1588

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

ST. JOHNS RIVER DISTRICT

3319 MAGUIRE BOULEVARD
SUITE 232
ORLANDO, FLORIDA 32803

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

ALEX SENKEVICH
DISTRICT MANAGER

PAID
1,000
AUG 12 1983
SAINT JOHNS
RIVER DISTRICT

RECEIVED
AUG 1983
Saint Johns River
District

DER
AUG 24 1983
BAQM

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Blanket Spreading Operation [x] New¹ [ ] Existing¹

APPLICATION TYPE: [x] Construction [ ] Operation [ ] Modification

COMPANY NAME: DAVID "M" COMPANY COUNTY: SEMINOLE

Identify the specific emission point source(s) addressed in this application (i.e. Lime Kiln No. 4 with Venturi Scrubber; Peaking Unit No. 2, Gas Fired) Spreaders #1,#2,#3 Festooning and Mixing are

SOURCE LOCATION: Street 201 Valentine Way City Longwood

UTM: East 17-470106 North 3177160

Latitude 28 ° 43 ' 26 "N Longitude 81 ° 18 ' 18 "W

APPLICANT NAME AND TITLE: Wayne L. Brady, General Manager

APPLICANT ADDRESS: 201 Valentine Way, Longwood, Florida 32750

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of David "M" Company

I certify that the statements made in this application for a construction permit are true, correct and complete to the best of my knowledge and belief. Further I agree to maintain and operate the pollution control source and pollution contro facilities in such a manner as to comply with the provision of Chapter 403, Florid Statutes, and all the rules and regulations of the department and revisions thereof. I also understand that a permit, if granted by the department, will be non-transferabl and I will promptly notify the department upon sale or legal transfer of the permitte establishment.

*Attach letter of authorization

Signed:

Vice President &
Wayne L. Brady, General Manager
Name and Title (Please Type)

Date: 8/ /83 Telephone No. 305/321-0945

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA (where required by Chapter 471, F.S.)

This is to certify that the engineering features of this pollution control project hav been designed/examined by me and found to be in conformity with modern engineerin principles applicable to the treatment and disposal of pollutants characterized in th permit application. There is reasonable assurance, in my professional judgment, that

---

[1] See Florida Administrative Code Rule 17-2.100(57) and (104)

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

№ 74416

RECEIPT FOR APPLICATION FEES AND MISCELLANEOUS REVENUE

Received from Sinclair & Valentine Co. Date Aug 10, 1983

Address 201 Valentine Way, Longwood Dollars $ 1,000.00

Applicant Name & Address

Source of Revenue David "M" Co / Blanket Spreading

Revenue Code 001001 Ck# 1588 Application Number AC59-73966

By K Tulloch

the pollution control facilities, when properly maintained and operated, will discharge an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

JOHN W. SEABURY No 8719

Signed John W. Seabury

John W. Seabury
Name (Please Type)

Seabury-Bottorf Associates, Inc.
Company Name (Please Type)

3702 Silver Star Rd., Orlando, Florida 32808
Mailing Address (Please Type)

Florida Registration No. 8719 Date: August 11,1983 Telephone No. 305/298-0846

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

The project will involve the installation of a lithographic printing blanket manufacturing facility and will include the following sources which are part of a common exhuast system. Spreaders #1,#2,#3, Festooning area, and Mixing area. Please refer to emission points 1-5 on the following process layout diagrams to ascertain particular emission points and exhaust ventilation configurations.

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction upon arrival Completion of Construction 1 month post approval

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

Not applicable

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

None known

E. Requested permitted equipment operating time: hrs/day 16 ; days/wk 5 ; wks/yr 50 ;

if power plant, hrs/yr N.A. ; if seasonal, describe:

F. If this is a new source or major modification, answer the following questions. (Yes or No)

1. Is this source in a non-attainment area for a particular pollutant? No

   a. If yes, has "offset" been applied? No

   b. If yes, has "Lowest Achievable Emission Rate" been applied? No

   c. If yes, list non-attainment pollutants. No

2. Does best available control technology (BACT) apply to this source? If yes, see Section VI. Yes

3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. No

4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? No

5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

H. Do "Reasonably Available Control Technology" (RACT) requirements apply to this source? No

   a. If yes, for what pollutants? N.A.

   b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable.

F. 2. (Yes) Florida Air Pollution Regulation 17-2.500(5)(c) Application of best available control technology to pollutants subject to NSR requirements as set forth in 17.2.5(2)(f).

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Rubber	None Known	-	Variable	Used to formulate cements 2
Rubber Cement	V.O.C.	30-70%	Variable	Mixing (2), Spreading (3,4,5), Festooning (6)
	MEK Toluene			(At step #6 99%+ of V.O.C. has been flashed
				off)

*The process utilizes rubber cements which are mixtures of various rubber compounds i.e.(nitrile, e and hydrocarbon diluents such as toluene or MEK. VOC content of cement may vary from 30 to 70% of coating weight depending upon type.

B. Process Rate, if applicable: (See Section V, Item 1)

1. **Total Process Input Rate (lbs/hr):** Variable

2. **Product Weight (lbs/hr):** Variable

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

Name of Contaminant	Emission[1]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
VOC - MEK/ Toluene	103	84	BACT	To be determined	420,000	210	1
"	5	4	BACT	To be determined	20,000	10	3
"	94.5	75.6	BACT	To be determined	378,000	189	4
"	94.5	75.6	BACT	To be determined	378,000	189	5

* Potential emissions are based upon a two shift (16 hour) operation, five days per week and 250 days per year. Actual emissions are based upon a one shift (8 hour) operation, five days per week, and 250 days per year.

---

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

D. Control Devices: (See Section V, Item 4)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: N.A. Percent Ash: N.A.

Density: N.A. lbs/gal Typical Percent Nitrogen: N.A.

Heat Capacity: N.A. BTU/lb N.A. BTU/gal

Other Fuel Contaminants (which may cause air pollution): N.A.

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N.A. Maximum N.A.

G. Indicate liquid or solid wastes generated and method of disposal.

Rubber cement waste is generated by the process and consists of rubber and varying amounts of rubber mixed with VOC. The waste is packaged in 55 gallon open head drums and disposed of in a secure hazardous waste land disposal site in Emille, Alabama.

H. **Emission Stack Geometry and Flow Characteristics** (Provide data for each stack): (See following page)

Stack Height: ____________________ ft. **Stack Diameter:** ____________________ ft.

Gas Flow Rate: __________ ACFM __________ DSCFM **Gas Exit Temperature:** ____________ °F.

Water Vapor Content: ____________ % **Velocity:** ____________ FPS

SECTION IV: INCINERATOR INFORMATION

Not Applicable

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

Description of Waste ____

Total Weight Incinerated (lbs/hr) ____________ Design Capacity (lbs/hr) ____________

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ____

Date Constructed ____________________ Model No. ____________________

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: __________ ft. Stack Diameter: ____________ Stack Temp. ____________

Gas Flow Rate: ______________ ACFM ______________ DSCFM* Velocity: ______________ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ____

H. Emission stack geometry and flow characteristics: From estimates

Emission Point <1> (SCE process floor diagram):

Stack Height: 18 ft.
Gas Flow Rate: 12,600 ACFM 9960 DSCFM
Water Vapor Content Ambient (variable)%

Stack Dimensions: 4.5 x 4.5 square (ft.)
Gas Exit Temp.: 150 (°F)
Velocity: 600 FPS

Emission Point <3> (See process flow diagram):

Stack Height: 12 ft.
Gas Flow Rate: 1575 ACFM 1410 DSCFM
Water Vapor Content Ambient (variable)%

Stack Dimensions: 1.5 x 1.5 square (ft.)
Gas Exit Temp.: 95 (°F)
Velocity: 700 FPS

Emission Point <4> (See process flow diagram):

Stack Height: 12.5 ft.
Gas Flow Rate: 1415 ACFM 1120 DSCFM
Water Vapor Content: Ambient (variable)%

Stack Dimensions: 2(1.33 x 1.33 outlets)(ft.)
Gas Exit Temp.: 150 (°F)
Velocity: 800 FPS

Emission Point <5> (See process flow diagram):

Stack Height: 12.5 ft.
Gas Flow Rate: 1415 ACFM 1120 DSCFM
Water Vapor Content: Ambient (variable)%

Stack Dimensions: 2(1.33 x 1.33 outlets)(ft.)
Gas Exit Temp.: 150 (°F)
Velocity: 800 FPS

Brief description of operating characteristics of control devices: Not Appliable

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

Not Applicable

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

NOT APPLICABLE

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

SEE APPENDIX 1 ATTACHED

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

SEE APPENDIX 1 ATTACHED

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

NOT APPLICABLE

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

NOT APPLICABLE

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

SEE APPENDIX 2

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

SEE APPENDIX 4

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

SEE APPENDIX 3

9. The appropriate application fee in accordance with Rule 17-4.05. The check should be made payable to the Department of Environmental Regulation. ATTACHED

10. With an application for operation permit, attach a Certificate of Completion of Construction indicating that the source was constructed as shown in the construction permit. NOT APPLICABLE

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?

[ ] Yes [ ] No

Contaminant	Rate or Concentration
N.A.	N.A.

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy)

[ ] Yes [x] No

Contaminant	Rate or Concentration
BACT has not been declared for this class of sources.	

C. What emission levels do you propose as best available control technology?

Contaminant	Rate or Concentration
VOLATILE ORGANIC COMPOUNDS	AVERAGE COATING VOC CONTENT OF 5.4 lbs./gal. VOC/gal. OF COATING DELIVERED TO COATING APPLICATOR.

D. Describe the existing control and treatment technology (if any).

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:

*Explain method of determining

Brief description of operating characteristics of control devices: ____________________

____

____

____

____

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

____

____

____

____

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

5. **Useful Life:** 6. **Operating Costs:**

7. **Energy:** 8. **Maintenance Cost:**

9. **Emissions:**

Contaminant	Rate or Concentration

10. **Stack Parameters**

a. **Height:** ft. b. **Diameter:** ft.

c. **Flow Rate:** ACFM d. **Temperature:** °F.

e. **Velocity:** FPS

E. Describe the control and treatment technology available (As many types as applicable, use additional pages if necessary).

1. LOW SOLVENT TECHNOLOGY

a. **Control Device:** FORMULATE COATING TO GIVEN SPECIFICATION b. **Operating Principles:** CONTROL VOC EMISSION BY FORMULATION

c. **Efficiency:**[1] NOT APPLICABLE d. **Capital Cost:** ESTIMATE, $10,000.00

e. **Useful Life:** CONTINUING f. **Operating Cost:** $20,000.00

g. **Energy:**[2] NOT APPLICABLE h. **Maintenance Cost:** NOT AVAILABLE

i. **Availability of construction materials and process chemicals:** AVAILABLE

j. **Applicability to manufacturing processes:** APPLICABLE

k. **Ability to construct with control device, install in available space, and operate within proposed levels:** ABLE TO INITIATE

2. CATALYTIC INCINERATION

a. **Control Device:** CATALYTIC INCINERATOR b. **Operating Principles:** CATALYZED INCINCERATI

c. **Efficiency:**[1] 90% + d. **Capital Cost:** $500,000.00

e. **Useful Life:** 10-15 YEARS f. **Operating Cost:** NOT AVAILABLE AT THIS WRITI

g. **Energy:**[2] NOT AVAILABLE FROM BUDGET QUOTATION h. **Maintenance Cost:** NOT AVAILABLE

i. **Availability of construction materials and process chemicals:** AVAILABLE

---

[1] Explain method of determining efficiency.

