Romic Environmental Technologies Corp.

AZD 009015389

Chandler, Arizona

TSD Facility

Section M

Air Emission Standards for Process Vents

January 2005

CONTENTS

Tables, Figures, and Appendices are presented
in separate sections following the main body of the text.

M1 APPLICABILITY AND DEFINITIONS

The requirements of 40 CFR 264 Subpart AA apply to the facility because it operates a vacuum still pot, fractionation distillation column, and a thin film evaporation unit that process hazardous waste with organic concentrations of ≥10 ppmw. These units also process organic and aqueous non-hazardous wastes as well as hazardous wastes with organic concentrations less than 10 ppmw. Organic emissions from the process vents associated with the above processes are below the 3 lb/hr and 3.1 tons per year limits specified in 40 CFR 264.1032(a)(1). However, Romic has installed a control device for process vents as a precautionary measure, to further reduce emissions, and to avoid potential nuisance emissions. The control device is designed to a 95% or greater by weight removal efficiency for organic vapors although the total organic emission limits of § 264.1032(a)(1) for all process vents can be attained at an efficiency less than 95 weight percent as allowed by 40 CFR 264.1032(b).

Some terms used to describe compliance with Subpart AA are defined as follows (for detailed process unit descriptions, see Section E).

Closed vent system refers to a system that is not open to the atmosphere and that is composed of piping, connections, and flow inducing-devices that transport gas or vapor from process equipment to a control device.

Distillation operation refers to a process, either batch or continuous, that separates one or more feed stream(s) into two or more exit steams, each having component concentrations different from those in the feed stream(s). The separation is achieved by redistribution of the components between the liquid and vapor phases as they approach equilibrium within the distillation unit.

Fractionation operation is a method used to separate a mixture of several volatile components of different boiling points in successive stages, each removing from the mixture some proportion of one of the components.

Thin film evaporation operation refers to a distillation operation that employs a heating surface consisting of a large diameter tube that may be either straight or tapered, horizontal or vertical. Liquid is spread on the tube by a rotating assembly of blades that maintain a close clearance from the wall or actually ride on the film of liquid on the wall.

A process vent is any open-ended pipe or stack that is vented to the atmosphere either directly, through a vacuum-producing system, or through a tank associated with hazardous waste distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping.

A leak is defined by an instrument reading of >500 ppm organics above background level.

“VOC” stands for volatile organic compounds.

M2 VOC REDUCTION SYSTEM

M2.1 THE VOC REDUCTION SYSTEM DESIGN

The closed vent system and control device are designed to collect organic vapors from process equipment vents into a closed vent piping system which conveys the vapors to a volatile organic compound (VOC) reduction unit. The VOCs are condensed out of the vent air stream in the VOC reduction unit and pumped into a hazardous waste storage tank. The vent air is released to the atmosphere directly or through carbon beds. Figure M-1 is a process and instrumentation diagram of the system. Figure M-2 shows the VOC control system location and the location of units subject to Subpart AA.

M2.2 SYSTEM DESIGN PARAMETERS

Air/vapor flow rate – 120 scfm.(138 acfm)

Organic vapor reduction – ≥ 95% by weight design.

The VOC system incorporates:

- Two compressors in parallel to compress the organic vapor-laden stream to 100 psia with a compression ratio of 8.07.
- Two plate & frame high efficiency heat exchangers in series, adequately sized to remove the heat of compression and the heat of condensation of the incoming vapor stream.
- Two chilled ethylene glycol condensing units in parallel to maintain exit condensate recovery temperature of -5° C to maximize VOC vapor recovery efficiency.
- Transfer of condensed organic vapors to a hazardous waste storage tank.
- A semi-automated PLC control system.
- Safety interlocks for safely shutting down the operation.

M2.3 SYSTEM COMPONENTS

Separators SEP-1, SEP-2, & SEP-3

Condensate Receivers: CR-1, CR-2

Compressors CP-1 & CP-2.

Liquid handling Pump AP-1.

Heat Exchangers PF #1, PF #2,

Condensers CON-1, & CON-2

Filter F-1

Control Panel: VOC-PAN-1

Automatic Control System and Alarms.

Piping and Valves.

Equipment data display and chart recorder

Optional dual carbon bed system (as backup)

(See Process and Instrumentation Diagram – Figure M-1.)

M2.4 PROCESS VENTS

The three process vents that are regulated by Subpart AA are listed in Table M-1. The units associated with these process vents may operate up to 24 hours per day, 7 days per week. Normal operation is up to 16 hours per day, 5 days per week. The organic vapors generated from these processes are collected in piping manifold systems and directed to process system separator tanks. These tanks are used to separate liquid process condensate from residual vapors, which are vented to the closed vent system via the vacuum pumps. Liquid condensate collects in the process separator tanks, and is transferred to product storage tanks. The residual vapors are transferred via the closed vent system to the VOC reduction unit.

M2.5 SYSTEM EQUIPMENT DESCRIPTIONS

Overview

Residual process vapors enter VOC Separator 1 (S-1) prior to entering one of two liquid ring compressors. The compressors use water both as a compression chamber sealing mechanism and as a condensed organic and heat removal medium. The organic-laden water and compressed residual VOC vapors from the compressors enter Separator 2 (S-2). The water and vapor phases separate in S-2; the water flows by gravity into Separator 3 (S-3). S-2 has an automatic liquid level control; excess water is pumped through two plate and frame heat exchangers, which are cooled by plant cooling water and chiller fluid from a plant chiller unit. Excess liquid in S-2 and S-3 can be pumped off to a waste storage tank. Residual process vapors are directed from S-3 to one of two refrigerated condensers where the vapors are condensed; the condensed liquid drops to the condensate receivers CR-1 and CR-2. The effluent from the condensers is returned to ambient pressure, travels through a flame arrester, and is discharged to atmosphere through a stack or a series of carbon beds.

A. Separator SEP-1

SEP-1 is the VOC collector/compressor suction surge tank. Process vents from the column, thin film unit, vacuum distillation unit, and tank 105 are collected and conveyed through a 4"∅ header inclined at 5° and by a 2"∅ vent piping towards the separator SEP-1.

Material of Construction: 316 Stainless Steel, 3/16" swg

Size: 3'∅ x 6' height (seam/seam)

Capacity: 318 gallons (4.42 gallon/inch)

Equipped with Rosemount gauge pressure transmitter, Pressure gauge (-30 Hg - 15 psig), pressure & vacuum relief valves(set @ -1.0 psi vacuum and 1.0 psig pressure) and a differential pressure transmitter to control the level in the separator. The tank is, also, equipped with a sight glass, a high-level alarm switch, vapor inlet/exit connections and a Rosemount temperature transmitter (RTD-type).

B. Separator SEP-2

SEP-2 is the Compressor Discharge surge tank. The compressed vapor together with the circulating heat transfer media is discharged to this separator. An operating liquid level is maintained with in the separator to enable the liquid ring compressor to operate at its maximum efficiency. Condensation of condensable vapors inside the compressor will gradually raise the level in SEP-2, which spills over into SEP-3.

Material of Construction: 316 Stainless Steel, ¼" swg

Size: 1.5'∅ x 6' height (seam/seam)

Capacity: 79.4 gallons (1.102 gallon/inch)

Operating pressure: 100 psig

Equipped with Pressure gauge (0-100 psig), pressure relief valve (set @ 120 psig pressure), Rosemount temperature transmitter (RTD - type), and sight glass. The tank is also equipped with liquid and vapor inlet/exit connections, a drain valve, a connection for supplying water to the compressors and a differential pressure transmitter to control the level inside the separator. ½"∅ heat transfer coils are installed to provide excessive heat loading on the refrigerated condensers (i.e., on CR-1 and CR-2)

C. Separator SEP-3

SEP-3 is the Compressor Discharge overflow separator. Overflow from the SEP-2 is discharged to this separator. An ON/OFF automated valve is provided on the drain leg to empty the separator of its liquid content periodically.

Material of Construction: 316 Stainless Steel, ¼" swg

Size: 8"∅ x 3.0' height (seam/seam)

Capacity: 7.95 gallons (0.219 gallon/inch)

Operating pressure: 100 psig

Equipped with a Rosemount pressure differential transmitter to control the level, a sampling valve and liquid and vapor inlet/exit connections.

D. Condensate Receivers CR-1

CR-1 is a Condensate receiver. Condensate from the heat Exchanger (CON-1) is collected and discharged automatically to a wastewater storage tank. An ON/OFF automated valve is provided on the drain leg, of the Condensate receiver, to empty the liquid content periodically.

Material of Construction: 316 Stainless Steel, ¼" swg

Size: 8"∅ x 2.0' height (seam/seam)

Capacity: 5.3 gallons (0.2209 gallon/inch)

Operating pressure: 100 psig

Equipped with Rosemount differential pressure transmitter to control the level, Rosemount temperature transmitter (RTD-type), a sight glass and liquid and vapor inlet/exit connections. The receiver is also furnished with an automated ON/OFF valve and a check valve on the drain leg of the receiver.

E. Condensate Receiver CR-2

CR-2 is a Condensate receiver. Condensate from the heat Exchanger (CON-1) is collected and discharged automatically to a wastewater storage tank. An ON/OFF automated valve is provided on the drain leg, of the Condensate receiver, to empty the liquid content periodically.

Material of Construction: 316 Stainless Steel, ¼" swg

Size: 8"∅ x 2.0' height (seam/seam)

Capacity: 5.3 gallons (0.2209 gallon/inch)

Operating pressure: 100 psig

Equipped with Rosemount differential pressure transmitter to control the level, Rosemount temperature transmitter (RTD-type), a sight glass and liquid and vapor inlet/exit connections. The receiver is also furnished with an automated ON/OFF valve and a check valve on the drain leg of the receiver.

F. Compressors CP-1 & CP-2

Compressor CP-1 and CP-2 are electrically operated rotary liquid ring piston compressors, manufactured by SIHI pumps Inc.

Model No: KPHR 55206

Material of Construction: Stainless Steel

Material of Construction (Wetted parts): Stainless Steel

Capacity: 60 SCFM @ a discharge pressure of 100 psig

Circulating media: water @ 10 gpm with a typical temperature rise of 10 C

Motor Frame Size: 213TC

Equipped with a C framed, Explosion proof, Class 1 Groups C & D, 30 HP, 460V, 3PH motor operating at 1750 rpm

Installed with Pressure Gauge (0-150 psig), a temperature gauge (0-100° C) and a check valve on the discharge side of the compressor. Installed on the suction side of the compressor is a pressure gauge (-30" Hg/ 15 psig), a check valve and a manual isolation valve.

Installed on the liquid ring supply line to the compressor is a flow meter (1-10 gpm), a manual flow regulating valve, a flow switch and a air operated ON/OFF isolation valve.

G. Liquid Handling Pump AP-1

AP-1 is an air operated level control pump for SEP-1

Model #: Wilden M-4 (or equivalent)

Housing Material: Cast Steel

Seats: Stainless steel or Teflon

Balls & Diaphragm material: Teflon

Supplied with a manual isolation valve on the suction side and a check valve and a sampling valve on the discharge side of the pump.

H. Heat Exchanger PF-1, PF-2, CON-1, CON-2

a) PF-1 is a copper or nickel brazed, plate & frame, High Efficiency, Heat Exchanger. Its function is to remove heat of compression and heat of condensation from the compressor liquid ring medium after the compression cycle. PF-1 utilizes an ethylene glycol-water chillent cooled by the plant chiller unit.

Material of construction: 316 or 304 Stainless Steel

Heat Transfer Area: $\geq$ 16.57 FT^2

Maximum Plate side pressure rating: 450 psi

Maximum Frame side pressure rating: 450 psi

Maximum Design temperature: 450° F

Equipped with a temperature gauge (0-100° C) on the process media exit side of the Heat exchanger. Temperature (0-100° C) and pressure (0-50 psig) gauges are installed on the process media inlet side of the heat exchanger. Temperature gauges (0-100° C) and manual valves installed on the chillent supply and return lines of the heat exchanger. Pressure gauges (0-30 psig) and (0-15 psig) are installed on the supply and return lines receptively.

b) PF-2 is a copper or nickel brazed, plate & frame, High Efficiency, Heat Exchanger. Its function is to remove heat of compression and heat of condensation from the compressor liquid ring medium after the compression cycle. PF-2 utilizes cooling water from the plant cooling towers.

Model No: FP5 x 20 x 50

Material of construction: 304 or 316 Stainless Steel

Heat Transfer Area: $\geq$ 36.14 FT2

Maximum Plate side pressure rating: 450 psi

Maximum Frame side pressure rating: 450 psi

Maximum Design temperature: 450° F

Equipped with a temperature gauge (0-100° C) and a pressure gauge (0-50 psig) on the process media exit side of the Heat exchanger. Temperature (0-100° C) and pressure (0-150 psig) gauges are installed on the process media inlet side of the heat exchanger. Temperature gauges (0-100° C) and manual valves installed on the cooling water supply and return lines of the heat exchanger. Pressure gauges (0-30 psig) and (0-15 psig) are installed on the supply and return lines receptively.

c) CON-1 and CON-2 are identical finned tube Heat Exchangers. Their function is to condense the condensable components of the VOC laden inlet stream conveyed from SEP-2 and SEP-3. These condensers are cooled using an onboard refrigeration system.

