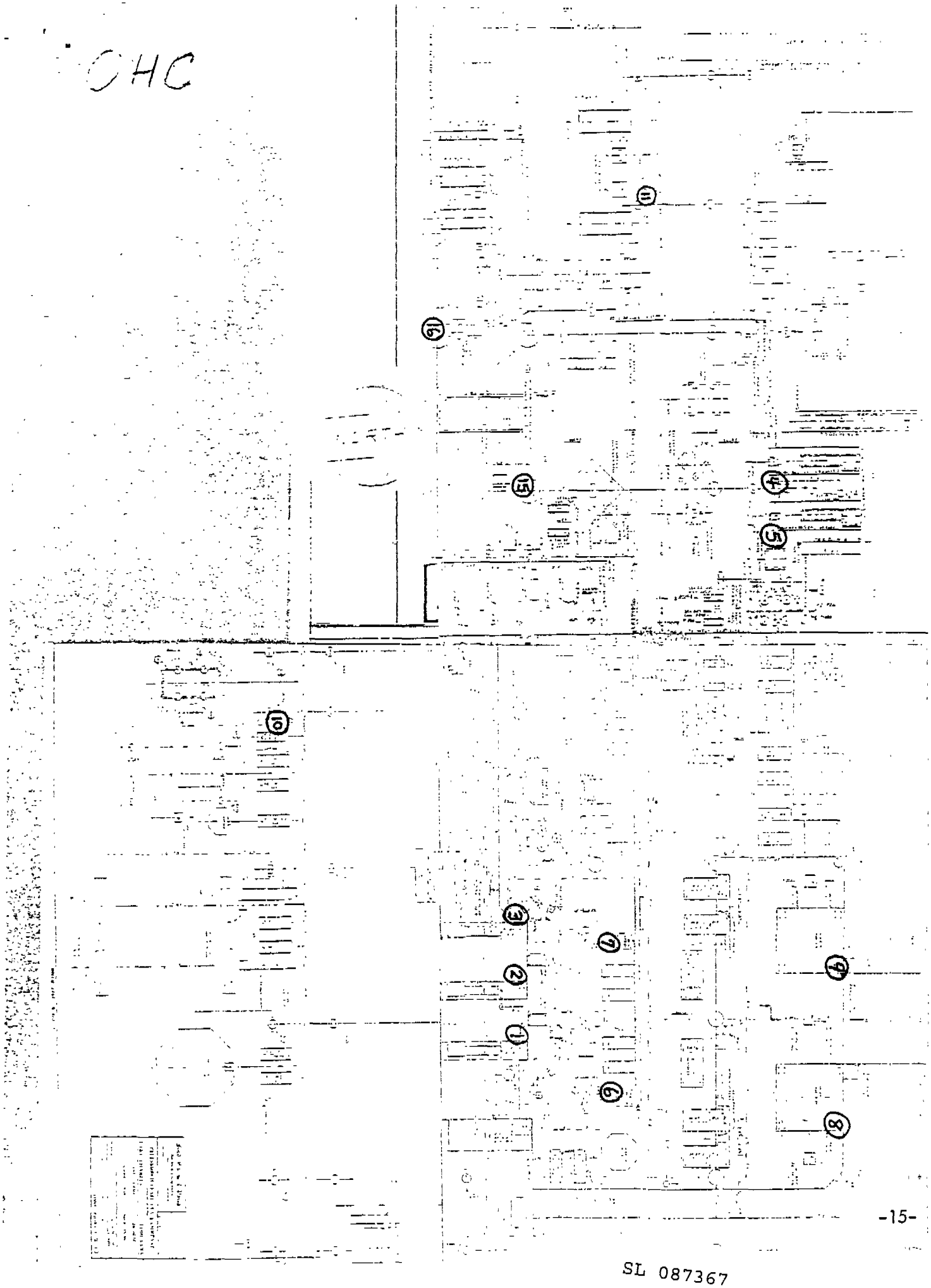
SL 087365

VAPOR DETECTOR LOCATIONS

OHC

1	Recycle Compressor #1
2	Recycle Compressor #2
3	Recycle Compressor #3
4	Recycle Compressor #4
5	Recycle Compressor #5
6	Gas Scrubber #1
7	Gas Scrubber #2
8	Reactor #1
9	Reactor #2
10	Dowtherm Heater
11	South Acid Pit
12	North Acid Pit
13	Northeast Incinerator
14	Northwest Incinerator
15	Northeast Reactor #3
16	Southwest Reactor #3
17	Fresh Air Duct