[2] Energy to be reported in units of electrical power - KWH design rate.

j. Applicability to manufacturing processes: APPLICABLE WITH SOME PROCESS MODIFICATIONS

k. Ability to construct with control device, install in available space, and operate within proposed levels: NO FORSEEABLE DIFFICULTIES

3. SOLVENT RECOVERY

a. Control Device: CARBON ADSORBER
b. Operating Principles: PHYSICAL ADSORPTION

c. Efficiency:[1] 85-90%
d. Capital Cost:$600,000.00-$700,000.00

e. Useful Life: 10-15 YEARS
f. Operating Cost: NOT AVAILABLE AT THIS WRITING

g. Energy:[2] NOT AVAILABLE FROM BUDGET QUOTATION
h. Maintenance Cost: NOT AVAILABLE

i. Availability of construction materials and process chemicals: AVAILABLE

j. Applicability to manufacturing processes: APPLICABLE WITH PROCESS MODIFICATIONS

k. Ability to construct with control device, install in available space, and operate within proposed levels: NO FORSEEABLE MAJOR OBSTACLES TO INSTALLATION

4.

a. Control Device:
b. Operating Principles:

c. Efficiency:[1]
d. Capital Costs:

e. Useful Life:
f. Operating Cost:

g. Energy:[2]
h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

F. Describe the control technology selected: LOW SOLVENT TECHNOLOGY

1. Control Device: FORMULATE TO GIVEN SPECIFICATION
2. Efficiency:[1] NOT APPLICABLE

3. Capital Cost: $10,000.00
4. Useful Life: CONTINUING

5. Operating Cost: $20,000.00
6. Energy:[2] NOT APPLICABLE

7. Maintenance Cost: NOT APPLICABLE
8. Manufacturer: NOT APPLICABLE

9. Other locations where employed on similar processes: NONE KNOWN

a. (1) Company: NOT APPLICABLE

(2) Mailing Address:

(3) City:
(4) State:

---

[1] Explain method of determining efficiency.
[2] Energy to be reported in units of electrical power - KWH design rate.

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

b. (1) Company:

(2) Mailing Address:

(3) City: (4) State:

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

10. Reason for selection and description of systems:

---

[1] Applicant must provide this information when available. Should this information not be available, applicant must state the reason(s) why.

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

NOT APPLICABLE

A. Company Monitored Data

1. ____________ no. sites ____________ TSP ____________ ( ) SO^2* ____________ Wind spd/dir

Period of Monitoring ______ / ______ / ______ to ______ / ______ / ______
month day year month day year

Other data recorded ______________________________

Attach all data or statistical summaries to this application.

*Specify bubbler (B) or continuous (C).

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? [ ] Yes [ ] No

b. Was instrumentation calibrated in accordance with Department procedures?

[ ] Yes [ ] No [ ] Unknown

B. Meteorological Data Used for Air Quality Modeling

1. _____ Year(s) of data from ____/____/____ to ____/____/____
month day year month day year

2, Surface data obtained from (location)____________________

3. Upper air (mixing height) data obtained from (location)____________________

4. Stability wind rose (STAR) data obtained from (location)____________________

C. Computer Models Used

1. ____________________ Modified? If yes, attach description.

2. ____________________ Modified? If yes, attach description.

3. ____________________ Modified? If yes, attach description.

4. ____________________ Modified? If yes, attach description.

Attach copies of all final model runs showing input data, receptor locations, and principle output tables.

D. Applicants Maximum Allowable Emission Data

Pollutant	Emission Rate	
TSP	____________________	grams/sec
SO^2	____________________	grams/sec

E. Emission Data Used in Modeling

Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review.

G. Discuss the social and economic impact of the selected technology versus other applicable technologies (i.e., jobs, payroll, production, taxes, energy, etc.). Include assessment of the environmental impact of the sources.

H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

VOLATILE ORGANIC COMPOUND EMISSION CALCULATIONS

APPENDIX I

Maximum Potential Emissions

Spreader #1

Maximum VOC loading in lbs./min. during spreading: 4.3 lbs./min. = 258 lbs./hr

Actual spreading time: 15% of operating time (from time study)

Potential operating parameters:
16 hours/day
250 days/year
5 days/week

Use Calculation:

16 hrs./day x .15 = 2.4 hrs./day in spread mode

2.4 hrs./day x $\frac{\text{60 min.}}{\text{1 hr.}}$ x 4.3 lbs./min. during spreading = 619.20 lbs./day emission (maximum potential)

619.20 lbs./day x 250 days/yr. = 154,800 lbs./yr. = $\boxed{\text{77.4 tons/yr.}}$

Spreaders #2 and #3

Maximum VOC loading in lbs./min. during spreading: 14 lbs./min. = 840 lbs./hr

Actual spreading time: 15% of operating time (from time study)

Potential operating parameters:
16 hours/day per spreader
250 days/year per spreader
5 days/week per spreader

Use Calculation:

16 hrs./day x .15 = 2.4 hrs./day in spread mode

24 hrs./day x $\frac{\text{60 min.}}{\text{1 hr.}}$ x 14 lbs./min. = 2016 lbs./day emission-maximum potential

2016 lbs./day x 250 days/yr. = 504,000 lbs./yr. = $\boxed{\text{252 tons/yr.}}$ per spreader

2 spreaders x 252 tons/year = $\boxed{\text{504 tons/yr.}}$ for spreaders #2 and #3 - Maximum potential

Festooning Area

The festooning area routinely flashes of one pass worth of solvent per day/blanket. Four blankets would be placed into festooning each day on a two shift operation. Process records indicate that a maximum of 10 lbs. of solvent per blanket enters the festooning area. The blankets leave nearly solvent free. Therefore maximum potential solvent emissions would approximate.

4 blankets/day x 250 days/yr. x 10 lbs. solvent/blanket = 10,000 lbs./yr. = $\boxed{\text{5 tons/yr.}}$

Mixing Area

Emissions from the mixing area can be expected to approximate 12 tons/yr. maximum potential by estimate. This would include both local and general room exhausts. 10 T/yr. can be associated with local mixing tank exhaust and 2 T/yr. can be associated with general room exhaust.

Emission Point Allocation

Emission Point <1> :

Emission point <1> captures 25% of the VOC exhaust from spreaders #2 and #3, 100% of the VOC exhaust emissions from spreader #1, 100% of the festooning area VOC exhaust and 100% of general room exhaust from the mixing area.

Emission Point 1 Total = (spreader (# 1 : 77.4 T/yr.) + (spreaders (2 and 3) 504 T/yr. x .25) + (festooning 5 tons/yr.) + (mixing general 2.0 T/yr.) = 210 T/yr.

Emission Point <3> :

Emission Point <3> captures 100% of the VOC exhaust from the mixing room tanks. This emission can be expected to approximate a maximum potential emission of 10 tons/yr.

Emission Point <4> :

Emission point <4> captures 75% of spreader #2's exhaust. Therefore maximum potential emission from emission point <4> would be

252 T/yr. x .75 = 189 tons/yr.

Emission Point <5> :

Emission point <5> captures 75% of spreader #3's exhaust. Therefore maximum potential emission from emission point <5> would be

252 T/yr. x .75 = 189 tons/yr.

Maximum Lbs./Hr. Calculation

Emission Point <1> :

a) Spreader #1 maximum spreading time/hr. = 9.0 min./hr.
Spreader #1 maximum solvent use/min. = 4.3 lbs./min.
Spreader #1 emission point collection % = 100%
9.0 min./hr. x 4.3 lbs./min x 1.0 = 38.7 lbs./hr.

b) Spreader #2 maximum spreading time/hrs. = 9.0 min./hr.
Spreader #2 maximum solvent use/min. = 14.0 lbs./min.
Spreader #2 emission point collection % = 25%
9.0 min./hr. x 14.0 x .25 = 31.5 lbs./hr.

c) Spreader #3 maximum spreading time/hr. = 9.0 min./hr.
Spreader #3 maximum solvent use/min. = 14.0 lbs./min.
Spreader #3 emission point collection % = 25%
9.0 min./hr. x 14.0 x .25 = 31.5 lbs./hr.

d) Mixing general exhaust 2 T/yr. = 4000 lbs./hr. ÷ 250 days/yr. = 16
16 lbs./day ÷ 16 hrs./day = 1 lb./hr.

TOTAL MAXIMUM LBS./HR. = a + b + c + d
= 103 lbs./hr.

Emission Point <3> :

Total annual emission = 10 T/yr. = 20,000 lbs./yr.

20,000 lbs./yr. ÷ 250 days/yr. = 80 lbs./day ÷ 16 hrs./day = 5.0 lbs./hr.

Emission Point <4> :

Spreader #2
Maximum spreading time/hr. = 9.0 min./hr.
Spreader #3
Maximum solvent use/min. = 14.0 lbs./min.
Spreader #2
Emission point collection % = 75%

9.0 min./hr. x 14.0 lbs./min. x .75 = 94.5 lbs./hr.

Emission Point <5> :

Spreader #3 maximum spreading time/hr. = 9.0 min./hr.
Spreader #3 solvent use/min. = 14.0 lbs./min.
Spreader #3 emission point collection % = 75%

9.0 min./hr. x 14.0 lbs./min. x .75 = 94.5 lbs./hr.

Actual Tons/Yr.

The facility currently operates at approximately 40% of its emitting potential. Therefore, potential T/yr. are multiplied by .40 to obtain actual emissions.

Emission Point	Potential Emissions	x	Actual Emissions .40	
<1>	210 T/yr.		84 T/yr.	
<3>	10 T/yr.		4 T/yr.	
<4>	189 T/yr.		75.6 T/yr.	
<5>	189 T/yr.		75.6 T/yr.	TOTAL ACTUAL TONS/YR. = 239.2

Total VOC/yr. figures correlate well with 1982/83 purchasing records for VOC raw materials. Current 1983 use projections would approimate 240 T/yr.

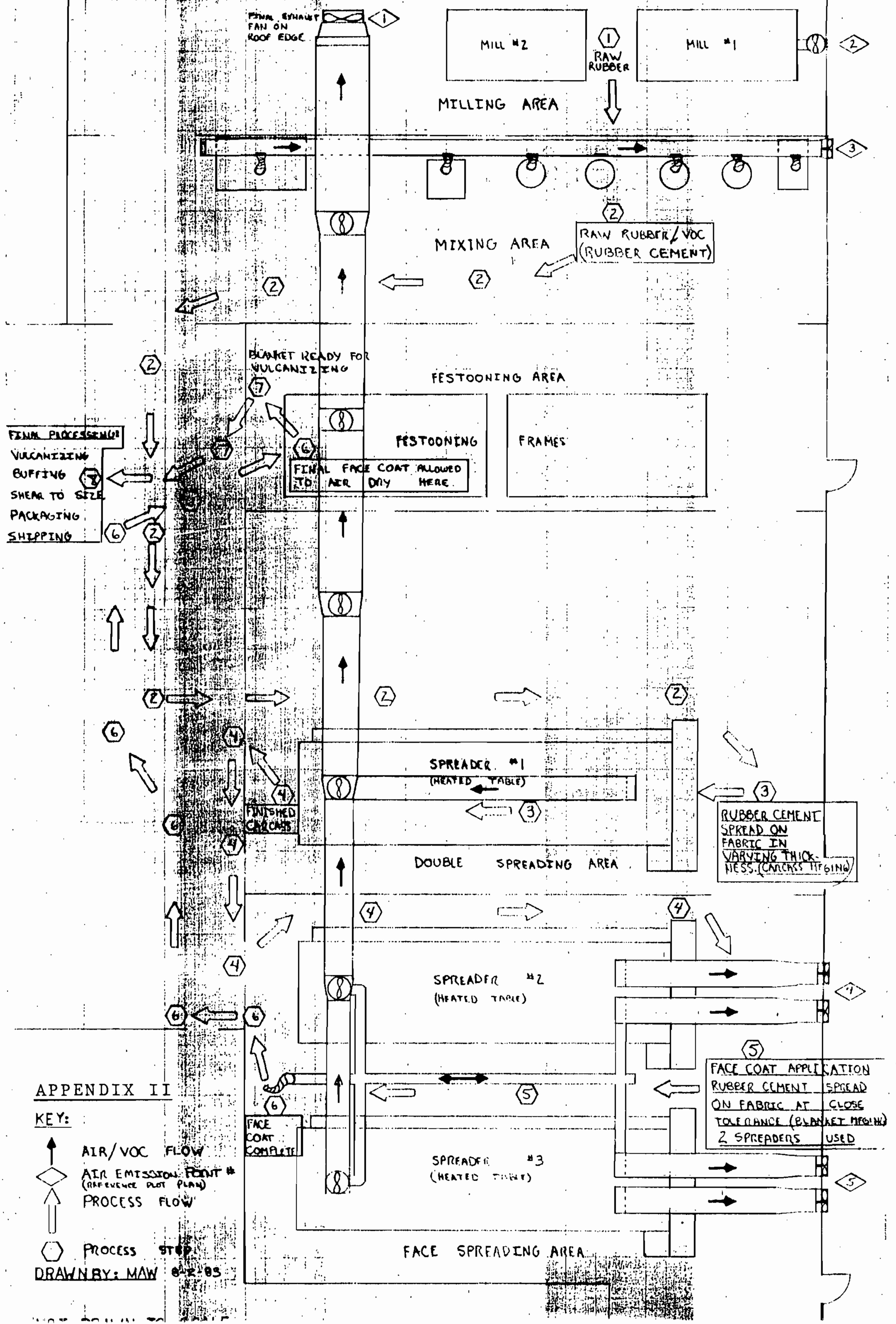
APPENDIX II CONT.