Equipped with air operated ON/OFF and manual isolation valves on the inlet and exit ports of the condensers. They are, also, furnished with Rosemount temperature transmitters and a common gauge pressure transmitter on the relevant side of the unit.

I. Filter F-1

F-1 is a Bag filter supplied by Wagner Process Equip. Its function is to remove any carry over debris and bacterial growth from entering the plate and frame heat exchanger, which would otherwise block the narrow channels of the plate & frame heat exchangers and lower the operating efficiency.

Model No: BFNP-12-4-304SS

Pressure Rating: 150 psig

Material of Construction: All 304 Stainless Steel

Basket with 3/32"∅ holes

Installed with pressure gauge (0-150 psig) and manual valves at the inlet and outlet sides of the unit. A drain valve on the bottom of the unit.

J. Control Panel: VOC-1

Operator interface terminal and emergency stop button is housed in a NEMA 7 & 9 rated control panel enclosure (VOC-1.)

M3 RECORDKEEPING

The EPA process vent regulations (Subpart AA) require that specific operating records, inspections and monitoring be retained for the process vent and VOC reduction systems.

M3.1 INSPECTIONS

Romic visually inspects the closed vent system annually for leaks that may result in increased air emissions. These inspections, required in accordance with Subpart AA, must take place when at least one process unit is treating hazardous waste. All joints, seams, and other connections that are permanently or semi-permanently sealed (e.g., welded seams and bolted flanges) are inspected. Romic monitors any other components and connections (e.g., camlock connections) of the closed vent system annually in accordance with 40 CFR 264.1034(b) to demonstrate that the system operates with no detectable emissions as indicated by an instrument reading of less than 500 ppmv above background. Inspection/ monitoring data for the Subpart AA closed vent system and VOC reduction unit are maintained in an electronic database, and is provided as Appendix F-5 of Section F.

M3.2 CONTINUOUS MONITORING

The VOC reduction unit is a condenser system that requires a temperature monitoring device installed in the exhaust vent stream from each condenser exit. The temperature monitor is equipped with a continuous chart recorder. The exit temperatures of the two condensers are recorded continuously on a 24 hour 7 day chart recorder, whether or not the VOC system is in operation. The charts are retained in EHS department files for a minimum of three years from the date of the record.

M3.3 HOURLY MONITORING

The closed vent system and VOC reduction unit require flow indicators on each process vent that provide a record of vent stream flow to the control device at least once per hour. The electronic process vent flow indicators are installed in the vent streams before they are combined at the VOC reduction unit. Process vent flow data are continuously displayed on each devise, as well as on a readout in the process control room. Flow data are retained electronically. In addition to electronic flow data retention, VOC reduction unit inlet flow measurement is continuously recorded on the same chart recorder that records condenser temperatures. The charts are retained in EHS department files for a minimum of three years from the date of the record.

M3.4 PROCESS OPERATIONS RECORD

Process unit operation record forms are completed by process unit operators for each shift that operates process equipment. The process operation records record the operating hours, material processed, and operating parameters of each run, and are maintained for non-hazardous waste as well as hazardous waste. Process records are maintained initially in the Production Manager’s files. The records are then retained in the EHS department files for a minimum of three years. Sample process operation record forms are found in Appendix N-1.

M3.5 SYSTEM MALFUNCTION OR FAILURE

If the VOC removal system fails to operate within the design specifications, as noted during daily inspections, facility maintenance is immediately notified to identify the source of the problem and make necessary adjustments or repairs. Examples of equipment tags and repair tags are provided in Appendix N-2. Maintenance request work order forms are used to document maintenance and repairs to the unit.

The VOC reduction unit is equipped with an audible alarm that sounds to alert process operators in the event of a cooling system failure or unplanned unit shutdown. The PLC controller that operates the VOC reduction unit automatically shuts down the unit and alarms whenever there is a high compressor temperature, high system pressure, high water level in separator 1, or chilled fluid loss.

The vent stream exiting the VOC reduction unit may be directed to a dual carbon bed system if necessary due to unit malfunction or other problems. If the vent stream is directed to carbon beds, carbon bed performance will be monitored by measuring VOC concentrations entering the carbon beds, between the two carbon beds, and exiting the carbon beds. Such monitoring will be conducted at least once per any operating day that vapors are directed to carbon. The facility will maintain records of the periods of time vapors are directed to the carbon beds, and the results of monitoring.

If breakthrough occurs from the first carbon bed, as indicated by a less than 95% reduction in measured VOC concentration across the bed, the first carbon bed will be changed out when the distillation processes are next shut down, but no later than 24 hours after detection. The second carbon bed will be placed in the position of the first carbon bed, and a fresh carbon bed placed in the second position. If breakthrough occurs from the second carbon bed, as indicated by a less than 95% reduction measured VOC concentration across the two-bed system, all distillation processes will be shut down as expeditiously as practicable, and both carbon beds replaced with fresh carbon.

All expended carbon beds will be disposed of in accordance with applicable regulations and waste characterization processes, or will be regenerated, if possible, in accordance with manufacturers recommendations.

TABLES

TABLE M-1

PROCESS EQUIPMENT VENTS

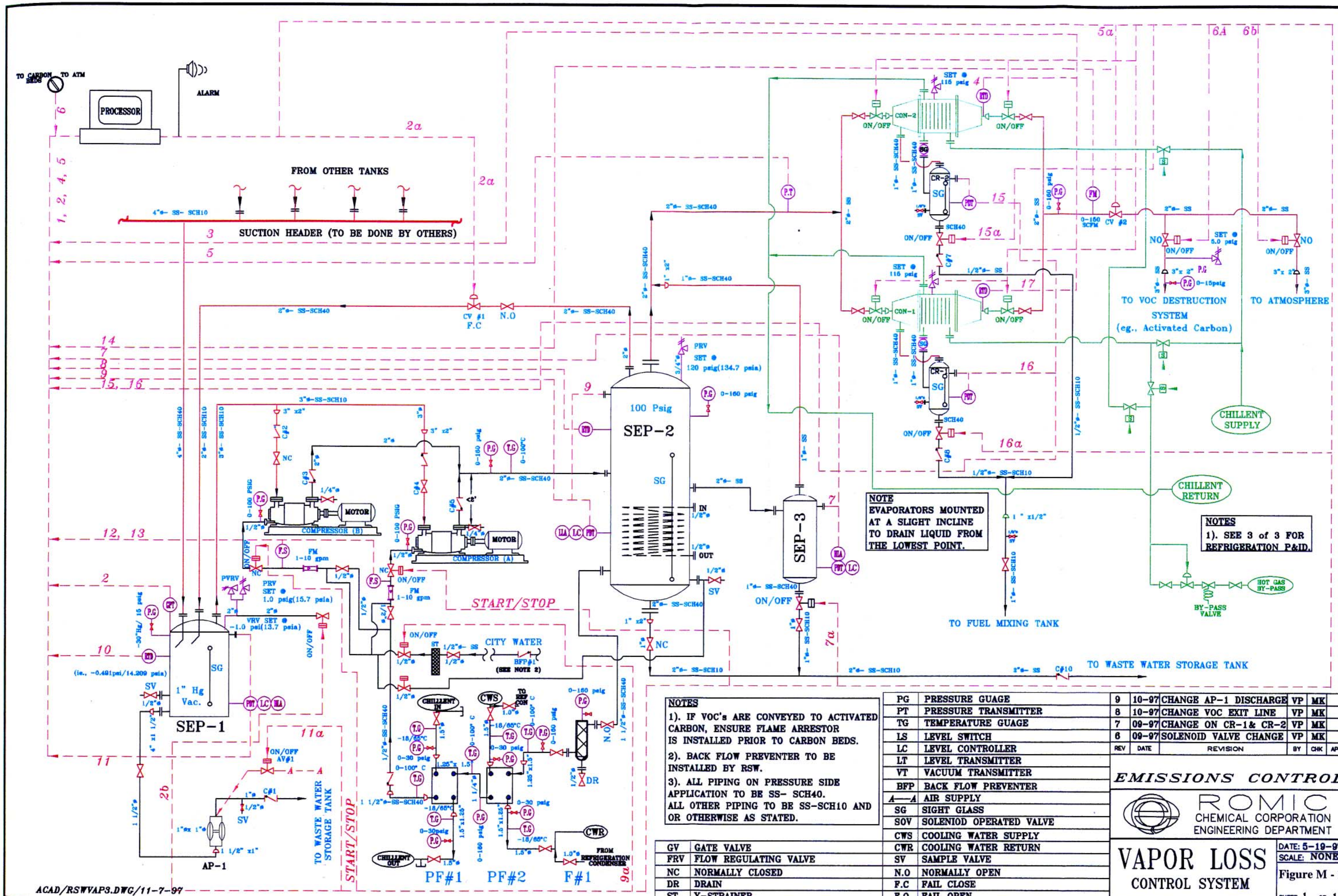
TABLE M-1
PROCESS EQUIPMENT VENTS

PROCESS SYSTEM	UNIT	VENT LOCATION
Distillation Column	Overhead Separator	Top of Overhead Separator
Thin Film Evaporator	Flush Tank	Top of Flush Tank
	Receiver Tank	Top of Receiver Tank
	Tank 105 (sludge/bottoms tank)	Top of Tank 105
Vacuum Pot	S-1	Top of S-1
	S-2	Top of S-2
	S-3	Top of S-3

FIGURES

FIGURE M-1

PROCESS AND INSTRUMENTATION DIAGRAM



NOTES

1). IF VOC's ARE CONVEYED TO ACTIVATED CARBON, ENSURE FLAME ARRESTOR IS INSTALLED PRIOR TO CARBON BEDS.

2). BACK FLOW PREVENTER TO BE INSTALLED BY RSW.

3). ALL PIPING ON PRESSURE SIDE APPLICATION TO BE SS- SCH40. ALL OTHER PIPING TO BE SS-SCH10 AND OR OTHERWISE AS STATED.

GV	GATE VALVE
FRV	FLOW REGULATING VALVE
NC	NORMALLY CLOSED
DR	DRAIN
ST	Y-STRAINER

PG	PRESSURE GUAGE
PT	PRESSURE TRANSMITTER
TG	TEMPERATURE GUAGE
LS	LEVEL SWITCH
LC	LEVEL CONTROLLER
LT	LEVEL TRANSMITTER
VT	VACUUM TRANSMITTER
BFP	BACK FLOW PREVENTER
A—A	AIR SUPPLY
SG	SIGHT GLASS
SOV	SOLENIOD OPERATED VALVE
CWS	COOLING WATER SUPPLY
CWR	COOLING WATER RETURN
SV	SAMPLE VALVE
N.O	NORMALLY OPEN
F.C	FAIL CLOSE
F.O	FAIL OPEN

REV	DATE	REVISION	BY	CHK	APP
9	10-97	CHANGE AP-1 DISCHARGE	VP	MK	
8	10-97	CHANGE PRESSURE TRANSMITTER	VP	MK	
7	10-97	CHANGE VOC EXIT LINE	VP	MK	
7	09-97	CHANGE ON CR-1& CR-2	VP	MK	
6	09-97	SOLENOID VALVE CHANGE	VP	MK	