CHC



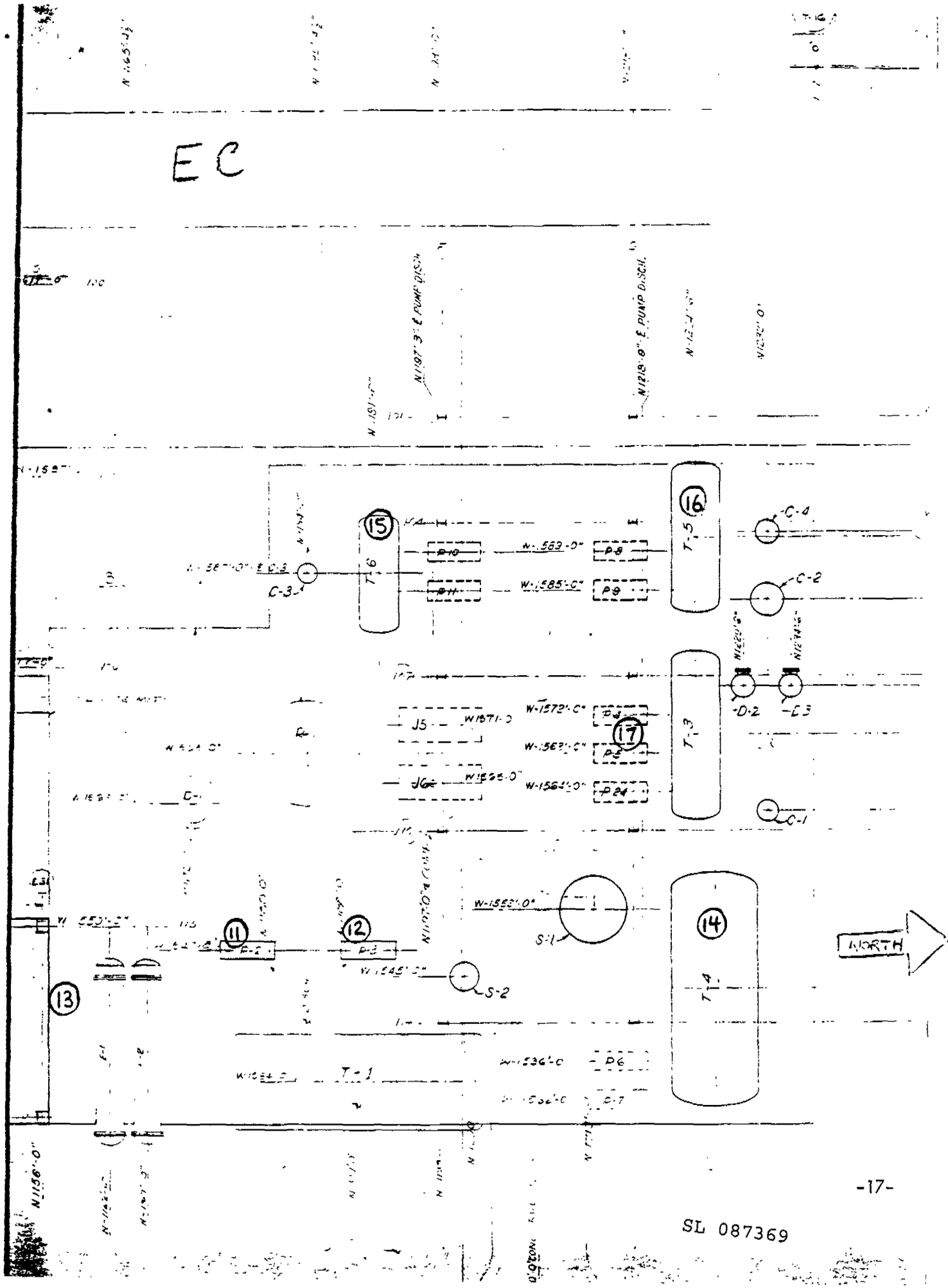
SL 087367

VAPOR DETECTOR LOCATIONS

EC

11	South Reactor Pump
12	North Reactor Pump
13	North Catalyst Building
14	North Process
15	EC Product Pumps
16	Scrubber
17	Primary Stripper Feed Pump