PROCESS FLOW EXPLANATION

Step ①	Rubber is milled into sheets for use in cement making. No calculation of emissions is included in this application since only particulate emissions would be regulated and this source is a minor one which will be dealt with separately from VOC emissions.
Step ②	Rubber is combined with VOC (MEK/Toluene) and mixed to the desired viscosity for spreading.
Step ③	Rubber cement is spread on cotton fabric in repeated passes of varying thicknesses utilizing a knife type applicator. This step forms the blanket carcass. VOC flashes off due to steam heated coils and is captured by overhead hoods.
Steps ④ & ⑤	Carcass is finished and moved in roll form to face spreaders 2 and 3 where top or face coats are applied to the blanket, solvent flashes off as in Step 3. The final pass is not dried, rather it is talced and recoiled with interleaving paper at which point it moves to Step 6.
Step ⑥	The blanket is then unrolled and hung open in the festooning area where the final pass dries. The blanket is virtually solvent free after 16 hours of air drying time.
Step ⑦	The blanket is once again rolled up and is put into a vulcanizer which is actually an autoclave which puts the final cure on the blanket.
Step ⑧	Following final cure the blanket may be buffed or sheared and then packaged for shipping.

BEST AVAILABLE COPY

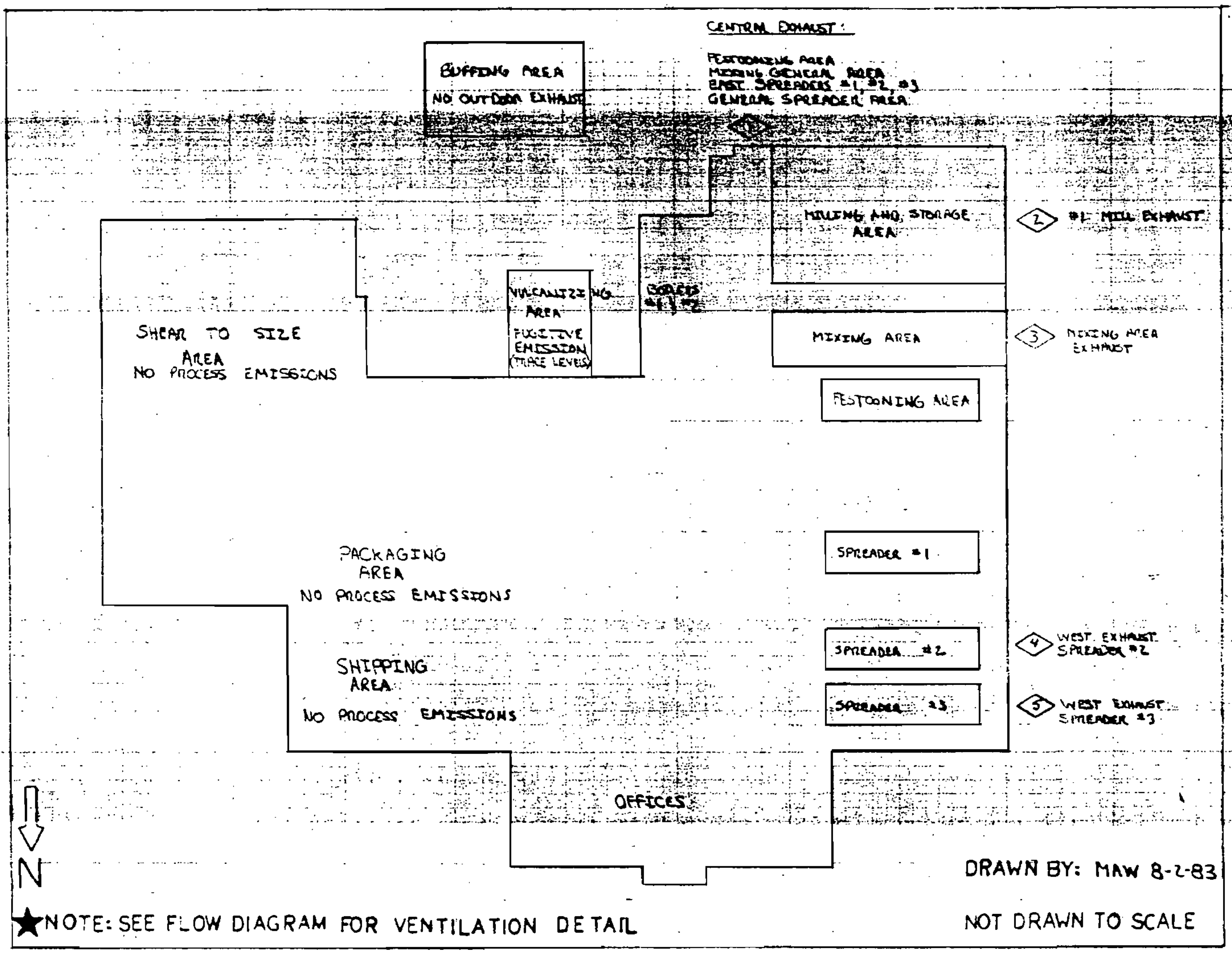
PROCESS LAYOUT AND FLOW DIAGRAM: VOC DATA