EMISSIONS CONTROL

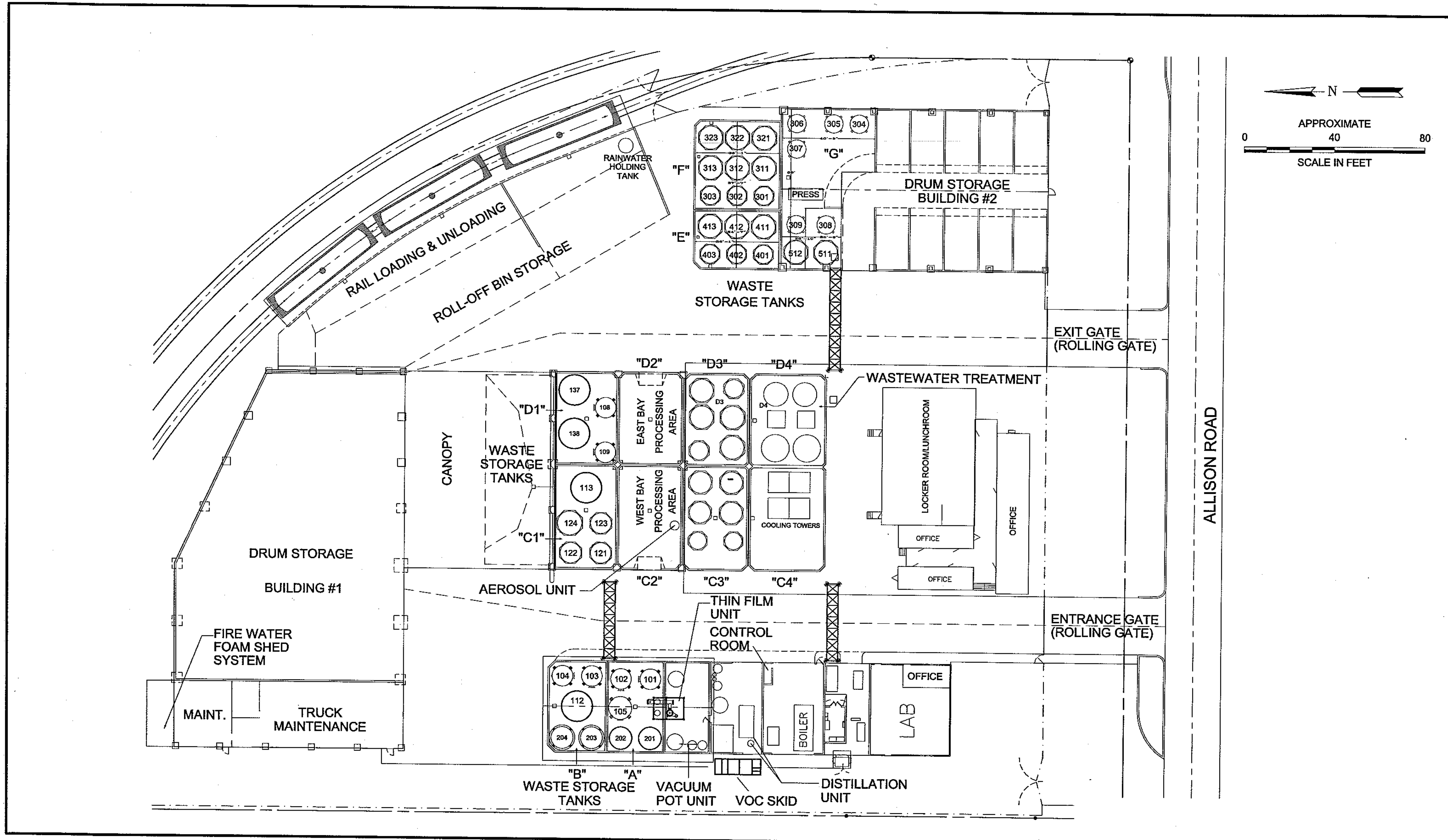
ROMIC CHEMICAL CORPORATION ENGINEERING DEPARTMENT

VAPOR LOSS CONTROL SYSTEM

DATE: 5-19-97
SCALE: NONE
Figure M - 1
SHEET 1 OF 1

FIGURE M-2

PROCESS UNIT AND VOC SYSTEM LOCATION



REFERENCE: BASEMAP PROVIDED BY:

ROMIC ENVIRONMENTAL TECHNOLOGIES CORP.
ROMIC SOUTHWEST, CHANDLER, ARIZONA

Facility Layout - Process Units

Romic - Southwest
Chandler, Arizona

URS

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Figure M-2

APPENDICES

APPENDIX M-1

OWNER CERTIFICATION STATEMENT

OPERATING PARAMETERS AND DESIGN ANALYSIS

OWNER CERTIFICATION STATEMENT

"I certify under penalty of law that the operating parameters used in the design analysis of process vent VOC emissions reasonably represent the conditions that exist when the waste management units are or would be operating at the highest load or capacity level reasonably expected to occur. The design analysis evaluation was prepared under my direction or supervision in accordance with the requirements of this regulation, and performed by a qualified independent contractor. Furthermore, qualified personnel properly gathered and evaluated the information necessary to comply with the design analysis requirements. Based upon my inquiry of the person or persons who prepared the design analysis, the design analysis is, to be the best of my knowledge and belief, true, accurate, and complete. The design analysis evaluation indicates that the VOC reduction unit is designed to operate at a VOC reduction efficiency of 95 weight percent or greater. I am aware that there are significant penalties for submitting false certification, including the possibility of fine and imprisonment for knowing violations."

Name (Print): Michael Therrien

Title: Vice President

Company: Romic Environmental Technologies, Inc. (Southwest)

Signature : Michael Therrien

Date Signed: 12/5/03

APPENDIX M-2

ENGINEERING ANALYSIS IN SUPPORT OF AIR EMISSIONS STANDARDS COMPLIANCE PROGRAM

ENGINEERING ANALYSIS IN SUPPORT OF
AIR EMISSIONS STANDARDS COMPLIANCE PROGRAM

Title 40, Code of Federal Regulations, Part 265, Subparts AA and CC

Prepared for: *Romic Environmental Technologies Corp.*
6760 West Allison Road
Chandler, Arizona 85226

USEPA ID #: AZD 009 015 389

Date of Report: November 15, 2003

This report was prepared for Romic Environmental Technologies Corp. by Clarus Management Solutions, Inc. The principal author was Ms. Haidie Tuazon, Chemical Engineer. The report was edited by Wayne Kiso, Project Manager. Any questions regarding the report may be directed to Wayne Kiso at waynek@ehs-mgr.com.

Clarus wishes to acknowledge the following persons for their assistance in gathering the information necessary to prepare this report:

Mr. Michael Therrien, Romic General Manager

Ms. Jennifer Manera, Romic EH&S Manager

Mr. Ashok Jain, Romic Operations Manager

Mr. John Rodriguez, Romic Production Supervisor

Mr. John Sigg, Maintenance Manager, Romic East Palo Alto

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EXECUTIVE SUMMARY

Romic Environmental Technologies Corp. (Romic) is the operator of an interim status off-site hazardous waste treatment and storage facility in Chandler, Arizona. The facility operates distillation equipment and stores organic hazardous wastes in tanks. These operations subject it to the requirements of 40 CFR Part 265, Subparts AA and CC. This engineering analysis was conducted to determine the compliance status of the facility with respect to certain Subpart AA and Subpart CC requirements.

Engineering calculations demonstrate that the facility does not, and will not, in the foreseeable future, exceed the hourly or annual organic emissions limits of Subpart AA for process vents. Total reasonable maximum hourly organic emissions were calculated to be 1.32 kilograms per hour, below the Subpart AA hourly limit of 1.4 kg/hr. Annual emissions were demonstrated to be well below the 2.8 megagram per year limit. Total organic emissions from process vents was determined to be 0.141 Mg in 2002, and 0.080 Mg in 2003 year-to-date as of October 15.

1 INTRODUCTION

1.1 BACKGROUND

Romic Environmental Technologies Corp. (Romic) commissioned Clarus Management Solutions, Inc. (Clarus) to conduct an engineering analysis in support of its compliance program for the RCRA Air Emission Standards (see Section 1.3 below). This report presents the results of this analysis.

1.2 FACILITY INFORMATION

This engineering analysis was conducted for the following facility:

Facility Name: Romic Environmental Technologies Corp.
Address: 6760 West Allison Road, Chandler, Arizona 85226
USEPA ID #: AZD 009 015 389

The facility is an offsite hazardous waste treatment and storage facility in interim status under the USEPA's RCRA program. The facility has submitted a Part B application; the application is currently under review by USEPA Region 9.

1.3 REGULATORY FRAMEWORK

The Romic facility includes distillation operations conducted in a vacuum pot (simple) still, a thin film evaporator unit, and a distillation column. These operations potentially subject the facility to the requirements of Subpart AA[1] of Part 265, Title 40 of the Code of Federal Regulations. The facility also stores organic hazardous wastes in tanks. This storage subjects the facility to the requirements of Subpart CC[2] of Part 265, Title 40 of the Code of Federal Regulations.

This engineering analysis was conducted in order to determine the applicability of certain requirements under Subpart AA to the Romic facility, and its compliance with those requirements under Subparts AA and CC that are determined to be applicable.

Subpart AA regulates air emissions from process vents on equipment managing organic hazardous wastes. A facility must install controls to reduce organic air emissions unless the total organic emissions from all affected process vents at the facility is less than 1.4 kilograms per hour (kg/hr) and total less than 2.8 megagrams per year (Mg/yr). If the total organic emissions exceed this level, the facility must control those emissions either to below 1.4 kg/hr and 2.8 Mg/yr, by 95%, or below 20 ppmv (through an enclosed combustion device).

Subpart CC regulates air emissions from tanks, containers, and surface impoundments. The Subpart CC provisions that drive this report are those governing tanks storing organic hazardous wastes. Air emissions from tanks storing lower vapor pressure

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[1] 40 C.F.R. 265.1030-1035 (2002).

[2] 40 C.F.R. 265.1080-1090 (2002).

organic hazardous wastes may be controlled either using Level 1 controls or Level 2 controls. An example of a tank with Level 1 controls is a closed roof tank equipped with conservation vents (pressure-vacuum relief devices set at low pressure/vacuum levels). An example of a Level 2 tank is one vented via a closed-vent system to a control device. This report concerns those storage tanks piped to the Romic Southwest control device.

1.4 ABOUT THIS REPORT

This engineering analysis report includes calculations of the following:

- Organic emissions from each of the distillation unit operations.
- Emissions from storage tanks in order to determine loading on the control device.
- Performance of the control device under reasonable maximum loading conditions.

These calculations are presented in Section 2.

2 ENGINEERING CALCULATIONS

2.1 DISTILLATION UNITS

The three distillation process units to be accounted for in this vapor emission calculation are:

- Vacuum Pot
- Thin Film Evaporator
- Distillation Column

The RCRA hazardous waste streams processed in these units are as follows:

- Vacuum Pot
  - Acetone
  - Lacquer Thinner
  - Ethyl Lactate
- Thin Film Evaporator
  - Acetone
  - Lacquer Thinner
  - Xylene
- Distillation Column
  - Methylene Chloride
  - Wastewater containing volatile organics
  - Perchloroethylene

Piping and Instrumentation Diagrams depicting these processes are included in Appendix A to this report.

2.1.1 Properties Of Streams

Stream properties for modeling purposes were based in part on analytical data supplied by the Romic Laboratory and anecdotal information by management personnel. Analytical data were reviewed, and typical compositional profiles. These data and information are included as Appendix B to this report. For products that have 95% or higher purity (i.e., ethyl lactate, methylene chloride, perchlorothylene, and xylene), a single-component system is assumed. Acetone, though the typical product purity is only 90%, is also modeled as a single-component system, because acetone is significantly more volatile than the other components (i.e., methanol, isopropanol, MEK, toluene, and water). For wastewater, the volatiles (methanol, ethanol, and isopropanol) are considered for the vapor calculation[3]. Lacquer thinner is modeled as a multi-component

[3] Typical Product Lab analyses were used to estimate composition of streams.

mixture, consisting of alcohols, ketones, acetates, and water. The modeled properties are based on the properties of the pure substances making up the mixture. Physical property determinations are described below.

Molecular Weight for Multi-Component System

For both wastewater volatiles and lacquer thinner, concentration-weighted averages of individual components were calculated for molecular weight (MW).

Heat Capacity, Heat of Vaporization and Specific Gravity for Multi-Component System

For both wastewater volatiles and lacquer thinner, weighted values were calculated for gas heat capacities (Cpgas), liquid heat capacity, (Cpliquid), heat of vaporization (Hvap), and specific gravity. These properties are obtained at an average temperature of 30^{o}C.

Boiling Point[4] for Multi-Component System

The boiling point estimations were determined using an iterative method based on the following equations:

$$Yi = Ni = KiXi$$

$$\text{or } Xi = Ni/Ki$$

$$\text{and } \sum Ni/Ki = 1.0$$

where:

Yi is the mole fraction of component i in the vapor phase

Xi is the mole fraction of component i in the liquid phase

Ni is the mole fraction of component i in the incoming mixture

Ki is the vapor-liquid equilibrium K value (vapor pressure/total pressure)

Ki is determined as follows:

$$Ki = Pvap/Ptotal$$

where

Pvap = Vapor pressure

Ptotal = Ambient pressure

Pvap is determined as described below, and Ptotal is assumed to be atmospheric.

At the mixture's dew point, it is assumed that, as the first drop forms upon cooling the vapor at constant pressure, the vapor remaining has the same composition as that of the initial vapor mixure, therefore Yi = Ni. An initial value of the boiling point temperature is given until the condition $\sum Ni/Ki = 1.0$ is met.

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4 Handbook of Chemical Engineering Calculations, 3rd Ed., Nicholas P. Chopey, McGraw Hill, New York 2004

Vapor Pressures for Multi-component Systems

Vapor pressures are temperature dependent obtained using the equations and constants from Perry's[5]

$$P = \exp\left[C1 + \left(\frac{C2}{T}\right) + C3 \bullet \ln(T) + C4 \bullet T^{C5}\right]$$

Or from Antoine's equation:

$$\log_{10} P = A - \left[\frac{B}{(T + C)}\right]$$

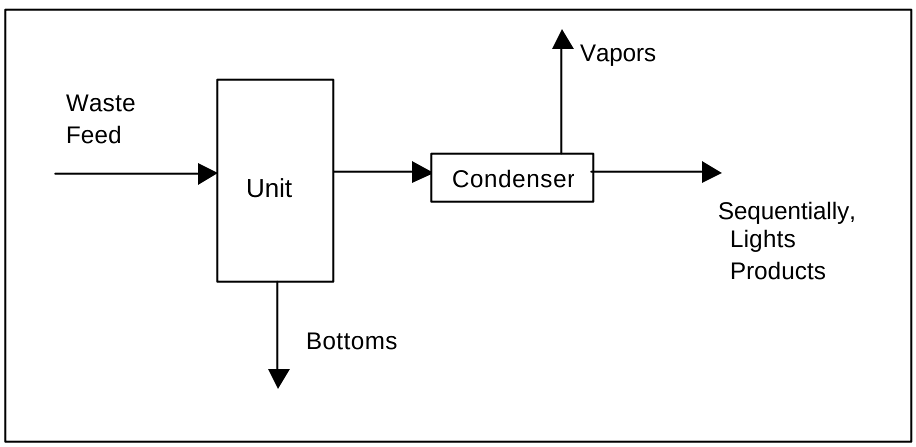
For the above equations, P is the vapor pressure, T is the temperature, and A, B, C, C1, C2, C3, C4, and C5 are constants. For a list of constants, refer to Appendix C.