SL 087368


EC
N1165'-0"
N1219'-0" E PUMP DISCH.
N1156'-0"
C-1
C-2
C-3
C-4
D-2
L-3
S-1
S-2
T-1
T-3
T-4
T-5
T-6
P-2
P-3
P-8
P-9
P-10
P-11
P-24
P-26
P-6
P-7
J5
J6
W-1572'-0"
W-1563'-0"
W-1564'-0"
W-1585'-0"
W-1552'-0"
W-1545'-0"
W-1536'-0"
W-563'-0"
NORTH

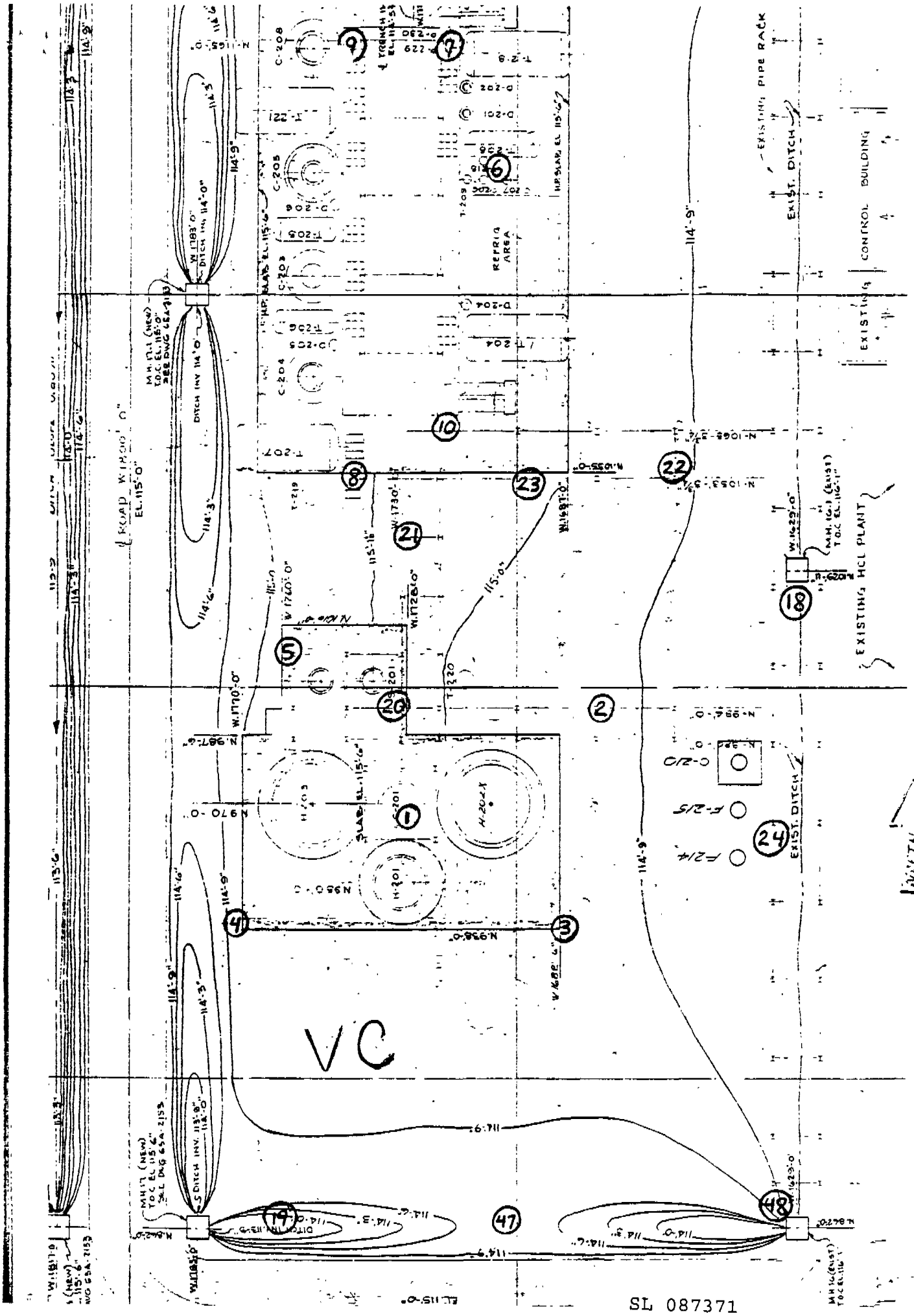
-17-

SL 087369

VAPOR DETECTOR LOCATIONS

VC

1	Mid Furnace
2	Northeast Furnace
3	Southeast Furnace
4	Southwest Furnace
5	Northwest Dopp
6	Neutralizer
7	Northeast Process
8	Southwest Process
9	Northwest Process
10	Southeast Process
18	Mid Sewer
19	Southeast Cracker Main Road
20	Southeast Dopp
21	South Process
22	East Vent Compressor
23	South Vent Compressor
24	East Carbon Filters
47	South Cracker Main Road
48	Southwest Cracker Main Road