Best Available Copy

APPENDIX III

PROCESS LAYOUT AND EMISSION POINTS: ◇

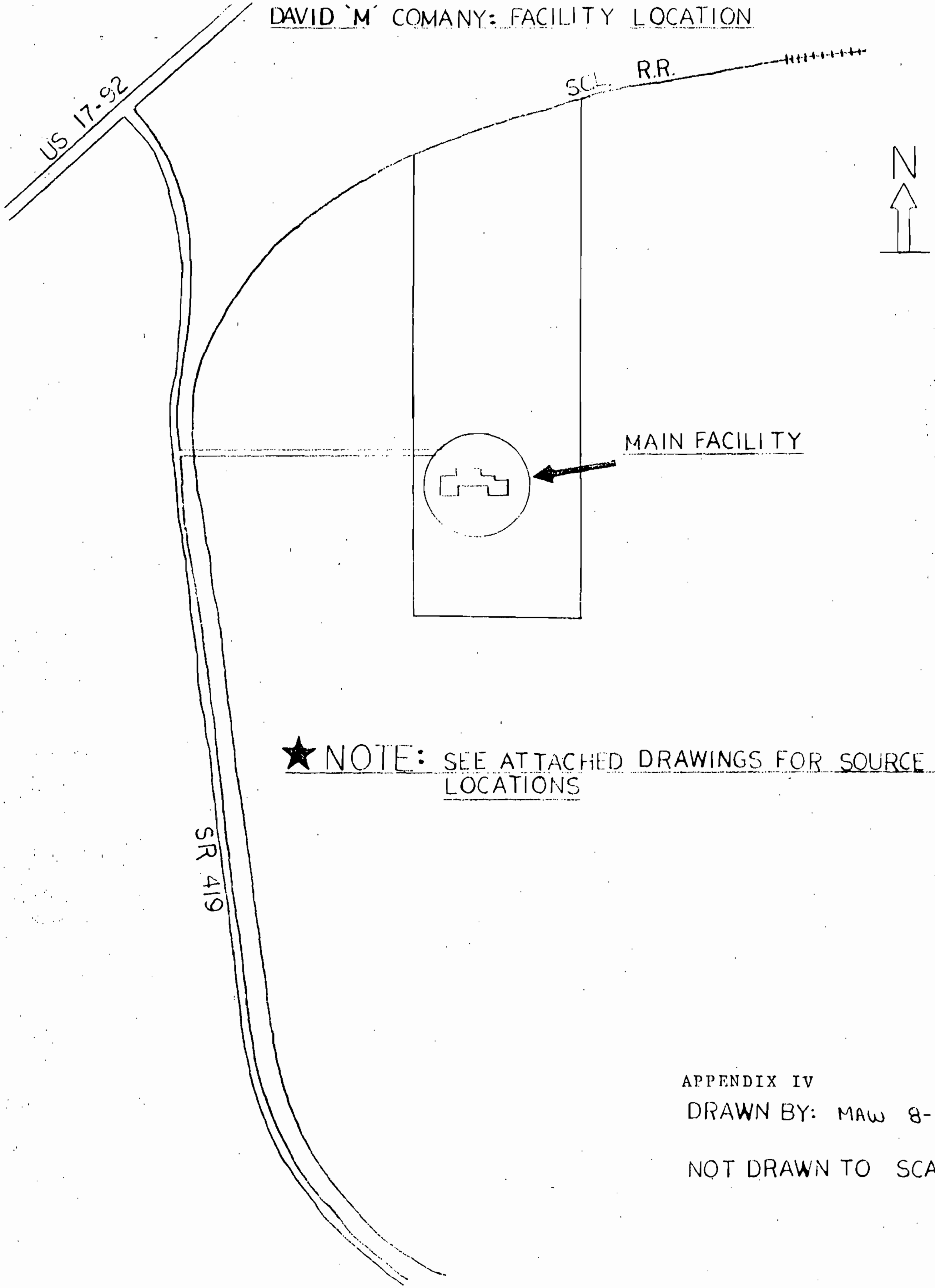


DRAWN BY: MAW 8-2-83

NOT DRAWN TO SCALE

★NOTE: SEE FLOW DIAGRAM FOR VENTILATION DETAIL

DAVID `M´ COMANY: FACILITY LOCATION



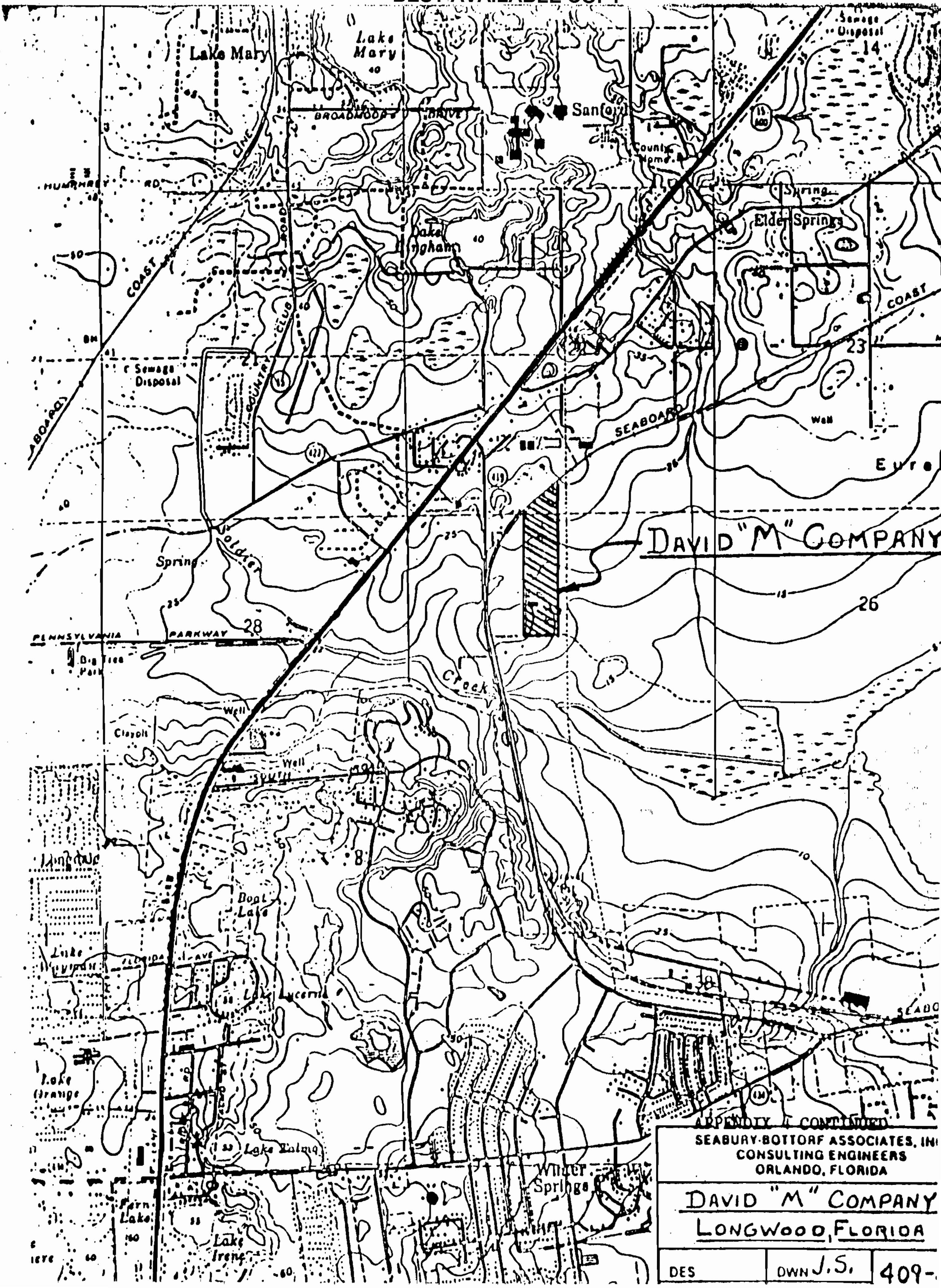
★NOTE: SEE ATTACHED DRAWINGS FOR SOURCE LOCATIONS

APPENDIX IV

DRAWN BY: MAW 8-2-83

NOT DRAWN TO SCALE

BEST AVAILABLE COPY



APPENDIX 4 CONTINUED

SEABURY-BOTTORF ASSOCIATES, IN
CONSULTING ENGINEERS
ORLANDO, FLORIDA

DAVID "M" COMPANY
LONGWOOD, FLORIDA

DES
DWN J.S.
409-

CASE HISTORY SHEET

FILE NAME: David "M" Co/ Spreaders 1,2,3

PATS NUMBER: AC59-73966

DATE RECEIVED	ACTION TAKEN & BY WHO (INITIALS PLEASE)	MANPOWER TIME:
ENTERED	AUG 12 1983 kf	.25

Best Available Copy

CASE HISTORY SHEET

FILE NAME: ____________________

PATS NUMBER: ____________________

DATE RECEIVED	ACTION TAKEN & BY WHO (INITIALS PLEASE)	MANPOWER TIME:

Signal UOP Group

Ten UOP Plaza
Des Plaines, Illinois 60016-6195
312-391-2000

DER
DEC 21 1984
BAQM

1-2-84
Copies to
Carol Forthman
+ Charles Collins

December 17, 1984

Mr. Willard Hanks
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32301-8241

Dear Mr. Hanks:

Those of us representing David M Company at the December 12, 1984 meeting feel it was quite productive. We appreciate your desire to review the implications of our changes in the permit application but also wish to reemphasize to you that the control technology does not change. We are forecasting this increased production to start in the fourth quarter 1985, and we feel it would have been counter-productive to have allowed the original permit application to go through and be followed immediately by a request for permission to install additional equipment.

In our meeting we discussed control of emissions from our organic liquid storage tanks. A letter addressed to Michael Ware dated September 27, 1984 from C. H. Fancy of the DER, directed us to investigate control methods and submit to your office by January 2, 1985 the results of our investigation rather than proceeding to install a control system. Per your instructions at our meeting on December 12, we will now take no further action on this phase of the VOC control pending direction from you after you have reviewed the revised permit application. I would like to ask you to review the calculations in that application indicating a total emission from the storage tanks of less than 150 pounds per year, and to consider whether a means of control is really necessary. It is a very small amount when compared to the other fugitive emissions.

You stated that, because of our revisions to the permit application, it will probably be the end of January 1985 before you can complete the preliminary determination and technical evaluation of this proposal, followed by a 30-day period for posting public notice of the intent to install this system. Consequently, you indicated approval of the application could be as late as March 15 of 1985. As we discussed, no allowance was made in our schedule for this delay, so it is not possible for us to meet the August 1, 1985 deadline for completion of installation. Sutcliffe Speakman estimates a minimum of five months for delivery after a purchase order is issued, plus eight weeks for installation. In our original schedule we had asked for a period from August 1, 1985 to December 1, 1985 for operational shakedown, debugging and compliance testing. Per our agreement with you on December 12 we are willing to shorten that period. Even though the August 1 date will be no longer valid, we will make every effort to complete final compliance testing by December 1, 1985. On that basis, the estimated compliance schedule has been revised and is attached.

As we told you, an expansion of the Orlando plant is being planned and construction will closely parallel the solvent recovery installation. Since the two are adjacent, I had intended to pour the foundation slab for the solvent recovery system along with the new building footers. You indicated no advance approval can be issued for only this portion of the VOC control system. Since, however, construction of the slab will not alter our current emissions, and will result in substantial cost savings by allowing us to combine it with construction of the footings, per our original plans we intend to proceed with this construction prior to DER approval, recognizing, of course, that we do so at our own risk. We will do this unless there is an objection from the DER.

We sincerely appreciate the openness with which you received our presentation and hope for your help in expediting the approval of our permit application.

Sincerely,

R. H. Baddeley
Project Engineer

RHB/djc
cc: John Gamble
Wayne Brady
Nick Feagler
Tim Westman

October 19, 1983 - Revised December 13, 1984

ESTIMATED
OVERALL COMPLIANCE SCHEDULE
DAVID M COMPANY VOC CONTROL PROJECT

PHASE	ORIGINAL DATE	REVISED DATE
Data Accumulation	January 1, 1984	
Spreader Enclosure - (1) For Temperature Evaluation	January 15, 1984	
Process Modifications and Development	April 1, 1984	
Methods Comparison/Analysis - Thermal Incineration vs. Recovery	May 15, 1984	
Final Specification Development	July 1, 1984	
Final Specification/Quotations and Analysis	Spetember 1, 1984	
Appropriation Request Development and Approval	December 1, 1984	
Oven Enclosure and Exhaust System Installation	March 1, 1985	May 17, 1985
Solvent Recovery Delivery and Installation	August 1, 1985	October 18, 1985
Operational Shakedown, Debugging and Compliance Testing	December 1, 1985	December 1, 1985

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

To be filed: DAVID M CO
cc to: ____________

OGC Case No. 84-0044

MEETING DOCUMENTATION

Attendees: (Attach list) *

Location: TALLAHASSEE   Date: 12/12/84   Time: 3:00 PM

Subject: ☑ Permitting   ☐ Enforcement   Other ____________

Meeting requested by: John Gamble, Signal UOP Group, (312) 391-2440

Meeting Objectives: SUBMIT REVISED APPLICATION FOR PERMIT TO CONSTRUCT AIR POLLUTION CONTROL EQUIPMENT FOR A lithographic printing blanket manufacturing facility and new process equipment

---

Notes:

* Robert H. Boddeley, Proj. Eng., (312) 391-3552 (Chief Spokesman)
(Contact for questions)
John H. Gamble, Director, " (FIN. PIT. MGR.)
HERB MYCROFT, Tech. Dir., David M. Co.
Ian Parry, Sutcliffe-Croftshaw tech. eng. (301) 337/2600 (Control equip. rep.)

Application noted above submitted. Appears complete.

Because of schedule in Consent order, Company told OK to expand building and pour cement slab for carbon absorption unit – at their risk.

Told Co. Preliminary Determination will be out in January, 1985.

Told Co. they could not increase production and emissions prior to receiving permit to construct.

Agreed that new mixing equipment won't increase production or emissions.

Explained permitting procedure/schedule.

Reviewed Consent order schedule. Told Co. FINAL DATE (12/1/85) IS DATE THEY MUST MEET OR REVISE Consent ORDER.

(over)

david M

DAVID M COMPANY
201 VALENTINE WAY ○ LONGWOOD, FLORIDA 32750 ● (305) 321-0945

DER
DEC 12 1984
BAQM

December 11, 1984

Mr. William Thomas
State of Florida
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301-6241

Dear Mr. Thomas:

Enclosed you will find a revised construction permit application for the David 'M' Company. The application contains some significant modifications which bear some explanation. You may remember from our discussions in Tallahassee in October of 1983 that we expected a real business recovery during 1984-85. That recovery has indeed occurred and as such has necessitated that we look at additional capacity earlier than we had planned. The application evidences our proposal to add one spreader, several additional mixers and a new festooning area. Since we had not yet sized our solvent recovery system, we felt that it would be prudent to include our expansion plans in our original construction permit in order to prevent a nearly immediate request for a permit addition. You will note that very little else has changed operationally; coating VOC content, methods of application, and etc. remain appreciably the same. You will notice changes reflecting a better knowledge of the process than that which was evident at the time of our previous application.

We believe this revised permit application represents a fair and environmentally sound proposal which will serve to mutally benefit all parties involved. We sincerely hope that we have provided sufficient data for your approval process to proceed. In the event that we have not, please do not hesitate to contact me directly.

Sincerely,

Wayne L. Brady
General Manager
& Vice President

Enclosure

No. 0157029

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED— NOT FOR INTERNATIONAL MAIL

(See Reverse)

SENT TO Mr. Michael A. Ware		
STREET AND NO.		
P.O., STATE AND ZIP CODE		
POSTAGE		$
CONSULT POSTMASTER FOR FEES	CERTIFIED FEE	¢
OPTIONAL SERVICES	SPECIAL DELIVERY	¢
	RESTRICTED DELIVERY	¢
RETURN RECEIPT SERVICE	SHOW TO WHOM AND DATE DELIVERED	¢
	SHOW TO WHOM, DATE, AND ADDRESS OF DELIVERY	¢
	SHOW TO WHOM AND DATE DELIVERED WITH RESTRICTED DELIVERY	¢
	SHOW TO WHOM, DATE AND ADDRESS OF DELIVERY WITH RESTRICTED DELIVERY	¢
TOTAL POSTAGE AND FEES		$
POSTMARK OR DATE 10/1/84		

PS Form 3800, Apr. 1976

PS Form 3811, Jan. 1978

RETURN RECEIPT, REGISTERED, INSURED AND CERTIFIED MAIL

● SENDER: Complete items 1, 2, and 3.
Add your address in the "RETURN TO" space on reverse.

1. The following service is requested (check one.)
   - ☒ Show to whom and date delivered............ ¢
   - ☐ Show to whom, date and address of delivery.... ¢
   - ☐ RESTRICTED DELIVERY
     Show to whom and date delivered............ ¢
   - ☐ RESTRICTED DELIVERY.
     Show to whom, date, and address of delivery.$____

   (CONSULT POSTMASTER FOR FEES)

2. **ARTICLE ADDRESSED TO:**

Mr. Michael A. Ware
201 Valentine Way
Longwood, Florida 32750

3. **ARTICLE DESCRIPTION:**

REGISTERED NO.	CERTIFIED NO.	INSURED NO.
	0157029	

(Always obtain signature of addressee or agent)

I have received the article described above.