Physical property determinations used in this analysis are included in Appendix D.

2.1.2 Heat Balance

The process flow diagram for these units may be generalized as follows:

Figure 1 General Process Flow Diagram for Processing Units



The amount of vapor exiting the process (and, it follows, the amount of vapor entering the VOC System) is comprised of the material that does not condense in the process condenser.

The following assumptions are used to estimate the vapor amount:

For all waste types the following material balance principle is used:

---

[5] Perry's Chemical Engineer's Handbook, 7th Ed., Robert H. Perry, Don W. Green, McGraw Hill, New York, 1997

Feed = Bottoms + Products + Lights

Or for simplicity,

Total Products = Products + Lights

Therefore:

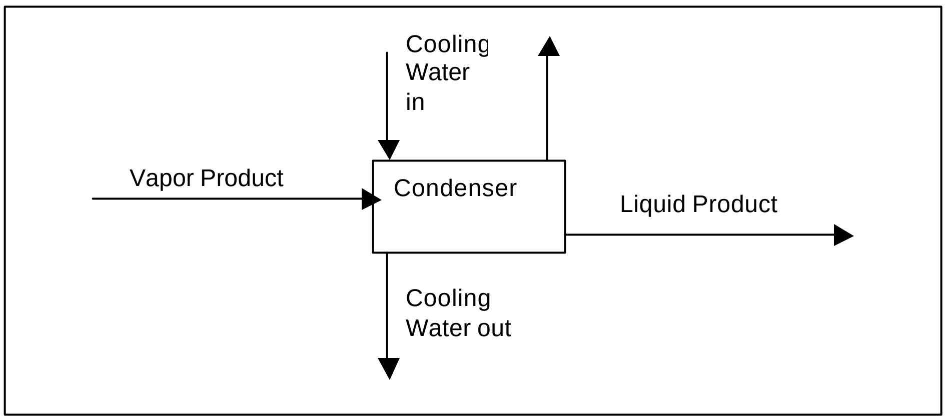
Feed = Bottoms + Total Products

Batch operations are assumed in order to estimate the flow rate. For the feed hourly flow rate, the total volume processed is divided by the average total run time[6]. For the vapor hourly flow rate, the flow of total products is divided by the average total runtime.

Vapor and liquid compositions are assumed constant during condensation. Atmospheri pressure conditions are assumed for vapor-liquid equilibrium calculations.

To perform the heat balance for the condenser, a more detailed process flow diagram as shown in Figure 2 is used.

Figure 2. Process Flow Diagram, Representative Unit Condenser



The heat balance for the condenser is:

$$Q_{CW} = Q_{sensible\ heat} + H_{vaporization}$$

where:

Q_{CW}	=	Heat removed by the cooling water
$Q_{sensible\ heat}$	=	Heat removed to reduce vapor temperature to the dew point
$H_{vaporization}$	=	Heat removed to condense vapors

For simplicity, the mass flow rate of the vapor product going into the condenser is assumed to be equal to the mass flow rate of the lquid product obtained from the

[6] Average runtimes are estimates from legible run sheets.

process (assuming that the vapor flow is negligible), and that the concentration of the vapor product is the same as the concentration of the liquid product (the concentrations vary from product to product, therefore a typical product breakdown is used for the incoming vapor state as well).

Heat Needed To Be Removed By Cooling Water

The heat removed by the cooling water is calculated as follows:

$Q_{CW} = mCp(T_{CWout} – T_{CWin})$

where:

m is the mass flow rate of the cooling water

Cp is the heat capacity of the cooling water

A pump rated for 1800 gpm is used to supply the cooling water to all three unit condensers, regardless of whether the units are running or not. This gives a volumetric flow of 600 gpm or 36,000 gal/hr for each process condenser.

Heat Exchanger Capacity Sample Calculation: Distillation Column

Sample runs were analyzed for the Distillation Column and Vacuum Pot unit operations. The adequacy of the process condensers was evaluated using sample cases representing heavy condensing loads. For the Distillation Column process, the case modeled was for the processing of wastewaters, with organic components being condensed.

Table 1. Distillation Column Condenser Calculation Parameters and Calculated Values

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	5,128,634	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	29	C
CW output Temperature:	Tcwout =	38	C
Density of CW:	Density =	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Volatiles	
Sensible Heat (vapor)	Q1 =	0	kJ/hr
Heat of Vaporization	Q2 =	119,226	kJ/hr
Sensible Heat (liquid)	Q3 =	15,424	kJ/hr
Total Heat	Q =	134,650	kJ/hr
Heat capacity of vapor:	Cp(vap) =	1.42	kJ/kg-K
Heat capacity of liquid:	Cp(liq) =	2.63	kJ/kg-K
Vapor Input Temperature:	Tin =	80	C
Liquid Output Temperature:	Tout =	33.3	C
Boiling point temperature:	Tbp =	80	C
Latent Heat of Vaporization	Hv =	949.4	kJ/kg
Theoretical Flow rate of vapor to be condensed:	M =	4783.19	kg/hr
		1599.73	gal/hr
Flow Rates			
Run time		5	hr/batch
Feed Stock (batch)		1000	gal
Product		21	%recovery
Density		789.92	kg/m3
Calculated Flow rate of product going through condenser		126	kg/hr
Amount of vapor to VOC System		0	kg/hr

From Table 1 above, the calculated heat removed by the cooling water was 5,130 MJ/hr. This heat removal rate results in a theoretical condensation rate of up to 4,780 kg/hr, or 1,600 gal/hr, of volatiles from wastewater. A typical product recovery of 20% volatiles was used. Volatiles for wastewater consisted primarily of methanol, ethanol, and isopropanol in roughly equal weight percents. For a feed rate of 1,000 gal and a typical runtime of 5 hours, the flow rate of product actually condensed through the condenser was calculated to be 126 kg/hr. The condenser is oversized, with far more heat removal capacity than necessary. Therefore the vapors exiting the distillation column process and entering the VOC system can be assumed to arise from displacement of vapors as condensed product flows into the product receiver vessel.

Heat Exchanger Capacity Sample Calculation: Vacuum Pot

The sample calculation presented here for the Vacuum Pot was for the processing and condensing of Stoddard Solvent.

Table 2. Vacuum Pot Condenser Calculation Parameters and Calculated Values

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,564,317	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	29.4	C
CW output Temperature:	Tcwout =	33.9	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Stoddard Solvent	
Sensible Heat (vapor)	Q1 =	0	kJ/hr
Heat of Vaporization	Q2=	125,462	kJ/hr
Sensible Heat (liquid)	Q3=	66,124	kJ/hr
Total Heat	Q=	191,586	kJ/hr
Heat capacity of vapor:	Cp(vap)=	0.83736	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	1.25604	kJ/kg-K
Vapor Input Temperature:	Tin=	127	C
Liquid Output Temperature:	Tout	29.4	C
Boiling point temperature:	Tbp=	127	C
Latent Heat of Vaporization	Hv=	232.6	kJ/kg
Theoretical Flow rate of vapor to be condensed:	m=	7219.57	kg/hr
		2543.09	gal/hr
Flow Rates			
Run time		4	hr/batch
Feed Stock (batch)		1000	gal
Product		76	%recovery
Density		750	kg/m3
Calculated Flow rate of product going through condenser		539	kg/hr
Amount of vapor to VOC System		0	kg/hr

From Table 2 above, the calculated heat removed by the cooling water was 2,560 MJ/hr. This heat removal rate results in a theoretical condensation rate of up to 7,200 kg/hr, or 2,540 gal/hr, of Stoddard Solvent product. A typical product recovery of 76% was used. For a feed rate of 1,000 gal and run time of 4 hours, the calculated flow rate of product actually condensed through the condenser was calculated to be 539 kg/hr. The condenser is oversized, with far more heat removal capacity than necessary. Therefore, the vapors exiting the vacuum pot process and entering the VOC system can be assumed to arise from displacement of vapors as condensed product flows into the product receiver vessel.

Heat Exchanger Capacity Sample Calculation: Thin Film Evaporator

The Thin Film Evaporator condenser calculations are conducted in the same manner as the Distillation Column and Vacuum Pot calculations; no sample calculation is given here.

Typical Run Calculation:

For standard runs, the following parameters are used:

For cooling water:

Flow = 36,000 gal/hr

Temperature difference ($T_{CWout} - T_{CWin}$) = 5 °C

For wastes:

$T_{product\ in}$ = 10 degrees above boiling, °C

$T_{product\ out}$ = 30 °C[7]

Assuming 1000 gal batches,

Product	Run times (hrs/1000 gal)
1. Vacuum Pot	
a. Acetone	5
b. Lacquer Thinner	5
c. Ethyl Lactate	2
2. Distillation Column	
a. Wastewater	4
b. Methylene Chloride	13
c. Perchloroethylene	11
3. Thin Film Evaporator	
a. Acetone	5
b. Lacquer Thinner	5
c. Xylene	2

Heat balances were conducted on each of the Subpart AA-regulated cases. These calculations are included in Appendix E. The condensation capacity was compared to the heat removal requirements for each type of run. Results are summarized in Table 3.

[7] Several actual temperature measurements were performed, and it is shown that the average product temperature (output to the process condensers) is approximately 30°C.

Table 3. Condenser Capacity Comparison

	Heat Removed by CW (MJ/Hr)	Heat Required to Condense Product (MJ/hr)	Difference (MJ/hr)
1. Vacuum Pot			
a. Acetone	2,840	302	2538
b. Lacquer Thinner	2,840	477	2363
c. Ethyl Lactate	2,840	633	2207
2. Distillation Column			
a. Wastewater	2,840	138	2702
b. Methylene Chloride	2,840	120	2730
c. Perchloroethylene	2,840	127	2713
3. Thin Film Evaporator			
a. Acetone	2,840	230	2610
b. Lacquer Thinner	2,840	378	2462
c. Xylene	2,840	508	2332

The condensers for all of the units, the vacuum pot, the distillation column, and the thin film evaporator, are oversized. The processing of ethyl lactate on the vacuum pot has the highest heat removal requirement (633 MJ/hr), at a feed rate of 1,000 gal/hr and runtime of two hours. For the heat requirement for condensation to equal the heat removal capability of the cooling water in the condensers, the feed rate would need to be increased by approximately threefold.

2.1.3 Organic Emissions Calculation

Because the condensers are oversized, the vapors exiting the process units, and therefore entering the VOC system, arise from displacement of vapors as condensed product flows into the product receiver vessel. The composition of these displaced vapors can be assumed to be the vapor that is in equilibrium with the product liquid at the receiver temperature and pressure.

Mass flow rates will be calculated using the ideal gas law:

$$PV = nRT$$

or

$$n = \frac{PV}{RT}$$

where:

n = vapor flow (kg-mol/hr)

P = pressure (Pa)

V = volumetric flow (m^3/hr)

R = constant, 8314.34 (m^3-Pa/kgmol-°K)

T = temperature (°K)

For single-component systems, P is the vapor pressure at the system temperature. For multi-component systems, P is the weighted vapor pressure; the weighted molecular weight was used to find the total mass flow rate.

Vapor flow rates were calculated using processing run data. The calculations are included as Appendix F. Results are shown in Table 4.

Table 4. Organic Vapor Flow Rates from Process Units

	Organic Vapor Emission Rate		
	Vacuum Pot	Distillation Column	Thin Film Evaporator
Acetone	0.53 kg/hr		0.40 kg/hr
Ethyl Lactate	0.01 kg/hr		
Lacquer Thinner	0.21 kg/hr		0.14 kg/hr
Methylene Chloride		0.39 kg/hr	
Organics Mixture from Processing Wastewater		0.05 kg/hr	
Perchloroethylene		0.05 kg/hr	
Xylene			0.05 kg/hr

These operating vapor flow rates were converted to emission factors in units of kilograms per 1000 gallons processed. This conversion was based on a compilation of historical run data. Using emission factors calculated in this manner facilitates the calculation of actual emissions. The use of hourly emission rates requires allowances for reboiler filling and intermediate recharge time, time periods when runs may be interrupted, and variations in the rate of steam application. Presenting emission factors in units of kg/1000 gallons processed negates these uncertainties and provides a more reliable emission estimation.