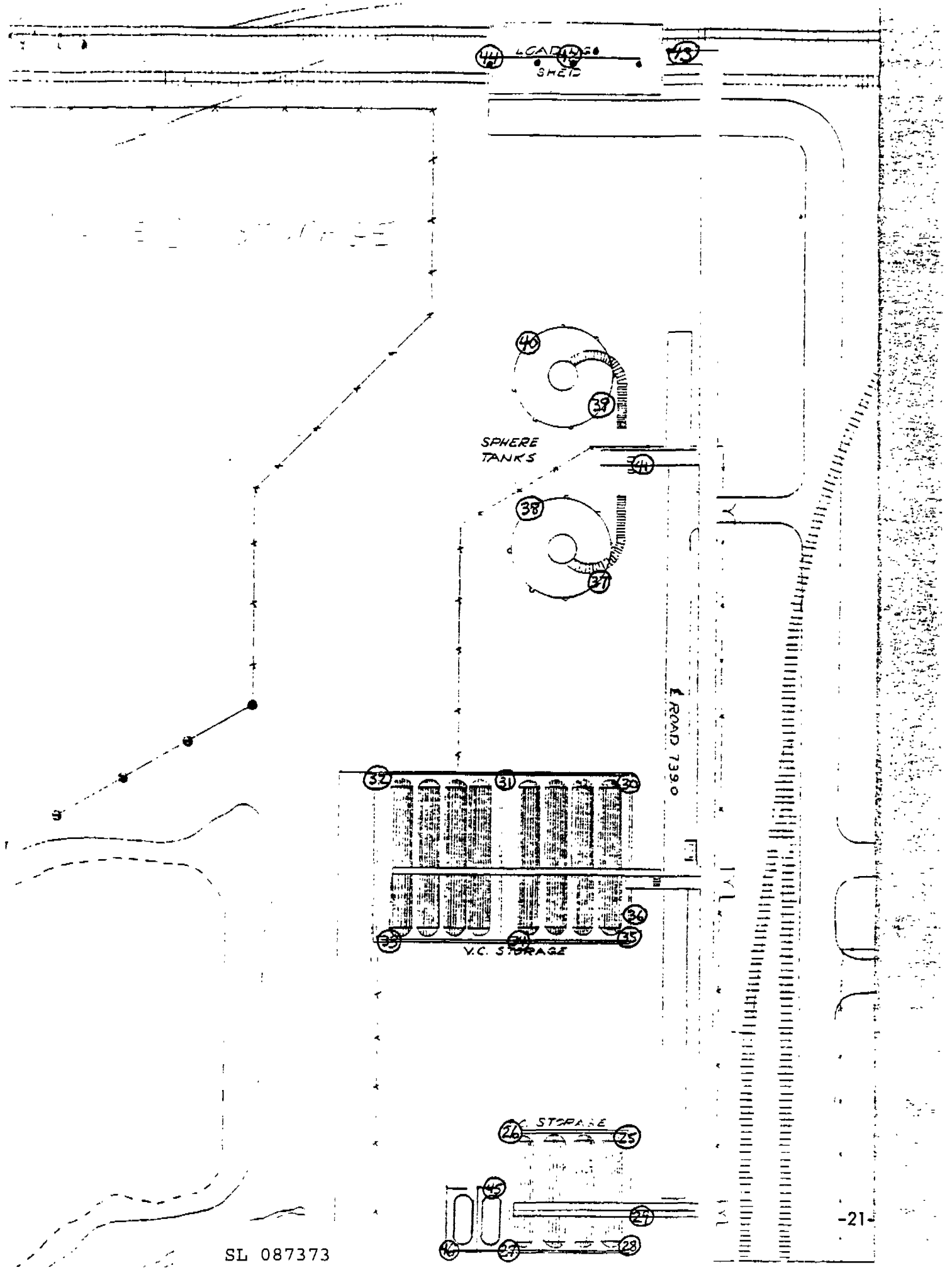

EXISTING PIPE RACK
EXIST. DITCH
EXISTING CONTROL BUILDING
EXISTING HCL PLANT
REFRIG AREA
ROAD WIDTH 30'-0"
EL. 115'-0"
DITCH INV 114'-0"
MH 17 (NEW) T.O.C. EL. 115'-6" SEE DWG 65A-2153
MH 16 (EXIST) T.O.C. EL. 116'-1"
MH 10-1 (EXIST) T.O.C. EL. 116'-1"
SLAB EL. 115'-6"
EXIST. DITCH
VC

SL 087371

VAPOR DETECTOR LOCATIONS

VC/EC STORAGE

25	~~Northwest~~ EC ~~Day Tank~~
26	Southwest EC Day Tank
27	Southeast EC Day Tank
28	VDCM Transfer Pumps
29	EC Transfer Pumps
30	Northwest VC Day Tanks
31	Midwest VC Day Tanks
32	Southwest VC Day Tanks
33	Southeast VC Day Tanks
34	Mideast VC Day Tanks
35	Northeast VC Day Tanks
36	VC Transfer Pumps
37	Northeast Sphere 1
38	Southwest Sphere 1
39	Northeast Sphere 2
40	Southwest Sphere 2
41	Loading Pumps
42	Mid Loading Rack
43	North Loading Rack
44	South Loading Rack
45	Northwest VDCM Day Tanks
46	South VDCM Day Tanks



SL 087373

SUBMITTED - 11-12-74
Ben Reynolds

REPORT OF ABNORMAL OPERATING INCIDENT