SIGNATURE ☐ Addressee ☐ Authorized agent

4. DATE OF DELIVERY 10/3/84

POSTMARK

OD. FL
OCT 3
USPS

5. ADDRESS (Complete only if requested)

6. UNABLE TO DELIVER BECAUSE:

CLERK'S INITIALS

☆GPO : 1979-300-459

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

September 27, 1984

Mr. Michael A. Ware
David M Company
201 Valentine Way
Longwood, Florida 32750

Dear Mr. Ware:

The department has reviewed your August 31, 1984, letter that summarizes the problems David M Company encountered in installing a vapor recovery system on the organic liquid storage tanks. We believe your company should investigate other means of controlling the volatile organic compound emissions from your storage tanks before selecting an air pollution control system for them. Among the systems we suggest you consider are:

1. A carbon absorption system, such as the ones used at dry cleaning establishments, or other type of controls to treat the vapors displaced whtn the storage tanks are filled.

2. Connecting the vent lines from the storage tanks to the air pollution control system selected for the coating production line.

3. Contact other industrial solvent distributors and gasoline carriers to see if trucks that are able to use the Coaxial Vapor Recovery System initially considered by your company are available.

There may other ways to control the emissions from these storage tanks and the department does not wish to restrict your company from investigating alternate means of control. Based on their regulations, the South Coast Air Quality Management District of El Monte, California have more experience in controlling emissions from small storage tanks than Florida and may be able to advise you of alternate control system that would be applicable to your situation.

The department does see some benefit to using the Coaxial Vapor Recovery System at your plant, even with the limitations described in your August 31, 1984, letter, but believes more effective systems are available. Instead of installing the Coaxial Vapor Recovery System at this time to comply with the Consent Order No. 84-0044, the department request you use the remained of this year to investigate alternate means of control and submit a written report, summarizing the results of your investigation, to this office by January 2, 1985. We understand that the pressure/vacuum vents are being installed on the tanks on schedule.

If you have any questions on the legal matters on the Consent Order, please contact Nancy Wright at (904)488-9730. Questions on technical matters should be addressed to Willard Hanks at (904)488-1344.

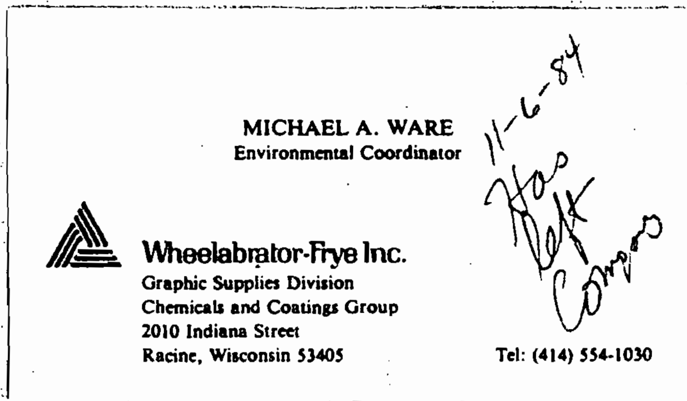
Sincerely,

C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality
Management

CHF/WH/s

cc: William Darling
Nancy Wright

9-18-84
Copies to Charles Collins and
Nancy Wright



MICHAEL A. WARE
Environmental Coordinator

Wheelabrator-Frye Inc.
Graphic Supplies Division
Chemicals and Coatings Group
2010 Indiana Street
Racine, Wisconsin 53405

Tel: (414) 554-1030

11-6-84
Has left Company

david M

DAVID M COMPANY
201 VALENTINE WAY ◦ LONGWOOD, FLORIDA 32750 ◦ (305) 321-0945

August 31, 1984

Mr. Willard Hanks
Department of Environmental Regulation
Bureau of Air Quality Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301-8241

File Reference: OGC Case No. 84-0044

Dear Mr. Hanks:

This correspondence shall serve as confirmation of our conversation of August 31, 1984, during the course of which we discussed evaporative emission controls for VOC Storage Tanks at our facility, required by item nine of our joint consent agreement.

We are encountering several problems in designing and implementing a storage tank Vapor Recovery System at our facility and would appreciate your assistance in this matter. The following obstacles to installation of such a system (which would displace vapors created by filling back into the tanker making the delivery) exist.

1. Standard vapor recovery equipment currently available is designed for service station use and as such is chemically resistant to gasoline only and would not be suitable for use with industrial solvents like Toluene and Methyl Ethyl Ketone. Such material incompatibilities would likely compromise the long term effectiveness of the control system. While we consider this problem to be significant, it is likely that o-rings, gaskets, valve seats and other components could be special ordered and received within 3-6 months time and therefore a system could possibly be custom made and installed for capture of VOC's at our facility. We perceive item 2 below to be a more significant problem than item 1 above.

2. We have contacted the three companies which currently sell and deliver our facility industrial solvents. None of these three companies have delivery equipment set up for vapor recovery at this time and more importantly, do not have facilities equipped to empty recovered vapors from a tanker when a facility is able to displace them back to the tanker. Our least frequent supplier informs us

that it may be possible to route all shipments via a gasoline carrier who would be set up for evaporative exhaust emission controls, however, we are unaware of what would happen to the vapors after leaving our site since our vendors do not have provisions for vapor recovery at their facilities. Our surmisal is that the vapors may find their way into the atmosphere even though much capital, time and effort has been expended for recovery activities at our location.

The aforementioned problems and questions have presented us with somewhat of a dilemma as to whether controls are appropriate and/or feasible in this case. We would sincerely appreciate your assistance in developing a proper course of action in this case. Pursuant to our recent conversation, we will not be required to comply with the 90 day installation period established by the original consent agreement for installation of Vapor Recovery equipment and we will await a reply from your office prior to proceeding with any installation of vapor recovery equipment.

In the event that you should require further information and/or assistance in resolving these questions, please feel free to contact me directly.

Sincerely,

Michael A. Ware

Michael A. Ware

cc: W. Brady
J. Spangler
H. Mycroft
B. Baddeley
T. Westman
J. Gamble

Clair, ~~Bill~~ 9/5

Incompleteness response. District & Nancy Wright copied. Please return for file

Patty

davidM
COMPANY
201 VALENTINE WAY
LONGWOOD, FLORIDA 32750

LONGWOOD
AUG 31 '84
FLA.
U.S. POSTAGE
1.55

RETURN RECEIPT
REQUESTED

CERTIFIED
P 211 559 780
MAIL

Mr. Willard Hanks
Department of Environmental Regulation
Bureau of Air Quality Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301-8241

DER
SEP 4 1984
BAQM

david M COMPANY

Wheelabrator-Frye Inc. Chemicals & Coatings Group

201 VALENTINE WAY • LONGWOOD, FLORIDA 32750 • (305) 321-0945

September 6, 1984

Department of Environmental Regulation
Bureau of Air Quality Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301-8241

DER
SEP 11 1984
BAQM

Subject: Case #84-044

Dear Compliance Evaluation Specialist:

This report is being submitted in compliance with consent order (reference Case #84-044). This is our second report which has been prepared in recognition of the September 1st date referenced in our overall compliance schedule codified as Exhibit #2.

Please be advised that we have concluded our review of the alternative methods of VOC control for our Orlando facility, namely incineration and solvent recovery. Due to economic reasons, we have ruled out incineration and are now concentrating on investigations on solvent recovery systems. A set of initial parameters and specifications for a bid have been prepared and are attached as an addendum to this report for your evaluation.

These specifications have been submitted to Vara International, Inc., Vero Beach, Florida and Sutcliffe Speakman, Inc. of Lutherville, Maryland for consideration. We expect to have quotations returned to us by the end of September and will proceed to select one of these companies to be the primary supplier of the necessary pollution control equipment. Upon receipt of final quotations from the afore-mentioned suppliers, we will proceed to develop formal plans and specifications which will be forwarded you for approval as soon as they become available.

Because of the magnitude of the cost of this project, the appropriation of funds for same must be approved by our corporate management. With this consideration in mind, we plan to have specifications and estimated costs complete and the appropriation request submitted to our corporate management on or before November 5th. We will continue to apprise you of our progress as the project moves forward.

In the event that you should have further questions and/or require further information, please do not hesitate to contact me directly.

Very truly yours,

DAVID 'M' COMPANY

Wayne L. Brady
Vice-President and General Mgr.

WLB:bjw
Attach.

cc: M. A. Ware
R. H. Baddeley
J. Spangler
H. Mycroft
T. G. Westman
J. H. Gamble

July 9, 1984

CERTIFIED MAIL NO. 7236065

BEFORE THE STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL REGULATION,

Complainant,

vs.

DAVID "M" COMPANY

Respondent.

IN THE OFFICE OF THE
ST.JOHNS RIVER DISTRICT

OGC Case No. 84-0044

RECEIVED
JUL 9 1984
Dept. of Environmental Regulation
Office of General Counsel

CONSENT ORDER

This Consent Order is made and entered into between the State of Florida Department of Environmental Regulation ("Department") and David "M" Company, 201 Valentine Way, Longwood, Seminole County, Florida 32750, ("Respondent").

The Department finds and Respondent admits the following:

1. Respondent owns and operates a coating production line facility located at 201 Valentine Way, Longwood, Florida 32750. Section 27, Township 20 south, Range 30 east, Seminole County, Exhibit 1. This production line began operations in 1978 and manufactures a fabric coated material used in the off-set printing process. Coating of the material involves using volatile organic compounds (VOC's), which are sources of air pollution regulated by the Department.

2. Respondent also owns and operates two oil fired steam boilers at this same plant site used in conjunction with the fabric coating process.

3. Respondent constructed and began operation of the coating line without first obtaining a Department permit authorizing such construction or operation. This violates Florida Administrative Code Rules 17-2.210 and 17-4.03 and Section 403.087 and 403.161, Florida Statutes.

4. The Department issued a Warning Notice to the Respondent on June 3, 1983 in which the Respondent was to meet with the Department to resolve the violation of operating the two boilers without a permit. Permits were issued for the boilers, one on January 5, 1984, and the other on January 6, 1984.

5. An informal conference was held between the Respondent and the Department on July 28, 1983. In that meeting it was recommended to the Respondent that he should enter a Consent Order to address the failure to control VOC emissions from the coating line and the violations for constructing and operating the coating line and the two boilers without a permit.

6. The Respondent submitted an application for construction of the pollution source at the plant, specifically the VOC emmission source, and the Department received the application on August 12, 1983.

THEREFORE, having reached a resolution of the matter, pursuant to Florida Administrative Code Rule 17-1.58, the Department and the Respondent mutually agree and it is:

ORDERED:

7. Respondent shall adopt and implement the compliance schedule proposed to the Department entitled: Estimated Overall Compliance Schedule David "M" Company VOC Control Project, dated October 19, 1983, attached and incorporated as Exibit 2. With respect to the VOC emission violations covered in this Consent Order, compliance will be met as per the Respondent's schedule, Exhibit 2, and consistent with Department rules.

8. Respondent shall deliver a report, in writing to the Department within fifteen days of each deadline date noted in Exhibit 2. The report shall specify what steps have been made toward compliance with the applicable deadline, whether the deadline has been met, and the reasons for any delays. This report and all other reports, notices and applications required by this Order shall be mailed to:

Department of Environmental Regulation
Bureau of Air Quality Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32301-8241

9. Respondent shall install Department approved VOC air pollution control devices on all VOC storage and holding tanks owned by the Respondent within ninety days of the effective date of this Consent Order. Notice shall be provided by the Respondent in writing within that ninety day period to the Department stating the type, name and manufacturer of the device(s). Any efficiency values shall be also noted. A brief sketch shall be attached showing the location of the control equipment and its connections to the tanks. Any pipe, valve, vent, exhaust, drain or other means for VOC's to be released into the ambient atmosphere shall be noted.