Table 5. Emission Factors by Processing Run Type

	Organic Vapor Emission Factor (kg/1000 gal processed)		
	Vacuum Pot	Distillation Column	Thin Film Evaporator
Acetone	2.6		2.0
Ethyl Lactate	0.026		
Lacquer Thinner	1.0		0.68
Methylene Chloride		5.0	
Organics Mixture from Processing Wastewater		0.19	
Perchloroethylene		0.52	
Xylene			0.092

2.1.4 Maximum Organic Emission Rate

The maximum hourly organic emission rate for the facility would be the sum of the highest flows from each unit. In this case, the highest organic emissions from the vacuum pot would be 0.53 kg/hr of acetone, from the distillation column, 0.39 kg/hr of methylene chloride, and from the thin film evaporator, 0.40 kg/hr of acetone. The total organic emissions if all three units are running under these conditions is:

Total Organic Emissions = 0.53 + 0.39 + 0.40 = 1.32 kg/hr

The facility seldom operates all three units simultaneously, rarely, if ever, running these particular products.

In order for the facility to exceed the 2.8 Mg/yr organic emission threshold, it would need to be operating under the above maximum conditions for at least 2,121 hours, exclusive of downtime.

Actual annual emissions were calculated based on processing run information (for those runs subject to Subpart AA) and calculated emission factors (see 2.1.3 above). Production run data upon which these calculations were based are included as Appendix G. This calculation is illustrated for calendar year 2002 in Table 6 and for calendar year 2003, through October 15, in Table 7.

Table 6. Annual Emission Calculation, 2002

	Volumes (gal)	Emission Factor (kg/1000 gallons)	Organic Emissions (Mg)
Vacuum Pot			
Acetone	4,921	2.63	0.013
Lacquer Thinner	9,192	1.04	0.010
Distillation Column			
Waste water (organic content)	53,579	0.19	0.008
Methylene Chloride	13,216	5.04	0.067
Perchloroethylene	12,433	0.52	0.006
Thin Film Evaporator			
Acetone	8,026	2.01	0.016
Lacquer Thinner	31,097	0.68	0.021
		TOTAL ORGANIC EMISSIONS (Mg):	**0.141**

Table 7. Annual Emission Calculation, 2003 (through 10/15/03)

	Volumes (gal)	Emission Factor (kg/1000 gallons)	Organic Emissions (Mg)
Vacuum Pot			
Acetone	2,808	2.63	0.007
Lacquer Thinner	10,442	1.04	0.011
Distillation Column			
Waste water (organic content)	124,018	0.19	0.023
Methylene Chloride	2,597	5.04	0.013
Thin Film Evaporator			
Acetone	5,449	2.01	0.011
Lacquer Thinner	20,502	0.68	0.014
Xylene	2,883	0.09	< 0.001
		TOTAL ORGANIC EMISSIONS (Mg):	**0.080**

Total organic emissions from Subpart AA process vents in 2002 was 0.141 Mg. Annualizing the data from the period 1/1/03 through 10/15/03, we project approximately 0.102 Mg of organic emissions from Subpart AA process vents in 2003.

2.2 TANK EMISSIONS

Several tanks that may contain organic liquid hazardous wastes are vented to the VOC control system. The loading on the VOC system from tank emissions was calculated applying the methods set forth in AP-42[8], Chapter 7, Section 1, Organic Liquid Storage Tanks.

Emissions from fixed roof tanks storing organic liquids consist of breathing (or standing storage) losses and working losses. Total losses are calculated using the following equation:

$$L_T = L_B + L_W \qquad \text{(eq. 2.2-1)}$$

where:

L_T = total losses in lb/unit time

L_B = breathing storage losses, in lb/unit time

L_W = working losses, in lb/unit time

Each of these components of tank emissions will be calculated separately below.

2.2.1 Breathing Losses

Breathing losses are calculated as follows:

$$L_B = V_V W_V K_E K_S \qquad \text{(eq. 2.2-2)}$$

where:

L_B = breathing storage losses, in lb/unit time

V_V = vapor space volume, ft^3

W_V = vapor density, lb/ft^3

K_E = vapor space expansion factor, dimensionless

K_S = vented vapor saturation factor, dimensionless

Vapor space volume is self-explanatory. Vapor density can be calculated:

$$W_V = \frac{M_V P_{VA}}{RT_{LA}} \qquad \text{(eq. 2.2-3)}$$

where:

M_V = vapor molecular weight, lb/lb-mole

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8 Compilation of Air Pollutant Emission Factors: AP-42, Fifth Edition, United States Environmental Protection Agency.

3 CONCLUSIONS

3.1 SUBPART AA COMPLIANCE

Subpart AA limits total organic emissions from all affected process vents at a facility to 1.4 kilograms per hour and 2.8 megagrams per year. The maximum hourly organic emission rate at Romic Southwest is 1.32 kg/hr, with the vacuum pot unit running acetone, the distillation column running methylene chloride, and the thin film evaporator running acetone. This combination rarely occurs, if ever. Actual total annual organic emissions were 0.141 Mg in 2002. Actual total organic emissions were 0.080 Mg in 2003, through October 15. Both of these rates are well below the Subpart AA limit of 2.8 Mg/yr. A majority of the processing conducted by the facility appears to involve non-RCRA hazardous waste, such as the recovery of ethylene glycol from waste automotive antifreeze.

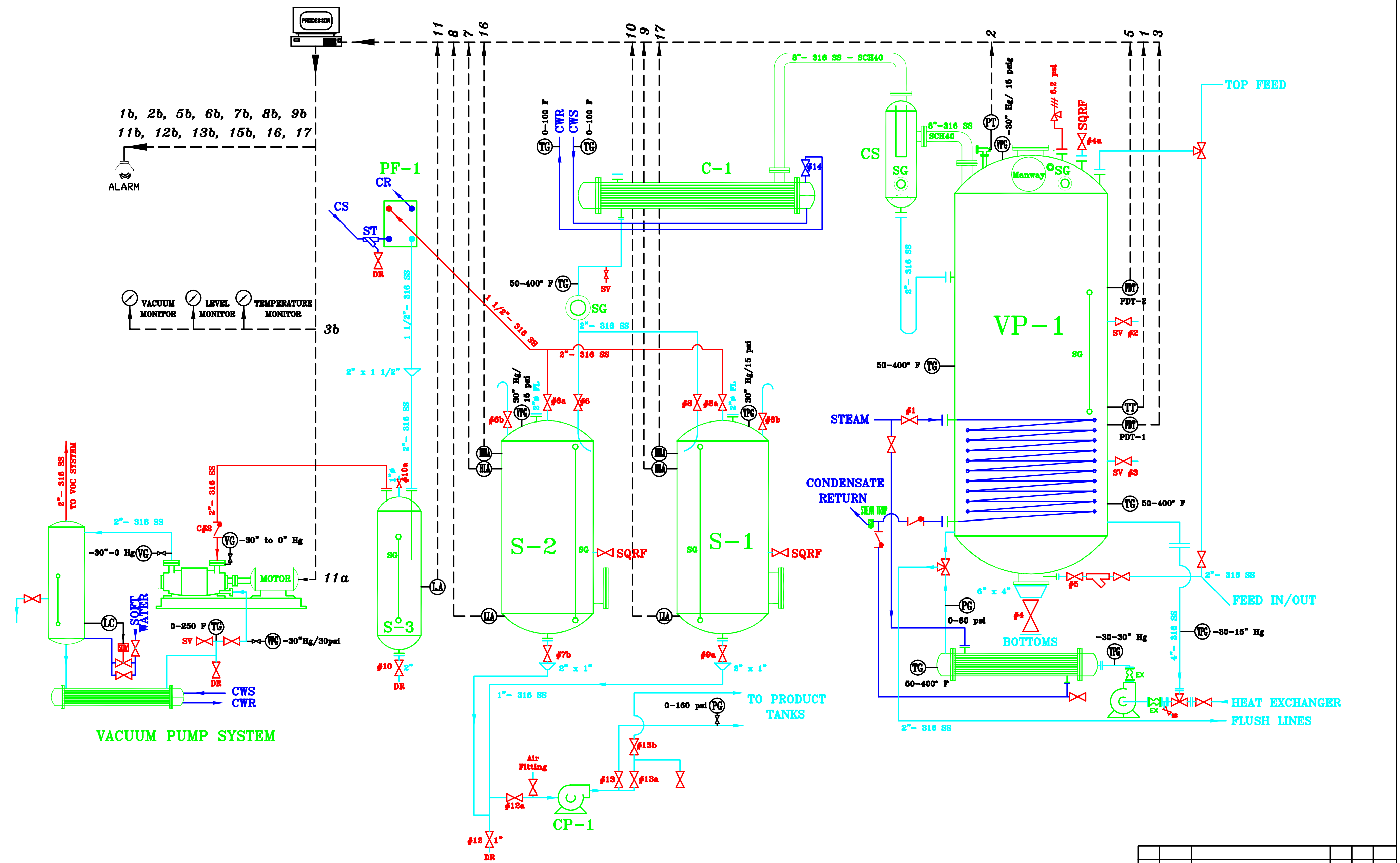
4 REFERENCES

1. 40 C.F.R. 265.1030-1035 (2002).
2. 40 C.F.R. 265.1080-1090 (2002).
3. Handbook of Chemical Engineering Calculations, 3rd Ed., Nicholas P. Chopey, McGraw Hill, New York 2004.
4. Perry's Chemical Engineer's Handbook, 7th Ed., Robert H. Perry, Don W. Green, McGraw Hill, New York, 1997.
5. Compilation of Air Pollutant Emission Factors: AP-42, Fifth Edition, United States Environmental Protection Agency.
6. Transport Processes and Unit Operations, 3rd Ed., Christie J. Geankoplis, Prentice Hall, New Jersey, 1993.
7. National Institute of Standards and Technology: Properties of Chemicals, http://webbook.nist.gov/chemistry/form-ser.html, [November, 2003].

APPENDICES

APPENDIX A

PIPING AND INSTRUMENTATION DIAGRAMS:
VACUUM POT PROCESS
DISTILLATION COLUMN PROCESS
THIN FILM EVAPORATOR PROCESS
VOC CONTROL SKID



Note: VP-1, S-1, S-2, and S-3 have SV at bottom of SG.