Date: 10-25-74

Location: ETHYL CHLORIDE PLANT

Describe the Incident: SEAL BLEW ON EC VENT CONDENSATE RECOVERY PUMP. WIND WAS FROM THE NORTH-EAST. A FAIR SIZED VAPOR CLOUD WAS RELEASED BUT WAS NOT DETECTED BY VAPOR DETECTORS. CLOUD WAS NOTICED BY OPERATOR AND PUMP SHUT DOWN BEFORE CLOUD REACHED THE VC PLANT.

Describe the Hazard or Loss Potential: WIND BLEW VAPORS DIRECTLY TOWARD VC FURNACES FROM EC PLANT. THE LOCATION OF THE DETECTOR ELEMENTS IS SUCH THAT IT IS POSSIBLE TO HAVE A BREAK IN THE EC PLANT (VENT RECY PUMP, RX, SEC STRIPPER, OR RX. COOLERS) AND NOT HAVE THE LEAK DETECTED BY THE VAPOR DETECTORS. IF VAPORS REACHED THE FURNACES AND SHUTDOWN SYSTEM DID NOT WORK IN TIME - BOOM.

Describe the Action Taken to Prevent Recurrence: OPERATIONS AND INDUSTRIAL ENGINEERING WILL STUDY THE PROBLEM TO SEE IF RELOCATION OF PRESENT DETECTORS OR ADDITIONAL DETECTORS ARE NECESSARY FOR PROTECTION FOR ALL WIND DIRECTIONS.

SEND TO LOSS PREVENTION ENGINEER!