10. Respondent shall limit the operations at the plant site which involve the emissions of VOC's to only sixteen hours per day. This provision shall be effective as of the date of this Consent Order, and shall remain in force until replaced by the hours of operation as specified in a construction permit as issued by the Department.

11. Respondent shall have received and installed all pollution abatement and control equipment for control of VOC's on the coating line by August 1, 1985, as stated in Exhibit 2.

12. Respondent shall pay a settlement fee as agreed upon relating to matters in this Consent Order to the Department's Pollution Recovery Fund with either a money order, cashier's check or certified check in the amount of $10,000.00. Payment shall be made within sixty (60) days of this Consent Order. The check or money order shall be mailed to the Department of Environmental Regulation, St. Johns River District, 3319 Maguire Boulevard, Suite 232, Orlando, Florida 32803.

13. Respondent shall allow authorized representatives of the Department access to the property at reasonable times for purposes of determining compliance with this Order and the rules of the Department.

14. The Department hereby expressly reserves the right to initiate appropriate legal action to prevent or prohibit the future violation of applicable statutes, or the rules promulgated thereunder.

15. Entry of this Consent Order does not relieve Respondent of the need to comply with applicable federal, state, or local laws, regulations, or ordinances. The entry of this Consent Order does not abrogate the rights of substantially affected persons who are not parties to this Order, pursuant to Chapter 120, Florida Statutes.

16. The terms and conditions set forth in the Consent Order may be enforced in a court of competent jurisdiction pursuant to Sections 120.69 and 403.121, Florida Statutes. Failure to comply with terms of this Consent Order shall constitute a violation of Section 403.161(1)(b), Florida Statutes.

17. Respondent is fully aware a violation of the terms of this Consent Order may subject Respondent to judicial imposition of damage, civil penalties of up to $10,000 per offense, and criminal penalties.

18. This Consent Order shall take effect upon the date of filing and acknowledgement by the Clerk of the Department and shall constitute final agency action by the Department pursuant to Section 120.69, Florida Statutes and Florida Administrative Code Rule 17-1.58(3).

FOR THE RESPONDENT:

June 13, 1984
Date

WAYNE BRADY
President and General
Manager
David "M" Company
201 Valentine Way
Longwood, Florida 32750

DONE AND ORDERED this 15 day of June, 1984, in Orlando, Florida.

A. ALEXANDER, P.E.
District Manager
State of Florida Department
of Environmental Regulation
3319 Maguire Boulevard
Suite 232
Orlando, Florida 32803
Telephone: (305) 894-7555

FILING AND ACKNOWLEDGEMENT
FILED, on this date, pursuant to S120.52 (9), Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

6/15/84
Clerk Date

Best Available Copy

1146 1463
BOOK PAGE
SEMINOLE COUNTY
FLORIDA

DOCUMENTARY SUR TAX FLORIDA 9 7 5 . 0 0
DOCUMENTARY SUR TAX FLORIDA 2 8 0 . 9 0

This Warranty Deed Made and executed the 29th day of September A.D. 1977 by

HOOVER BALL AND BEARING COMPANY
a corporation existing under the laws of Michigan, and having its principal place of business at Post Office Box 10033, Ann Arbor, Michigan 48106
hereinafter called the grantor, to

SINCLAIR & VALENTINE COMPANY, INC., a Delaware corporation,

whose postoffice address is Liberty Lane, Hampton, New Hampshire 03842

hereinafter called the grantee:

(Wherever used herein the terms "grantor" and "grantee" include all the parties to this instrument and the heirs, legal representatives and assigns of individuals, and the successors and assigns of corporations)

Witnesseth: That the grantor, for and in consideration of the sum of $ 10.00 and other valuable considerations, receipt whereof is hereby acknowledged, by these presents does grant, bargain, sell, alien, remise, release, convey and confirm unto the grantee, all that certain land situate in County, Florida, viz:

Lot 6, SHUMAN'S ADDITION TO EUREKA HAMMOCK, according to the plat thereof as recorded in Plat Book 2, Page 53, of the Public Records of Seminole County, Florida.

Subject to reservations in that certain Deed from the State of Florida through the Trustees of the Internal Improvement Fund of the State of Florida to T. J. Williams and R. W. Williams dated May 21, 1946 and recorded on June 26, 1946 in Deed Book 132, Page 336, which reservations have been partially released pursuant to those three certain Quitclaim Deeds dated February 7, 1973 and recorded on February 22, 1973 in Official Records Book 969, Pages 1103, 1104 and 1105, respectively, Public Records of Seminole County, Florida;

Together with all the tenements, hereditaments and appurtenances thereto belonging or in anywise appertaining.

To Have and to Hold, the same in fee simple forever.

And the grantor hereby covenants with said grantee that it is lawfully seized of said land in fee simple; that it has good right and lawful authority to sell and convey said land; that it hereby fully warrants the title to said land and will defend the same against the lawful claims of all persons whomsoever; and that said land is free of all encumbrances except taxes accruing subsequent to December 31, 1976, the reservations described above, and that certain Easement executed by Hoover Ball and Bearing, Inc. in favor of Florida Power Corporation dated May 8, 1973 and recorded June 4, 1973, in Official Records Book 982, Page 695, of the Public Records of Seminole County, Florida.

In Witness Whereof the grantor has caused these presents to be executed in its name, and its corporate seal to be hereunto affixed, by its proper officers thereunto duly authorized, the day and year first above written.

(CORPORATE SEAL)

ATTEST: Douglas E. Peck
Secretary

HOOVER BALL AND BEARING COMPANY

Signed, sealed and delivered in the presence of:

By Robert E. Ressler
Vice President

OCT 6 12 26 PM '77

077708

STATE OF Michigan
COUNTY OF Washtenaw

I HEREBY CERTIFY that on this day, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, personally appeared Robert E. Ressler and Douglas E. Peck, respectively, well known to me to be the Vice President and Secretary, ~~XXXXXXX~~ of the corporation named as grantor in the foregoing deed, and that they severally acknowledged executing the same in the presence of two subscribing witnesses freely and voluntarily under authority duly vested in them by said corporation and that the seal affixed thereto is the true corporate seal of said corporation.

WITNESS my hand and official seal in the County and State last aforesaid this 29th day of September A.D. 19 77.

Jeanne L. Meyer
JEANNE L. MEYER

This Instrument prepared by:

Return to:
CHICAGO TITLE INSURANCE COMPANY
P O Box 751
Orlando Florida 32802

D.E.I. ORLANDO
EXHIBIT NO. 1

October 13, 1983

ESTIMATED
OVERALL COMPLIANCE SCHEDULE
DAVID M COMPANY VOC CONTROL PROJECT

PHASE	
Data Accumulation	January 1, 1984
Spreader Enclosure - (1) For Temperature Evaluation	January 15, 1984
Process Modifications and Development	April 1, 1984
Methods Comparison/Analysis - Thermal Incineration Vs. Recovery	May 15, 1984
Final Specification Development	July 1, 1984
→ Final Specification/Quotations and Analysis	September 1, 1984
Appropriations Request Development and Approval	December 1, 1984
Oven Enclosure and Exhaust System Installation	March 1, 1985
Solvent Recovery Delivery and Installation	August 1, 1985
Operational Shakedown, Debugging and Compliance Testing	December 1, 1985

D.E.R. — ORLANDO
EXHIBIT NO. 2

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

Nº 81922

RECEIPT FOR APPLICATION FEES AND MISCELLANEOUS REVENUE

Received from Sinclair & Valentine Co. Date May 14, 1984

Address [illegible] University Ave, Des Moines Dollars $ 10,000.00

Applicant Name & Address

Source of Revenue Consent Order Case #

Revenue Code 004001 Ck# 272 Application Number N/A

By

DAVID M COMPANY
201 VALENTINE WAY • LONGWOOD, FLORIDA 32750 • (305) 321-0945

June 29, 1984

Department of Environmental Regulation
Bureau of Air Quality Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301-8241

Case No. 84-0044

Gentlemen:

In accordance with the requirements stated in paragraph 8 of the Consent Order (Ref. Case No. 84-0044), entered into between the State of Florida Department of Environmental Regulation and David M Company, please find the attached report and exhibits.

Respectfully yours,

DAVID M COMPANY

Wayne L. Brady
Vice President
& General Manager

Pkg says they are enclosing equip.
Evaluating VOC recvy vs Incineration
want to recover

June 28, 1984

REPORT TO FLORIDA DEPT. OF ENVIRONMENTAL REGULATIONS

This report has been prepared in compliance with the Consent Order (Ref. Case No. 84-044, Par. 8). We have been working on this project according to the agreed schedule contained in the Consent Order. The following items refer to that schedule.

Item 1 - Data Accumulation

As background for determination of the capacity of the unit required to take care of the VOC emissions in this plant, we did extensive testing and recording of process data on our spreader lines. We recorded blanket size, pounds of cement applied per pass, time per pass, and then calculated the amount of solvent (toluene) per pass and per minute. The assumption made was that 100% of the solvent was flashed off in the spreader and it was this amount of VOC emitted per minute that we were particularly interested in. Copies of the data are attached as Exhibit I; the column headed "TOL - MIN" is the calculated emission in pounds per minute. A review of the data shows the wide fluctuation of this factor. We have been working on process revisions to reduce the peak to 4.5#/minute.

Item 2 - Spreader Enclosure

We have been aware that the enclosures on the three spreader lines would not be adequate to give us the capture efficiency required for the VOC control system. Because these lines are equipped with steam coils to force dry the product, we were concerned that drying conditions would change with the revision of the enclosure and adversely affect the product quality. The enclosure on one spreader has been changed per drawings E0379-001 and -002 attached as Exhibit II. To date, this modification has not hurt product quality but, after reviewing the performance of this line, we have concluded the capture efficiency is not good enough. We have now contracted to have the "undercoil flooring" sections removed and panels added to the side of the structure. In this manner, the line will be totally enclosed with controlled air intake openings at each end.

Item 3 - Process Modifications and Development

Having accumulated much data in Phase I and enclosed one spreader (Phase II), David M Company then set out to better control run speed, thickness of spread and overall process control. In order to accomplish this end, tachometers and dial gauges have been added to our enclosed spreader. With these controls in place, we set out to evaluate: (1) our efficiency of capture with the newly-enclosed hood; (2) our ability to run at 40% of LEL and (3) the ability to continuously monitor fume generation in the enclosure via an infrared gas detection system. You will find attached as Exhibit III three example data sheets which summarize the type of information gathered by this phase of the project.

This information suggested that 40% of LEL operation and monitoring is feasible. In addition, it suggested that a significant amount of solvent was escaping underneath the spreader which is currently unenclosed. As a result, the enclosure will be extended to the floor, yielding a totally enclosed spreader with a capture efficiency that we consider to be acceptable. The additional sheet metal panels will be installed the week of July 6th and additional diagnostic tests will be performed to assure that the enclosure lives up to our expectations. In addition, a permanent LEL detection system for this first unit is now on order and is expected to arrive and be installed in mid-August.

Item 4 - Methods Comparison

We have felt from the outset that our direction would be toward solvent recovery and have made an analysis of the comparative costs of incineration vs. recovery. However, no final decision has as yet been reached; and, therefore, we are leaving our options open, until such time as final costs of these two comparative systems are known.

We now have sufficient process data from which the air volume requirements of a control device may be calculated. In compliance with Exhibit II of the Consent Agreement, we will begin developing our final specifications for bids for the job on July 1, 1984. We are also expecting completion of same by September 1, 1984, in compliance with our overall compliance schedule. We would also expect to deliver the remaining information necessary to complete our permit application concurrently on September 1, 1984.