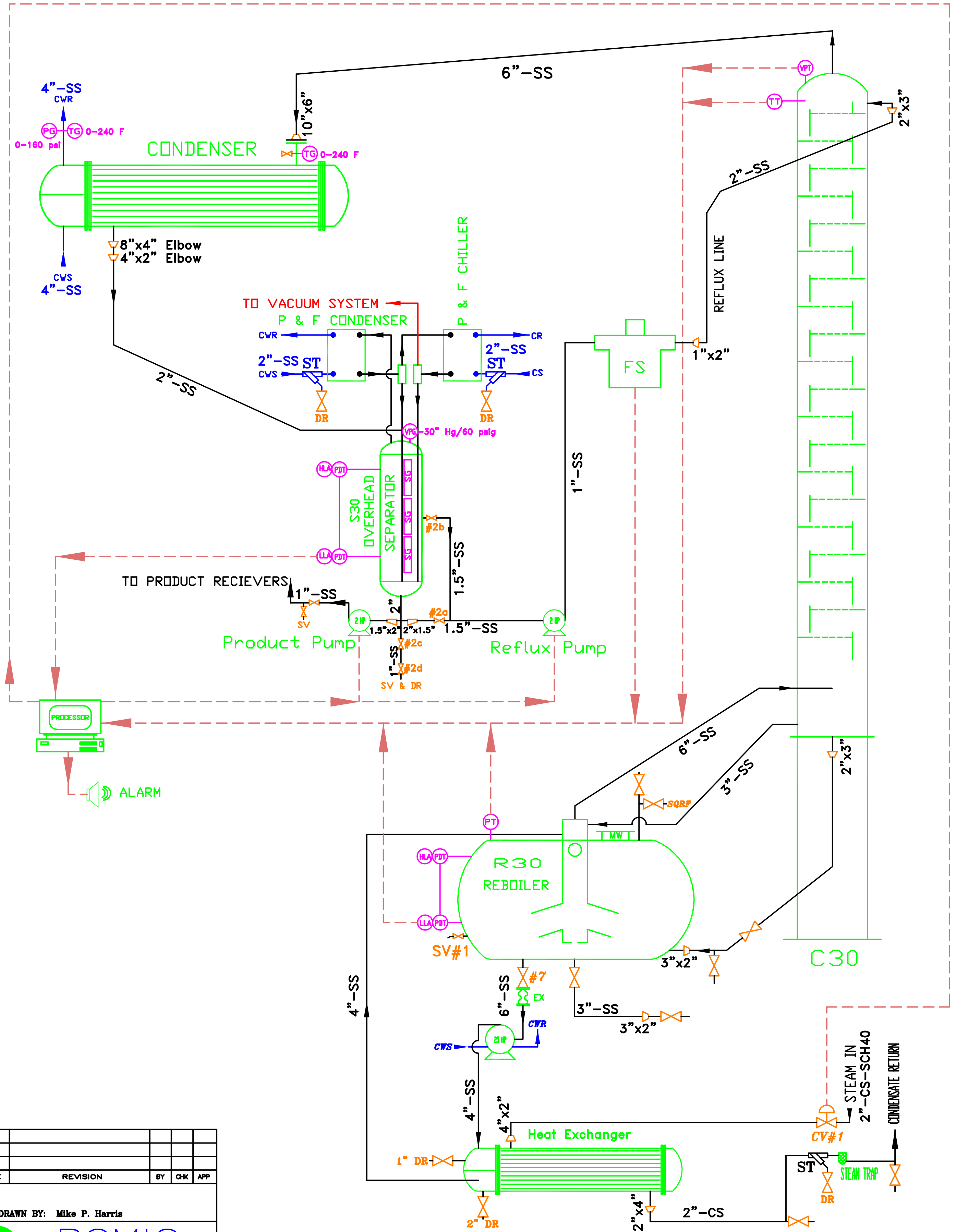
REV	DATE	REVISION	BY	CHK	APP

DESIGN/DRAWN BY: Mike P. Harris

ROMIC ENVIRONMENTAL TECHNOLOGIES
ENGINEERING DEPARTMENT

RSW VAC POT P &ID

DATE: 11-4-02
SCALE: NONE
DRAWING NO. RSWVPMPH
SHEET 1 OF 1

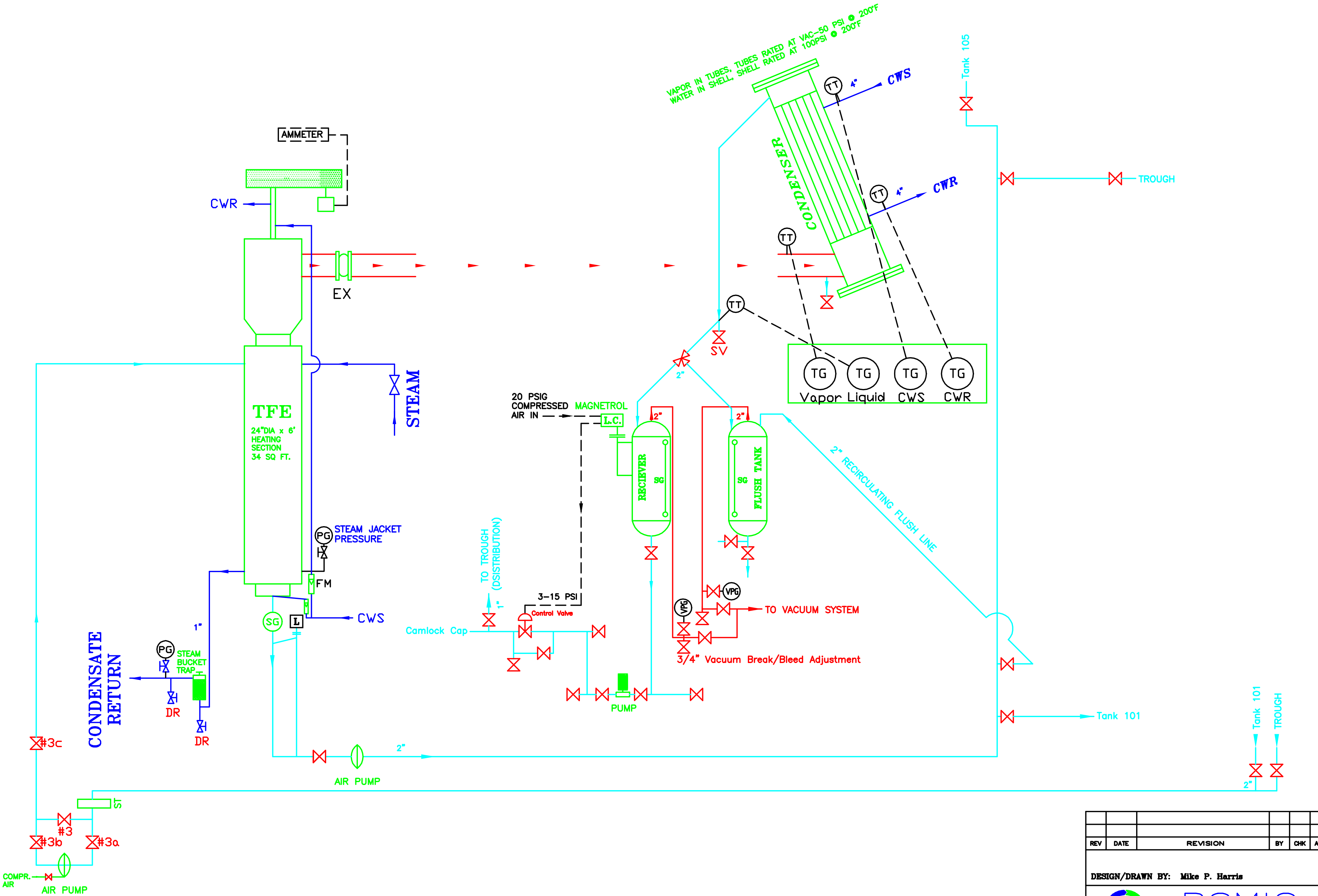


REV	DATE	REVISION	BY	CHK	APP

DESIGN/DRAWN BY: Mike P. Harris

ROMIC
ENVIRONMENTAL TECHNOLOGIES
ENGINEERING DEPARTMENT

PROCESS FLOW DIAGRAM FOR COLUMN C30	DATE: 11-14-02
	SCALE: NONE
	DRAWING NO. COLUMN 30
	SHEET 1 OF 1



REV	DATE	REVISION	BY	CHK	APP

DESIGN/DRAWN BY: Mike P. Harris

ROMIC
ENVIRONMENTAL TECHNOLOGIES
ENGINEERING DEPARTMENT

Thin Film Evaporator P & ID

DATE: 7-14-03
SCALE: NONE
DRAWING NO. RSWTFE
SHEET 1 OF 1

Note: Receiver and Flush Tank have SV at bottom of SG.

Appendix B – Stream Compositional Profiles

Typical Run Data

Product	Purity		Specific Gravity				Non Volatile Residue		
	Initial	Final	Initial	Lights	Final	Bottoms	Initial	Final	Bottoms
Acetone	80%	90%	0.82	unk	0.80	na	5%	<1%	na
NMP-DEG	74%	80%	1.04	dna	1.02	1.11	<1%	<1%	na
Wastewater	90%	100%	1.01	unk	1.00	1.10	10%	<1%	na
Methylene Chloride	80%	98%	1.20	unk	1.32	na	10%	<1%	na
Perchloroethylene	50%	98%	1.22	unk	1.54	na	50%	<1%	na
Stoddard Solvent	90%	98%	0.82	unk	0.78	na	10%	<1%	na

dna **Does Not Apply**
na **Not Available**
unk **Unknown**

Typical Waste and Product Compositions

Lacquer Thinner		
Component	Waste %	Product %
Methanol	1	1
Ethanol	1	1
Acetone	4	10
Isopropanol	3	8
MIBK	5	5
MEK	5	5
Ethyl Acetate	5	5
n-Propyl Acetate	5	5
Toluene	15	25
n-Butyl Acetate	8	10
Xylenes	8	10
Petroleum Naphtha	10	20
Water	3	3
Non Volatile Residue	25	0

Acetone		
Component	Waste %	Product %
Acetone	82	83
Methanol	4	8
Isopropanol	1	1
MEK	1	2
Toluene	0.5	1
Water	7	4
Non Volatile Residue	5	0

Methylene Chloride		
Component	Waste %	Product %
Methylene Chloride	70	98
Perchloroethylene	5	0
Trichloroethylene	5	0
Acetone	5	1
Isopropanol	5	1
Water	5	0.1
Non Volatile Residue	5	0

Perchloroethylene		
Component	Waste %	Product %
Perchloroethylene	50%	100
Non volatile Residue	50%	0

Stoddard Solvent		
Component	Waste %	Product %
Stoddard Solvent	92	99
Water	3	0.01
Non Volatile Residue	5	0

Wastewater		
Component	Waste %	Product %
Water	93	100
Ethylene Glycol	1	0
NMP	1	0
Ethanol	1	0
Ispropanol	1	0
Methanol	1	0
Non volatile Residue	2	0

Appendix C – Vapor Pressures of Organic Liquids

1. Vapor Pressure Constants from Perry's Chemical Engineering Handbook (see References)

Chemical	C1	C2	C3	C4	C5
Methanol	81.768	-6876	-8.7078	7.19E-06	2
Acetone	69.006	-5599.6	-7.0985	6.22E-06	2
Isopropanol	88.134	-8498.6	-9.0766	8.33E-18	6
MEK	72.698	-6143.6	-7.5779	5.65E-06	2
Ethyl Acetate	66.824	-6227.6	-6.41	1.79E-17	6
n-Propyl Acetate	115.16	-8433.9	-13.934	1.03E-05	2
Ethyl Benzene	88.09	-7688.3	-9.7708	5.88E-06	2
MIBK	153.23	-10055	-19.848	1.64E-05	2
Toluene	80.877	-6902.4	-8.7761	5.80E-06	2
n-Butyl Acetate	71.34	-7285.8	-6.9459	9.99E-18	6
Xylenes	90.356	-7948.7	-10.081	5.98E-06	2
Ethanol	74.475	-7164.3	-7.327	3.13E-06	2
Water	73.649	-7258.2	-7.3037	4.17E-06	2

For use in the vapor pressure estimation equation:

P=exp[C1+(C2/T)+C3xln(T)+C4xT^C5]

Where P = vapor pressure in Pa

T = temperature in K

2. Vapor Pressure Constants, Antoine's Equation

Chemical	A	B	C
Perchloroethylene	4.18056	1440.819	-49.171

For use in Antoine's equation:

log10(P) = A - (B / (T + C))

Where P = vapor pressure in bar

T = temperature in K

Appendix D – Physical Properties of Multi-component Systems

1. Waste water Volatiles: Weighted Molecular Weight and Density

	Wt %	MW	Flow (kmol/hr)	Mole Fraction	Weighted MW	Density (kg/m3)	Weighted Density
Methanol	33.33	32.04	1.040	0.449	14.376	792	263.974
Ethanol	33.33	46.07	0.723	0.312	14.376	789	262.974
Isopropanol	33.33	60.09	0.555	0.239	14.376	789	262.974
Total=	100		2.318	1	43.129		789.922

2. Water Volatiles: Weighted Heat Capacities and Heat of Vaporization

	Cp,gas (J/mol-K)	Weighted Cp,gas	Cp,liq (J/mol-K)	Weighted Cp,liq	Hvap (kJ/mol)	Weighted Hvap
Methanol	44.2	0.619	85	1.190	37.8	529.364
Ethanol	65.5	0.444	112	0.759	38.5	260.779
Isopropanol	89.7	0.357	170	0.677	40	159.259
Total=		1.420		2.626		949.402

3. Water Volatiles: Boiling Point Estimation

Tbp (C)	80		
Tbp (K)	353		
P (Pa)	1.01E+05		
	Vapor P (Pa)	Ki	Ni/Ki
Methanol	180138	1.778	0.252
Ethanol	107629	1.062	0.294
Isopropanol	50371	0.497	0.481
		Total =	1.027

Appendix D – Physical Properties of Multi-component Systems

4. Lacquer Thinner: Weighted Molecular Weight and Density

	Wt %	MW	Flow (kmol/hr)	Mole Fraction	Weighted MW	Sp. Gr.	Weighted Density (kg/m3)
Methanol	0.9	32.04	0.029	0.022	0.720	0.792	17.786
Acetone	9.3	58.08	0.159	0.124	7.195	0.792	98.119
Isopropanol	7.4	60.09	0.123	0.096	5.756	0.789	75.582
MEK	4.6	72.1	0.064	0.050	3.598	0.805	40.168
Ethyl Acetate	4.6	88.1	0.053	0.041	3.598	0.901	36.794
n-Propyl Acetate	4.6	102.13	0.045	0.035	3.598	0.886	31.211
Ethyl Benzene	18.5	106.16	0.174	0.136	14.391	0.867	117.528
MIBK	4.6	100.12	0.046	0.036	3.598	0.802	28.819
Toluene	23.1	92.13	0.251	0.195	17.988	0.866	169.087
n-Butyl Acetate	9.3	116.16	0.080	0.062	7.195	0.882	54.634
Xylenes	9.3	106.16	0.087	0.068	7.195	0.881	59.713
Ethanol	0.9	46.07	0.020	0.016	0.720	0.789	12.323
Water	2.8	18.016	0.154	0.120	2.159	1	119.816
Total=	100		1.287	1	77.710		861.581

5. Lacquer Thinner: Weighted Heat Capacities and Heat of Vaporization

	Cpgas (J/mol-K)	Cpliq (J/mol-K)	Weighted Cpliq (kJ/kg-K)	Hvap (kJ/mol)	Weighted Hvap (kJ/mol)
Methanol	44	85	0.060	38	26.495
Acetone	71	125	0.267	33	69.431
Isopropanol	90	170	0.271	40	63.767
MEK	102	158	0.109	35	24.223
Ethyl Acetate	114	169	0.078	35	16.223
n-Propyl Acetate	153	196	0.068	39	13.452
Ethyl Benzene	128	185	0.236	42	53.630
MIBK	180	212	0.076	41	14.572
Toluene	104	157	0.333	38	80.533
n-Butyl Acetate	185	228	0.122	43	22.930
Xylenes	133	187	0.119	43	27.709
Ethanol	66	112	0.038	39	13.052
Water	36	75	0.501	44	292.924
Total=			2.278		718.941