REC'D BY L.P.E.
11/13/74

SL 087374

REPORT OF ABNORMAL OPERATING INCIDENT

Date: 7-18-75 1ST SHIFT

Location: EC UNIT

Describe the Incident: GASKET (1". 150# GARLOCK) UNDER S. EC PRI. STR. FEED DRYER RUPTURE DISC HOLDER BLEW OUT, RELEASING A CLOUD OF ETHYL CHLORIDE VAPORS AND HCL. THE LEAK WAS NOT PICKED UP BY THE VAPOR DETECTORS. CLOUD WAS SPOTTED BY A VC OPR. IN VINYL UNIT WHO ALERTED EC OPR.. THE EC OPR. LOWE THE PARISH ROAD GATES, TRIPPED THE SPRINKLERS, AND ISOLATED THE DRYER.

Describe the Hazard or Loss Potential: THE S-SE WIND BLEW THE CLOUD ACROSS PARISH ROAD. IF THE LEAK HAD NOT BEEN SPOTTED AND THE ROAD GATES DROPPED, THE VAPOR CLOUD POSSIBLY COULD HAVE BEEN IGNITED BY A VEHICLE ON THE ROAD.

Describe the Action Taken to Prevent Recurrence: AN REC. HAS BEEN WRITTEN TO STUDY THE LOCATION OF THE VAPOR DETECTORS IN EC TO DETERMINE WHERE ADDITIONAL DETECTORS ARE NEEDED TO PROVIDE FULL COVERAGE. OPERATIONS FEELS THAT ADDITIONAL DETECTORS ARE NEEDED ALONG THE NORTH FENCE (PARALLEL TO PARISH ROAD) AND ALONG THE N-S PIPE RACK BETWEEN THE EC AND VC UNITS. (P-604)

SEND TO LOSS PREVENTION ENGINEER!

BAR
8-1-75

SL 087375

Reviewed by L.P.E.
8-5-75

REPORT OF ABNORMAL OPERATING INCIDENT

Date: November 8, 1975 - a.m.

Location: ETHYL CHLORIDE UNIT

Describe the Incident: A crack 4 - 6" long developed in the head (process side) of the Freon Vent Condenser - SAC #71-786, releasing a large amount of HCl. The cloud was so thick that the Operators could not isolate the leak and the unit had to be shut completely down. No vapor detector alarms went off. The leak was spotted by an Instrument Mechanic in the VC unit who notified the control room via radio.

Describe the Hazard or Loss Potential: The vent stream contains approximately 60% HCl, 30% C_2H_4 and 10% EC. A large flammable vapor cloud could have resulted and been ignited if the Operators had not acted quickly to stop the release. The control room water curtain and the VC furnace hydroshield were tripped. A shift mechanic donned a Scott Air Pack and helped the lead operator and operator to shut the unit down.

Describe the Action Taken to Prevent Recurrence: A Kynar lined head was installed to replace the steel head. This, however, does not solve the corrosion problems which have plagued this section of the EC unit since its startup in 1966. A study will be made to locate the source of the problem and correct it.

SEND TO LOSS PREVENTION ENGINEER!!!

Ben Reynolds 11-17-7

Rec'd by L.P.E.
11/18/75

SL 087376

REPORT OF ABNORMAL OPERATING INCIDENT

Date: 12-19-75 1:30 AM

Location: EC UNIT

Describe the Incident: FOUR ADJACENT BOLTS ON BOTTOM FLANGE (4" 150# FLG - 8 BOLTS) OF EC SEC. VENT CONDENSER HEAD BROKE, RELEASING A CLOUD OF HCL, ETHYLENE, AND ETHYL CHLORIDE. LEAK WAS SPOTTED BY A SUPERVISOR. CONDENSER WAS ISOLATED QUICKLY.

Describe the Hazard or Loss Potential: IGNITION OF A VAPOR CLOUD COULD RESULT IN SIGNIFICANT DAMAGE TO PERSONNEL AND EQUIPMENT.

Describe the Action Taken to Prevent Recurrence: BAD BOLTS WILL BE STUDIED BY INDUSTRIAL ENGINEERING. BOLTS ARE TO BE SENT OFF FOR A METALLURGICAL EXAMINATION TO DETERMINE CAUSE OF FAILURE.

SEND TO LOSS PREVENTION ENGINEER!

BDR
12-31-75
Rec'd by I.P.E.

SL 087377