EXHIBIT I

Best Available Copy

```
UN ON 01/23/84 AT 14:11:22                     DAVID M TOLUENE ANALYSIS                                              PAGE  1
                                                     %                                 CEM   TOLUENE    TOL    TOL      TOL     FEET   F/FEET
 DATE     LEN  WIDTH      DESCRIPTION               TOL    LBS   MINS  SQ YDS   SYD    USED     SYD    LYD      MIN      MIN     MIN

9/14/83   110  86.75  RUBBER 1492 1ST PASS          60.0   45.5   5.7  265.06  .171   27.300   .102   .248    4.789    57.89   62.77
9/14/83   110  86.75     2ND PASS                   60.0   28.0   5.2  265.06  .105   16.600   .063   .152    3.230    63.46   68.81
9/14/83   110  86.75     3RD PASS                   60.0   21.0   5.6  265.06  .079   12.600   .047   .114    2.250    58.92   63.90
9/14/83   110  86.75  RUBBER 7002 1ST PASS          55.9   35.0   6.7  265.06  .132   19.565   .073   .177    2.920    49.25   53.40
9/14/83   110  86.75     2ND PASS                   55.9   55.0   6.0  265.06  .207   30.745   .115   .279    5.124X   55.00   59.64
9/14/83   110  86.75     3RD PASS                   55.9   47.0   4.6  265.06  .177   26.273   .099   .238    5.711X   71.73   77.79
9/14/83   110  86.75     4TH PASS                   55.9   47.0   4.0  265.06  .177   26.273   .099   .238    6.568X   82.50   89.46
9/14/83   110  86.75     5TH PASS                   55.9   39.5   6.4  265.06  .149   22.080   .083   .200    3.450    51.56   55.91
9/14/83   110  86.75     6TH PASS                   56.8   39.5   6.4  265.06  .149   22.436   .084   .203    3.505    51.56   55.91
9/14/83   110  86.75     7TH PASS                   56.8   63.0   7.5  265.06  .237   35.784   .135   .325    4.771    44.00   47.71
9/14/83   110  86.75     8TH PASS                   56.8   48.0   4.4  265.06  .181   27.264   .102   .247    6.196    75.00   81.32
9/14/83   110  86.75     9TH PASS                   56.8   34.0   3.0  265.06  .128   19.312   .072   .175    6.437   110.00  119.28
9/14/83   110  86.75    10TH PASS                   56.8   32.0   3.1  265.06  .120   18.176   .068   .165    5.863   106.45  115.43
9/14/83   110  86.75    11TH PASS                   56.8   47.0   4.4  265.06  .177   26.696   .100   .242    6.067    75.00   81.32
9/14/83   110  86.75    12TH PASS                   56.8   44.0   3.2  265.06  .166   24.992   .094   .227    7.810   103.12  111.82
9/14/83   110  86.75    13TH PASS                   59.3   30.5   2.4  265.06  .115   18.086   .068   .164    7.535   137.50  149.10
9/14/83   110  86.75    14TH PASS                   59.3   29.0   2.8  265.06  .109   17.197   .064   .156    6.141   117.85  127.80
9/14/83   110  86.75    15TH PASS                   59.3   28.0   2.7  265.06  .105   16.604   .062   .150    6.149   122.22  132.53
9/14/83   110  86.75    16TH PASS                   59.3   30.0   3.0  265.06  .113   17.790   .067   .161    5.930   110.00  119.28
9/14/83   110  86.75    17TH PASS                   59.3   25.5   2.8  265.06  .096   15.121   .057   .137    5.400   117.85  127.80
9/14/83   110  86.75   RUBBER 6607 1ST PASS         63.0   20.5   4.0  265.06  .077   12.915   .048   .117    3.228    82.50   89.46
9/14/83   110  86.75     2ND PASS                   63.0   42.5   6.8  265.06  .160   26.775   .101   .243    3.937    48.52   52.62
9/14/83   110  86.75     3RD PASS                   63.0   29.0   4.7  265.06  .109   18.270   .068   .166    3.887    70.21   76.13
9/14/83   110  86.75     4TH PASS                   63.0   22.5   3.7  265.06  .084   14.175   .053   .128    3.831    89.18   96.71
9/14/83   110  86.75     5TH PASS                   63.0   24.5   3.4  265.06  .092   15.435   .058   .140    4.539    97.05  105.24
9/14/83   110  86.75     6TH PASS                   63.0   24.5   3.8  265.06  .092   15.435   .058   .140    4.061    86.84   94.16
9/14/83   110  86.75     7TH PASS                   63.0   21.0   3.3  265.06  .079   13.230   .049   .120    4.009   100.00  108.43
9/14/83   110  86.75     8TH PASS                   63.0   23.0   3.5  265.06  .086   14.490   .054   .131    4.025    91.66   99.40
9/14/83   110  86.75     9TH PASS                   63.0   26.5   4.9  265.06  .099   16.695   .062   .151    3.407    67.34   73.02
9/14/83   110  86.75    10TH PASS                   63.0   20.5   3.7  265.06  .077   12.915   .048   .117    3.490    89.18   96.71
9/14/83   110  86.75   TALC PASS                    63.0   22.0  15.5  265.06  .083   13.860   .052   .126     .894    21.29   23.08
                 TOTALS                                 1023.0  131.6 7951.80  .128  601.425

TAL PASSES  30                                           MIN   2.4                     MIN   .047   .114    2.250    44.00   47.71
TAL PRODUCTION TIME 08:09:35                             MAX   7.5                     MAX   .135   .325    7.810   137.50  149.10
ERAGE LBS CEMENT PER PASS  34.100                        AVG   4.3                     AVG   .075   .181    4.808    82.77   89.76
ERAGE LBS CEMENT PER SQUARE YARD 3.859
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                         DAVID M TOLUENE ANALYSIS                                               PAGE 24

                                                  %                                CEM   TOLUENE     TOL     TOL      TOL     FEET    F/FEET
  DATE     LEN   WIDTH      DESCRIPTION          TOL    LBS    MINS   SQ YDS    SYD     USED       SYD     LYD      MIN     MIN      MIN
11/17/83    90   47.00  RUBBER 7402 1ST PASS    56.7   18.0    4.4   117.49   .153    10.206    .086    .113    2.319    61.36    36.04
11/17/83    90   47.00     2ND PASS             56.7   12.0    4.0   117.49   .102     6.804    .057    .075    1.701    67.50    39.65
11/17/83    90   47.00     3RD PASS             56.7    8.0    4.0   117.49   .068     4.536    .038    .050    1.134    67.50    39.65
11/17/83    90   47.00  RUBBER 7002 1ST PASS    60.2   25.0    7.3   117.49   .212    15.050    .128    .167    2.061    36.98    21.72
11/17/83    90   47.00     2ND PASS             60.2   36.0    7.3   117.49   .306    21.672    .184    .240    2.968    36.98    21.72
11/17/83    90   47.00     3RD PASS             60.2   31.0    5.6   117.49   .263    18.662    .158    .207    3.332    48.21    28.32
11/17/83    90   47.00     4TH PASS             60.2   31.0    7.2   117.49   .263    18.662    .158    .207    2.591    37.50    22.02
11/17/83    90   47.00     5TH PASS             60.2   23.0    5.3   117.49   .195    13.846    .117    .153    2.612    50.94    29.92
11/17/83    90   47.00     6TH PASS             60.2   20.0    4.1   117.49   .170    12.040    .102    .133    2.936    65.85    38.68
11/17/83    90   47.00     7TH PASS             60.2   20.0    4.1   117.49   .170    12.040    .102    .133    2.936    65.85    38.68
11/17/83    90   47.00     8TH PASS             60.2   22.0    5.2   117.49   .187    13.244    .112    .147    2.546    51.92    30.50
11/17/83    90   47.00     9TH PASS             60.2    4.0    4.6   117.49   .034     2.408    .020    .026     .523    58.69    34.48
11/17/83    90   47.00    10TH PASS             60.2   15.0    3.1   117.49   .127     9.030    .076    .100    2.912    87.09    51.16
11/17/83    90   47.00    11TH PASS             60.2   13.0    3.7   117.49   .110     7.826    .066    .086    2.115    72.97    42.86
11/17/83    90   47.00    12TH PASS             60.2   16.0    2.8   117.49   .136     9.632    .081    .107    3.440    96.42    56.64
11/17/83    90   47.00  RUBBER 6607 1ST PASS    68.5   18.0    4.3   117.49   .153    12.330    .104    .137    2.867    62.79    36.88
11/17/83    90   47.00     2ND PASS             68.5   14.0    3.4   117.49   .119     9.590    .081    .106    2.820    79.41    46.65
11/17/83    90   47.00     3RD PASS             68.5   12.0    2.3   117.49   .102     8.220    .069    .091    3.573   117.39    68.96
11/17/83    90   47.00     4TH PASS             68.5   17.0    4.0   117.49   .144    11.645    .099    .129    2.911    67.50    39.65
11/17/83    90   47.00     5TH PASS             68.5   11.0    2.2   117.49   .093     7.535    .054    .083    3.425   122.72    72.09
11/17/83    90   47.00     6TH PASS             68.5   13.0    3.5   117.49   .110     8.905    .075    .098    2.544    77.14    45.31
11/17/83    90   47.00     7TH PASS             68.5    8.0    2.6   117.49   .068     5.460    .046    .060    2.107   103.84    61.00
11/17/83    90   47.00     8TH PASS             68.5    9.0    3.0   117.49   .076     6.165    .052    .068    2.055    90.00    52.87
11/17/83    90   47.00     9TH PASS             68.5    8.0    1.6   117.49   .068     5.460    .046    .060    3.425   168.75    99.13
11/17/83    90   47.00    10TH PASS             68.5    6.0    1.9   117.49   .051     4.110    .034    .045    2.163   142.10    83.47
11/17/83    90   47.00    11TH PASS             68.5    6.0    3.6   117.49   .051     4.110    .034    .045    1.141    75.00    44.05
11/17/83    90   47.00    TALC PASS             68.5    9.0   12.3   117.49   .076     6.165    .052    .068     .501    21.95    12.89
                 TOTALS                               416.0  105.1  3054.74   .136   259.228

TOTAL PASSES  26                                      MIN    1.6                       MIN    .020    .026     .523    36.98    21.72
TOTAL PRODUCTION TIME 06:46:24                        MAX    7.3                       MAX    .184    .240    3.573   168.75    99.13
AVERAGE LBS CEMENT PER PASS  16.000                   AVG    4.0                       AVG    .084    .110    2.506    77.40    45.46
AVERAGE LBS CEMENT PER SQUARE YARD 3.540
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                        DAVID M TOLUENE ANALYSIS                                                    PAGE 23
                                                                       CEM  TOLUENE    TOL      TOL       TOL      FEET    F/FEET
  DATE    LEN  WIDTH      DESCRIPTION         %TOL    LBS  MINS  SQ YDS  SYD   USED      SYD      LYD       MIN      MIN      MIN
11/13/83  120  80.00  RUBBER 1492 1ST PASS    61.8   52.0  10.3  266.66 .195  32.136    .120     .267     3.120    34.95    34.95
11/13/83  120  80.00     2ND PASS             61.8   35.0  10.1  266.66 .131  21.630    .081     .180     2.141    35.64    35.64
11/13/83  120  80.00     3RD PASS             61.8   24.0   7.3  266.66 .090  14.832    .055     .123     2.031    49.31    49.31
11/13/83  120  80.00  RUBBER 7002 1ST PASS    61.8   71.0   9.9  266.66 .266  43.878    .164     .365     4.432    36.36    36.36
11/13/83  120  80.00     2ND PASS             61.8   64.0   8.4  266.66 .240  39.552    .148     .329     4.708    42.85    42.85
11/13/83  120  80.00     3RD PASS             61.8   50.0   4.9  266.66 .187  30.900    .115     .257     6.306    73.46    73.46
11/13/83  120  80.00     4TH PASS             61.8   41.0   5.3  266.66 .153  25.338    .095     .211     4.780    67.92    67.92
11/13/83  120  80.00     5TH PASS             61.8   35.0   3.9  266.66 .131  21.630    .081     .180     5.546    92.30    92.30
11/13/83  120  80.00     6TH PASS             61.8   63.0   4.6  266.66 .236  38.934    .146     .324     8.463    78.26    78.26
11/13/83  120  80.00     7TH PASS             61.8   42.0   4.9  266.66 .157  25.956    .097     .216     5.297    73.46    73.46
11/13/83  120  80.00     8TH PASS             61.8   35.0   3.7  266.66 .131  21.630    .081     .180     5.845    97.29    97.29
11/13/83  120  80.00     9TH PASS             61.8   33.0   3.3  266.66 .123  20.394    .076     .169     6.180   109.09   109.09
11/13/83  120  80.00     10TH PASS            61.8   29.0   3.1  266.66 .108  17.922    .067     .149     5.781   116.12   116.12
11/13/83  120  80.00     11TH PASS            61.8   33.0   2.2  266.66 .123  20.394    .076     .169     9.270   163.63   163.63
11/13/83  120  80.00     12TH PASS            61.8   22.0   4.3  266.66 .082  13.596    .050     .113     3.161    83.72    83.72
11/13/83  120  80.00     13TH PASS            61.8   39.0   4.8  266.65 .146  24.102    .090     .200     5.021    75.00    75.00
11/13/83  120  80.00     14TH PASS            61.8   35.0   3.7  266.66 .131  21.630    .081     .180     5.845    97.29    97.29
11/13/83  120  80.00     15TH PASS            61.8   10.0   3.0  266.65 .037   6.180    .023     .051     2.060   120.00   120.00
11/13/83  120  80.00     16TH PASS            61.8   29.0   2.9  266.66 .108  17.922    .067     .149     6.180   124.13   124.13
11/13/83  120  80.00     17TH PASS            61.8   50.0  13.4  266.66 .187  30.900    .115     .257     2.305    26.86    26.86
 1/13/83  120  80.00     18TH PASS            61.8   45.0   4.1  266.66 .168  27.810    .104     .231     6.782    87.80    87.80
 1/13/83  120  80.00  RUBBER 2202 1ST PASS    70.5   27.0   4.9  266.66 .101  19.035    .071     .158     3.884    73.46    73.46
 1/13/83  120  80.00     2ND PASS             70.5   33.0   4.5  266.66 .123  23.265    .087     .193     5.170    80.00    80.00
 1/13/83  120  80.00     3RD PASS             70.5   27.0   4.3  266.66 .101  19.035    .071     .158     4.426    83.72    83.72
 1/13/83  120  80.00     4TH PASS             70.5   54.0   7.1  266.66 .202  38.070    .142     .317     5.361    50.70    50.70
 1/13/83  120  80.00     5TH PASS             70.5   46.0   6.2  266.66 .172  32.430    .121     .270     5.230    58.06    58.06
 1/13/83  120  80.00     6TH PASS             70.5   18.0   4.8  266.66 .067  12.690    .047     .105     2.643    75.00    75.00
 1/13/83  120  80.00     7TH PASS             70.5   14.0   4.7  266.66 .052   9.870    .037     .082     2.100    76.59    76.59
 1/13/83  120  80.00     8TH PASS             70.5   16.0   4.0  266.66 .060  11.280    .042     .094     2.820    90.00    90.00
 1/13/83  120  80.00     9TH PASS             70.5   25.0   5.8  266.66 .093  17.625    .066     .146     3.038    62.06    62.06
 1/13/83  120  80.00     10TH PASS            70.5   30.0   4.6  266.66 .112  21.150    .079     .176     4.597    78.26    78.26
 1/13/83  120  80.00     11TH PASS            70.5   31.0   4.4  266.66 .116  21.855    .081     .182     4.967    81.81    81.81
 1/13/83  120  80.00  TALC PASS               70.5   23.0  16.9  266.66 .086  16.215    .060     .135      .959    21.30    21.30
                  TOTALS                       1158.0 173.4 8533.12 .135 743.571

OTAL PASSES  32                                      MIN  2.2                   MIN     .023     .051     2.031    26.86    26.86
OTAL PRODUCTION TIME 06:16:20                        MAX 13.4                   MAX     .164     .365     9.270   163.63   163.63
VERAGE LBS CEMENT PER PASS  36.187                   AVG  5.4                   AVG     .086     .193     4.671    77.97    77.97
VERAGE LBS CEMENT PER SQUARE YARD 4.342
```