Appendix D – Physical Properties of Multi-component Systems

6. Lacquer Thinner: Boiling Point Estimation

Tbp (C)	112		
Tbp (K)	385		
P (Pa)	1.01E+05		
	Vapor P (Pa)	Ki	Ni/Ki
Methanol	506222	4.996	0.004
Acetone	501317	4.948	0.025
Isopropanol	171379	1.691	0.057
MEK	259012	2.556	0.020
Ethyl Acetate	281100	2.774	0.015
n-Propyl Acetate	137972	1.362	0.026
Ethyl Benzene	50244	0.496	0.273
MIBK	88246	0.871	0.041
Toluene	105097	1.037	0.188
n-Butyl Acetate	66022	0.652	0.095
Xylenes	39384	0.389	0.174
Ethanol	331556	3.272	0.005
Water	152243	1.503	0.080
		Total =	1.00

Appendix E – Process Unit Condenser Heat Balance Calculations

1. Vacuum Pot:

a. Acetone

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Acetone	
Sensible Heat (vapor)	Q1 =	6,144	kJ/hr
Heat of Vaporization	Q2=	268,881	kJ/hr
Sensible Heat (liquid)	Q3=	27,329	kJ/hr
Total Heat	Q=	302,355	kJ/hr
Heat capacity of vapor:	Cp(vap)=	1.22	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	2.15	kJ/kg-K
Vapor Input Temperature:	Tin=	67	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	56.5	C
Latent Heat of Vaporization	Hv=	560.566	kJ/kg
Theoretical Flow rate of vapor to be condensed:	m=	4520.09	kg/hr
		1507.76	gal/hr
Flow Rates			
Run time		5	hr/batch
Feed Stock (batch)		1000	gal
Product		80	%recovery
Density		792	kg/m3
Calculated Flow rate of product going through condenser		480	kg/hr
Amount of vapor to VOC System		0	kg/hr

Appendix E – Process Unit Condenser Heat Balance Calculations

1. Vacuum Pot (cont.):

b. Lacquer Thinner

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Lacquer Thinner	
Sensible Heat (vapor)	Q1 =	8,771	kJ/hr
Heat of Vaporization	Q2=	351,175	kJ/hr
Sensible Heat (liquid)	Q3=	117,124	kJ/hr
Total Heat	Q=	477,070	kJ/hr
Heat capacity of vapor:	Cp(vap)=	1.4	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	2.28	kJ/kg-K
Vapor Input Temperature:	Tin=	122	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	112	C
Latent Heat of Vaporization	Hv=	560.566	kJ/kg
Theoretical Flow rate of vapor to be condensed by CW:	m=	3741.49	kg/hr
		1146.70	gal/hr
Flow Rates			
runtime=		5	hr/batch
Feed Stock (batch)		1000	gal
Product		96	%recovery
Density		862	kg/m3
Calculated Flow rate of product going through condenser		626	kg/hr
Amount of vapor to VOC System		0	kg/hr

2. Distillation Column:

a. Water (Volatiles)

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Water Volatiles	
Sensible Heat (vapor)	Q1 =	1,783	kJ/hr
Heat of Vaporization	Q2=	119,226	kJ/hr
Sensible Heat (liquid)	Q3=	16,514	kJ/hr
Total Heat	Q=	137,523	kJ/hr
Heat capacity of vapor:	Cp(vap)=	1.42	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	2.63	kJ/kg-K
Vapor Input Temperature:	Tin=	90	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	80	C
Latent Heat of Vaporization	Hv=	949.4	kJ/kg
Theoretical Flow rate of vapor to be condensed by CW:	m=	2671.08	kg/hr
		893.34	gal/hr
Flow Rates			
runtime=		5	hr/batch
Feed Stock (batch)		1000	gal
Product		21	%recovery
Density		789.92	kg/m3
Calculated Flow rate of product going through condenser		126	kg/hr
Amount of vapor to VOC System		0	kg/hr

2. Distillation Column (cont.):

b. Methylene Chloride

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Methylene Chloride	
Sensible Heat (vapor)	Q1 =	1,867	kJ/hr
Heat of Vaporization	Q2=	114,640	kJ/hr
Sensible Heat (liquid)	Q3=	3,395	kJ/hr
Total Heat	Q=	119,902	kJ/hr
Heat capacity of vapor:	Cp(vap)=	0.55	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	1	kJ/kg-K
Vapor Input Temperature:	Tin=	50	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	40	C
Latent Heat of Vaporization	Hv=	337.67	kJ/kg
Theoretical Flow rate of vapor to be condensed by CW:	m=	8326.97	kg/hr
		1660.28	gal/hr
Flow Rates			
runtime=		13	hr/batch
Feed Stock (batch)		1000	gal
Product		88	%recovery
Density		1325	kg/m3
Calculated Flow rate of product going through condenser		340	kg/hr
Amount of vapor to VOC System		0	kg/hr

2. Distillation Column (cont.):

c. Perchloroethylene

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Perchloroethylene	
Sensible Heat (vapor)	Q1 =	1,876	kJ/hr
Heat of Vaporization	Q2=	100,073	kJ/hr
Sensible Heat (liquid)	Q3=	25,540	kJ/hr
Total Heat	Q=	127,489	kJ/hr
Heat capacity of vapor:	Cp(vap)=	0.633	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	0.947	kJ/kg-K
Vapor Input Temperature:	Tin=	131	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	121	C
Latent Heat of Vaporization	Hv=	337.67	kJ/kg
Theoretical Flow rate of vapor to be condensed by CW:	m=	6824.25	kg/hr
		1360.66	gal/hr
Flow Rates			
runtime=		11	hr/batch
Feed Stock (batch)		1000	gal
Product		65	%recovery
Density		1325	kg/m3
Calculated Flow rate of product going through condenser		296	kg/hr
Amount of vapor to VOC System		0	kg/hr

Appendix E – Process Unit Condenser Heat Balance Calculations

3. Thin Film Evaporator

a. Acetone

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Acetone	
Sensible Heat (vapor)	Q1 =	4,462	kJ/hr
Heat of Vaporization	Q2=	205,022	kJ/hr
Sensible Heat (liquid)	Q3=	20,857	kJ/hr
Total Heat	Q=	230,342	kJ/hr
Heat capacity of vapor:	Cp(vap)=	1.22	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	2.152	kJ/kg-K
Vapor Input Temperature:	Tin=	66.5	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	56.5	C
Latent Heat of Vaporization	Hv=	560.566	kJ/kg
Theoretical Flow rate of vapor to be condensed by CW:	m=	4706.42	kg/hr
		1569.92	gal/hr
Flow Rates			
runtime=		5	hr/batch
Feed Stock (batch)		1000	gal
Product		61	%recovery
Density		792	kg/m3
Calculated Flow rate of product going through condenser		366	kg/hr
Amount of vapor to VOC System		0	kg/hr

3. Thin Film Evaporator (cont.)

b. Lacquer Thinner

Heat absorbed by Cooling Water (CW)			
mCp(Tcwin - Tcwout):	Q =	2,849,241	kJ/hr
flow rate of CW:	m =	36000	gal/hr
heat capacity of liquid CW:	Cp =	4.2	kJ/kg-K
CW input Temperature:	Tcwin =	30	C
CW output Temperature:	Tcwout =	35	C
Density of CW:	Density=	995.68	kg/m3
Sensible Heat + Heat of Vaporization		Lacquer Thinner	
Sensible Heat (vapor)	Q1 =	5,756	kJ/hr
Heat of Vaporization	Q2=	295,569	kJ/hr
Sensible Heat (liquid)	Q3=	76,863	kJ/hr
Total Heat	Q=	378,188	kJ/hr
Heat capacity of vapor:	Cp(vap)=	1.4	kJ/kg-K
Heat capacity of liquid:	Cp(liq)=	2.28	kJ/kg-K
Vapor Input Temperature:	Tin=	122	C
Liquid Output Temperature:	Tout	30	C
Boiling point temperature:	Tbp=	112	C
Latent Heat of Vaporization	Hv=	718.94	kJ/kg
Theoretical Flow rate of vapor to be condensed by CW:	m=	3194.57	kg/hr
		979.08	gal/hr
Flow Rates			
runtime=		5	hr/batch
Feed Stock (batch)		1000	gal
Product		63	%recovery
Density		862	kg/m3
Calculated Flow rate of product going through condenser		411	kg/hr
Amount of vapor to VOC System		0	kg/hr

Appendix F – Vapor Flow and Emission Factor Calculation

1. Vacuum Pot

	Lacquer Thinner	Acetone	Ethyl Lactate	Units
Emission Factor	1.04	2.63	0.0256	kg/1000 gal
Vapor Flow	0.21	0.53	0.01	kg/hr
Vapor Pressure	9301.215	37719.00	266.64	Pa (at T)
Temperature	30	30	30	C
Run time	5	5	2	hr/1000gal feed
% Product (yield)	96	80	54	gal Product/gal Feed
constant R	8314.34	8314.34	8314.34	m3-Pa/kgmol-K
MW	77.710	58.08	118.13	kg/kgmol

2. Distillation Column

	Organics from Wastewater	Methylene Chloride	Perchloroethylene	Units
Emission Factor	0.19	5.0	0.52	kg/1000 gal
Vapor Flow	0.05	0.39	0.05	kg/hr
Vapor Pressure	13856.6984	46000	3193	Pa (at T)
Temperature	30	30	30	C
Run time	4	13	11	hr/1000gal feed
% Product (yield)	21	88	65	gal Product/gal Feed
constant R	8314.34	8314.34	8314.34	m3-Pa/kgmol-K
MW	43.13	82.92	165.83	kg/kgmol

3. Thin Film Evaporator

	Acetone	Lacquer Thinner	Xylene	Units
Emission Factor	2.01	0.68	0.092	kg/1000 gal
Vapor Flow	0.40	0.14	0.05	kg/hr
Vapor Pressure	37719	9301.22	1178.82	Pa (at T)
Temperature	30	30	30	C
Run time	5	5	2	hr/1000gal feed
% Product (yield)	61	63	49	gal Product/gal Feed
constant R	8314.34	8314.34	8314.34	m3-Pa/kgmol-K
Molecular Weight	58.08	77.71	106.16	kg/kgmol

Appendix G – Production and Run Information Summary

Production Runs, 2002

Batch	Product	RCRA?	AA?	Start	Volume (gal)	Product (gal)	Lites (gal)
C-558	EG	N	N	1/2/02 7:00			
C-592	EG	N	N	2/26/2002			
C-596	EG	N	N	3/5/2002			
C-584	EG	N	N	3/10/2002			
C-601	EG	N	N	3/16/2002			
C-2	EG	N	N	3/26/2002			
C-12	EG	N	N	5/8/2002			
C-18	EG	N	N	5/29/2002			
C-24	EG	N	N	6/14/2002			
C-35	EG	N	N	7/3/2002			
C-50	EG	N	N	8/6/2002			
C-61	EG	N	N	9/12/2002			
C-69	EG	N	N	9/30/2002			
C-75	EG	N	N	10/22/2002			
C-81	EG	N	N	11/15/2002			
C-87	EG	N	N	12/10/2002			
	EG Total				0		
C-576	MC	Y	Y	1/31/2002	6068	4624	1200
C-586	MC	Y	Y	2/15/2002	1823	1414	209
C-607	MC	Y	Y	3/22/2002	1784	1237	340
C-45	MC	Y	Y	7/30/2002	2677	865	1550
C-46	MC	Y	Y	7/30/2002	864	460	200
	MC Total				13216		
C-587	nMP	N	N	2/15/2002			
C-604	nMP	N	N	3/16/2002			
C-4	nMP	N	N	3/28/2002			
C-7	nMP	N	N	4/17/2002			
C-30	nMP	N	N	6/26/2002			
C-47	nMP	N	N	8/1/2002			
C-55	nMP	N	N	8/21/2002			
C-58	nMP	N	N	8/30/2002			
	nMP Total				0		
C-569	Perc	Y	Y	1/16/2002	8746	7888	658
C-16	Perc	Y	Y	5/15/2002	1679	221	1200
C-20	Perc	Y	Y	6/12/2002	700	0	500
C-85	Perc	Y	Y	12/4/2002	1308	486	700
	Perc Total				12433		
C-605	Stoddard	N	N	3/18/2002			
C-570	Stoddard	N	N	1/22/2002			
	Stoddard Total				0		
C-564	Wastewater	Y	Y	1/8/2002	11905	9492	1500
C-593	Wastewater	Y	Y	3/3/2002	4164	3626	338
C-10	Wastewater	Y	Y	5/1/2002	12294	10250	1704
C-65	Wastewater	Y	Y	9/20/2002	8679	8337	0
C-74	Wastewater	Y	Y	10/17/2002	4162	4022	0
C-79	Wastewater	Y	Y	11/11/2002	4243	3561	460
C-92	Wastewater	Y	Y	12/27/2002	8132	4329	1850
	Wastewater Total				53579		
T-566	Acetone	Y	Y	1/9/2002	3648	1224	0
T-577	Acetone	Y	Y	1/30/2002	2696	1850	0
T-602	Acetone	Y	Y	3/14/2002	1682	773	0
	Acetone Total				8026		
T-572	Lacquer	Y	Y	1/29/2002	3410	1850	0

Note 1: Volumes are only indicated for RCRA/Subpart AA-subject waste runs

Note 2: Batches prefaced by a "C" were distillation Column runs; a "T" were Thin film evaporator runs; a "V" were Vacuum pot runs

Production Runs, 2002

Batch	Product	RCRA?	AA?	Start	Volume (gal)	Product (gal)	Lites (gal)
T-595	Lacquer	Y	Y	3/4/2002	3291	1837	0
T-6	Lacquer	Y	Y	4/8/2002	4223	1568	0
T-29	Lacquer	Y	Y	6/24/2002	3966	1351	0
T-34	Lacquer	Y	Y	7/1/2002	4679	1889	0
T-54	Lacquer	Y	Y	8/21/2002	5671	2677	0
T-67	Lacquer	Y	Y	9/26/2002	3490	1528	0
T-90	Lacquer	Y	Y	12/19/2002	2367	1626	0
	Lacquer Total				31097		
V-31	Acetone	Y	Y	6/27/2002	2617	2235	0
V-62	Acetone	Y	Y	9/16/2002	1388	1200	0
V-76	Acetone	Y	Y	10/24/2002	916	700	0
	Acetone Total				4921		
V-574	BLO	N	N	1/29/2002			
V-608	BLO	N	N	3/24/2002			
V-8	BLO	N	N	4/29/2002			
	BLO Total				0		
V-562	EG	N	N	1/2/02 7:00			
V-568	EG	N	N	1/14/2002			
V-571	EG	N	N	1/23/2002			
V-575	EG	N	N	1/30/2002			
V-579	EG	N	N	2/5/2002			
V-581	EG	N	N	2/7/2002			
V-583	EG	N	N	2/12/2002			
V-589	EG	N	N	2/24/2002			
V-591	EG	N	N	2/26/2002			
V-599	EG	N	N	3/8/2002			
V-603	EG	N	N	3/16/2002			
V-606	EG	N	N	3/20/2002			
V-1	EG	N	N	3/25/2002			
V-5	EG	N	N	4/8/2002			
V-11	EG	N	N	5/2/2002			
V-15	EG	N	N	5/15/2002			
V-19	EG	N	N	5/29/2002			
V-23	EG	N	N	6/14/2002			
V-26	EG	N	N	6/19/2002			
V-28	EG	N	N	6/24/2002			
V-38	EG	N	N	7/3/2002			
V-40	EG	N	N	7/15/2002			
V-42	EG	N	N	7/24/2002			
V-44	EG	N	N	7/30/2002			
V-49	EG	N	N	8/2/2002			
V-52	EG	N	N	8/15/2002			
V-56	EG	N	N	8/27/2002			
V-60	EG	N	N	9/12/2002			
V-64	EG	N	N	9/18/2002			
V-71	EG	N	N	10/1/2002			
V-73	EG	N	N	10/17/2002			
V-77	EG	N	N	10/24/2002			
V-80	EG	N	N	11/11/2002			
V-83	EG	N	N	11/25/2002			
V-86	EG	N	N	12/10/2002			
V-89	EG	N	N	12/15/2002			
	EG Total				0		

Note 1: Volumes are only indicated for RCRA/Subpart AA-subject waste runs
Note 2: Batches prefaced by a "C" were distillation Column runs; a "T" were Thin film evaporator runs; a "V" were Vacuum pot runs

Production Runs, 2002

Batch	Product	RCRA?	AA?	Start	Volume (gal)	Product (gal)	Lites (gal)
V-598	Lacquer	Y	Y	3/7/2002	2702	2456	0
V-32	Lacquer	Y	Y	6/28/2002	1749	1463	0
V-63	Lacquer	Y	Y	9/17/2002	2926	2367	0
V-70	Lacquer	Y	Y	10/1/2002	1815	1528	0
	Lacquer Total				9192		
V-563	nMP	N	N	1/9/2002			
V-580	nMP	N	N	2/7/2002			
V-585	nMP	N	N	2/14/2002			
V-588	nMP	N	N	2/23/2002			
V-597	nMP	N	N	3/7/2002			
V-600	nMP	N	N	3/11/2002			
V-3	nMP	N	N	3/28/2002			
V-9	nMP	N	N	5/1/2002			
V-13	nMP	N	N	5/9/2002			
V-17	nMP	N	N	5/21/2002			
V-22	nMP	N	N	6/11/2002			
V-33	nMP	N	N	7/1/2002			
V-43	nMP	N	N	7/27/2002			
V-53	nMP	N	N	8/20/2002			
V-57	nMP	N	N	8/30/2002			
V-59	nMP	N	N	9/3/2002			
V-66	nMP	N	N	9/20/2002			
V-72	nMP	N	N	10/14/2002			
V-78	nMP	N	N	11/4/2002			
	nMP Total				0		
V-14	Stoddard	N	N	5/13/2002			
V-21	Stoddard	N	N	6/6/2002			
V-41	Stoddard	N	N	7/22/2002			
V-51	Stoddard	N	N	8/12/2002			
V-68	Stoddard	N	N	9/25/2002			
V-82	Stoddard	N	N	11/22/2002			
V-88	Stoddard	N	N	12/10/2002			
V-84	Stoddard	N	N	12/11/2002			
V-91	Stoddard	N	N	12/20/2002			
V-567	Stoddard	N	N	1/11/2002			
V-573	Stoddard	N	N	1/29/2002			
V-578	Stoddard	N	N	2/5/2002			
V-582	Stoddard	N	N	2/12/2002			
V-590	Stoddard	N	N	2/26/2002			
V-594	Stoddard	N	N	3/4/2002			
V-25	Stoddard	N	N	6/20/2002			
V-27	Stoddard	N	N	6/20/2002			
V-39	Stoddard	N	N	7/12/2002			
V-48	Stoddard	N	N	8/4/2002			

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Production Runs, 2003 through 10/15

Batch	Product	RCRA?	AA?	Start	Volume (gal)	Product (gal)	Lites (gal)
C-106	EG	N	N	2/11/03			
C-111	EG	N	N	2/27/03			
C-115	EG	N	N	3/12/03			
C-123	EG	N	N	4/3/03			
C-129	EG	N	N	4/15/03			
C-133	EG	N	N	4/28/03			
C-139	EG	N	N	5/20/03			
C-147	EG	N	N	6/10/03			
C-150	EG	N	N	6/13/03			
C-154	EG	N	N	6/20/03			
C-155	EG	N	N	6/23/03			
C-157	EG	N	N	7/3/03			
C-162	EG	N	N	7/16/03			
C-166	EG	N	N	7/24/03			
C-170	EG	N	N	8/10/03			
C-173	EG	N	N	8/13/03			
C-176	EG	N	N	8/19/03			
C-182	EG	N	N	9/10/03			
C-193	EG	N	N	9/30/03			
C-199	EG	N	N	10/9/03			
	EG Total				0		
C-121	MC	Y	Y	3/28/03	2597	1837	540
	MC Total				2597		
C-102	Wastewater	Y	Y	2/3/03	1393	1193	0
C-108	Wastewater	Y	Y	2/15/03	10091	9891	0
C-113	Wastewater	Y	Y	3/5/03	7720	7200	150
C-119	Wastewater	Y	Y	3/20/03	11956	1635	0
C-124	Wastewater	Y	Y	4/7/03	5228	4703	260
C-126	Wastewater	Y	Y	4/9/03	5100	4917	183
C-128	Wastewater	Y	Y	4/11/03	8150	7500	450
C-130	Wastewater	Y	Y	4/22/03	11250	10727	523
C-136	Wastewater	Y	Y	5/5/03	5000	4450	300
C-146	Wastewater	Y	Y	6/6/03	8500	7932	200
C-153	Wastewater	Y	Y	6/17/03	8725	8100	625
C-156	Wastewater	Y	Y	6/30/03	11047	10797	0
C-163	Wastewater	Y	Y	7/21/03	7944	7744	0
C-178	Wastewater	Y	Y	8/25/03	5152	4704	248
C-183	Wastewater	Y	Y	9/12/03	5885	5575	0
C-191	Wastewater	Y	Y	9/25/03	4377	4177	0
C-196	Wastewater	Y	Y	10/4/03	1821	1189	249
C-201	Wastewater	Y	Y	10/13/03	4679	4679	0
	Wastewater Total				124018		
T-118	Acetone	Y	Y	3/20/03	1586	884	0
T-135	Acetone	Y	Y	4/29/03	1725	1108	0
T-167	Acetone	Y	Y	8/5/03	856	410	0
T-172	Acetone	Y	Y	8/12/03	297	202	0
T-188	Acetone	Y	Y	9/23/03	985	707	0
	Acetone Total				5449		
T-141	Lacquer	Y	Y	5/21/03	4085	2439	0
T-160	Lacquer	Y	Y	7/13/03	2695	998	0
T-181	Lacquer	Y	Y	9/4/03	4600	1351	0
T-185	Lacquer	Y	Y	9/14/03	3252	1773	0

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Production Runs, 2003 through 10/15

Batch	Product	RCRA?	AA?	Start	Volume (gal)	Product (gal)	Lites (gal)
T-190	Lacquer	Y	Y	9/25/03	4917	2517	0
T-192	Lacquer	Y	Y	9/29/03	953	506	0
	Lacquer Total				20502		
T-110	Xylenes	Y	Y	2/27/03	1500	644	0
T-144	Xylenes	Y	Y	5/31/03	1383	754	0
	Xylenes Total				2883		
V-151	Acetone	Y	Y	6/17/03	2808	2658	0
	Acetone Total				2808		
V-96	EG	N	N	1/10/03			
V-98	EG	N	N	1/20/03			
V-100	EG	N	N	1/27/03			
V-103	EG	N	N	2/3/03			
V-105	EG	N	N	2/10/03			
V-109	EG	N	N	2/22/03			
V-114	EG	N	N	3/7/03			
V-117	EG	N	N	3/19/03			
V-122	EG	N	N	3/29/03			
V-127	EG	N	N	4/11/03			
V-134	EG	N	N	4/29/03			
V-138	EG	N	N	5/12/03			
V-140	EG	N	N	5/21/03			
V-145	EG	N	N	6/6/03			
V-148	EG	N	N	6/10/03			
V-152	EG	N	N	6/17/03			
V-161	EG	N	N	7/16/03			
V-165	EG	N	N	7/24/03			
V-169	EG	N	N	8/10/03			
V-174	EG	N	N	8/13/03			
V-177	EG	N	N	8/22/03			
V-180	EG	N	N	9/3/03			
V-187	EG	N	N	9/18/03			
V-194	EG	N	N	9/30/03			
V-195	EG	N	N	10/1/03			
V-198	EG	N	N	10/8/03			
V-200	EG	N	N	10/9/03			
	EG Total				0		
V-131	Ethyl Lactate	Y	Y	4/23/03	1547	510	500
V-175	Ethyl Lactate	Y	Y	8/18/03	4838	2102	0
	Ethyl Lactate Total				6385		
V-94	Lacquer	Y	Y	1/7/03	600	600	0
V-95	Lacquer	Y	Y	1/9/03	895	795	0
V-142	Lacquer	Y	Y	5/29/03	2439	2099	165
V-158	Lacquer	Y	Y	7/10/03	1467	1257	0
V-189	Lacquer	Y	Y	9/24/03	5041	4603	0
	Lacquer Total				10442		
V-97	nMP/DEG	N	N	1/15/03			
V-101	nMP/DEG	N	N	2/3/03			
V-104	nMP/DEG	N	N	2/6/03			
V-112	nMP/DEG	N	N	3/4/03			
V-120	nMP/DEG	N	N	3/26/03			
V-132	nMP/DEG	N	N	4/24/03			
V-143	nMP/DEG	N	N	5/30/03			
V-159	nMP/DEG	N	N	7/10/03			

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Production Runs, 2003 through 10/15

Batch	Product	RCRA?	AA?	Start	Volume (gal)	Product (gal)	Lites (gal)
V-168	nMP/DEG	N	N	8/5/03			
V-184	nMP/DEG	N	N	9/13/03			
V-197	nMP/DEG	N	N	10/5/03			
	nMP/DEG Total				0		
V-99	Stoddard	N	N	1/23/03			
V-107	Stoddard	N	N	2/14/03			
V-116	Stoddard	N	N	3/17/03			
V-125	Stoddard	N	N	4/4/03			
V-137	Stoddard	N	N	5/7/03			
V-149	Stoddard	N	N	6/13/03			
V-164	Stoddard	N	N	7/21/03			
V-171	Stoddard	N	N	8/11/03			
V-179	Stoddard	N	N	8/27/03			
V-186	Stoddard	N	N	9/15/03			
V-202	Stoddard	N	N	10/14/03			
V-203	Stoddard	N	N	10/15/03			

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