Best Available Copy

```
UN ON 01/23/84 AT 14:11:22                         DAVID W TOLUENE ANALYSIS                                                    PAGE 22

                                                      %                            CEM   TOLUENE    TOL     TOL      TOL     FEET   F/FEET
 DATE    LEN   WIDTH      DESCRIPTION                TOL     LBS   MINS  SQ YDS    SYD    USED      SYD     LYD      MIN      MIN     MIN

1/12/83  120   80.00  RUBBER 1492 1ST PASS          61.8    27.0   5.7  266.66   .101   16.686    .062    .139    2.927    63.15    63.15
1/12/83  120   80.00      2ND PASS                  61.8    21.0   9.7  266.65   .078   12.978    .048    .108    1.337    37.11    37.11
1/12/83  120   80.00      3RD PASS                  61.8    15.0   4.9  266.66   .056    9.270    .034    .077    1.891    73.46    73.46
1/12/83  120   80.00  RUBBER 7002 1ST PASS          60.8    55.0   6.9  266.66   .206   33.440    .125    .278    4.845    52.17    52.17
1/12/83  120   80.00      2ND PASS                  60.8    47.0   4.5  266.66   .176   28.576    .107    .238    6.350    80.00    80.00
1/12/83  120   80.00      3RD PASS                  60.8    60.0   5.7  266.66   .225   36.480    .136    .304    6.400    63.15    63.15
1/12/83  120   80.00      4TH PASS                  60.8    51.0  64.9  266.66   .191   31.008    .116    .258     .477     5.54     5.54
1/12/83  120   80.00      5TH PASS                  60.8    38.0   4.2  266.66   .142   23.104    .086    .192    5.500    85.71    85.71
1/12/83  120   80.00      6TH PASS                  60.8    49.0   4.3  266.66   .183   29.792    .111    .248    6.928    83.72    83.72
1/12/83  120   80.00      7TH PASS                  60.8    27.0   3.4  266.66   .101   16.416    .061    .136    4.828   105.88   105.88
1/12/83  120   80.00      8TH PASS                  60.8    39.0   4.2  266.66   .146   23.712    .088    .197    5.645    85.71    85.71
1/12/83  120   80.00      9TH PASS                  60.8    33.0   4.4  266.66   .123   20.064    .075    .167    4.560    81.81    81.81
1/12/83  120   80.00     10TH PASS                  60.8    36.0   4.7  266.66   .135   21.888    .082    .182    4.657    76.59    76.59
1/12/83  120   80.00     11TH PASS                  60.8    34.0   7.3  266.65   .127   20.672    .077    .172    2.831    49.31    49.31
1/12/83  120   80.00     12TH PASS                  60.8    28.0   3.4  266.66   .105   17.024    .063    .141    5.007   105.88   105.88
1/12/83  120   80.00     13TH PASS                  60.8    24.0   3.2  266.66   .090   14.592    .054    .121    4.560   112.50   112.50
1/12/83  120   80.00     14TH PASS                  60.8    24.0   4.0  266.66   .090   14.592    .054    .121    3.648    90.00    90.00
1/12/83  120   80.00  RUBBER 2202 1ST PASS          60.8    40.0  11.9  266.66   .150   24.320    .091    .202    2.043    30.25    30.25
1/12/83  120   80.00  RUBBER 2202 1ST PASS          70.5    15.0   7.9  266.66   .056   10.575    .039    .088    1.338    45.56    45.56
1/12/83  120   80.00      2ND PASS                  70.5    27.0   5.0  266.66   .101   19.035    .071    .158    3.807    72.00    72.00
1/12/83  120   80.00      3RD PASS                  70.5    25.0   4.7  266.66   .093   17.625    .066    .146    3.750    76.59    76.59
1/12/83  120   80.00      4TH PASS                  70.5    49.0   6.6  266.65   .183   34.545    .129    .287    5.234    54.54    54.54
1/12/83  120   80.00      5TH PASS                  70.5    39.0   5.3  266.66   .146   27.495    .103    .229    5.187    67.92    67.92
1/12/83  120   80.00      6TH PASS                  70.5    33.0   4.3  266.66   .123   23.265    .087    .193    5.410    83.72    83.72
1/12/83  120   80.00      7TH PASS                  70.5    32.0   4.7  266.66   .120   22.560    .084    .188    4.800    76.59    76.59
1/12/83  120   80.00      8TH PASS                  70.5    28.0   3.7  266.65   .105   19.740    .074    .164    5.335    97.29    97.29
1/12/83  120   80.00      9TH PASS                  70.5    22.0   3.5  266.66   .082   15.510    .058    .129    4.431   102.85   102.85
1/12/83  120   80.00     10TH PASS                  70.5    21.0   4.1  266.65   .078   14.805    .055    .123    3.610    87.80    87.80
1/12/83  120   80.00     11TH PASS                  70.5    26.0   4.4  266.66   .097   18.330    .068    .152    4.165    81.81    81.81
1/12/83  120   80.00     12TH PASS                  70.5    51.0   7.6  266.65   .191   35.955    .134    .299    4.730    47.36    47.36
1/12/83  120   80.00     13TH PASS                  70.5    16.0   3.7  266.66   .060   11.280    .042    .094    3.048    97.29    97.29
1/12/83  120   80.00     14TH PASS                  70.5    14.0   5.2  266.66   .052    9.870    .037    .082    1.898    69.23    69.23
1/12/83  120   80.00     15TH PASS                  70.5    16.0   3.9  266.66   .060   11.280    .042    .094    2.892    92.30    92.30
1/12/83  120   80.00  TALI PASS                     70.5    21.0  18.9  266.65   .078   14.805    .055    .123     .783    19.04    19.04
                TOTALS                                    1062.0 231.9 8799.78   .120  686.484

OTAL PASSES  33                                            MIN   3.2                  MIN     .034    .077     .477     5.54     5.54
OTAL PRODUCTION TIME 04:32:38                              MAX  64.9                  MAX     .136    .304    6.928   112.50   112.50
VERAGE LBS CEMENT PER PASS  32.181                         AVG   7.0                  AVG     .077    .172    4.062    73.78    73.78
VERAGE LBS CEMENT PER SQUARE YARD 3.982
```

Best Available Copy

```
UN ON 01/23/84 AT 14:11:22                         DAVID W TOLUENE ANALYSIS                                              PAGE 21

                                                    %                                CEM   TOLUENE    TOL     TOL      TOL     FEET    F/FEET
 DATE     LEN    WIDTH      DESCRIPTION            TOL     LBS    MINS   SQ YDS     SYD     USED      SYD     LYD      MIN      MIN      MIN

1/07/83   100    60.00   RUBBER 3492 1ST PASS     62.5    37.0    5.0   166.66    .222   23.125    .138    .231    4.625    60.00    45.00
1/07/83   100    60.00      2ND PASS              62.5    18.0    4.2   166.65    .108   11.250    .067    .112    2.678    71.42    53.57
1/07/83   100    60.00      3RD PASS              62.5    12.0    3.7   166.66    .072    7.500    .045    .075    2.027    81.08    60.81
1/07/83   100    60.00   RUBBER 7002 1ST PASS     61.0    28.0    7.5   166.65    .168   17.080    .102    .170    2.277    40.00    30.00
1/07/83   100    60.00      2ND PASS              61.0    32.0    6.2   166.66    .192   19.520    .117    .195    3.148    48.38    36.29
1/07/83   100    60.00      3RD PASS              61.0    39.0    6.2   166.65    .234   23.790    .142    .237    3.837    48.38    36.29
1/07/83   100    60.00      4TH PASS              61.0    32.0    4.3   166.66    .192   19.520    .117    .195    4.539    69.76    52.32
1/07/83   100    60.00      5TH PASS              61.0    45.0    8.2   166.65    .270   27.450    .164    .274    3.347    36.58    27.43
1/07/83   100    60.00      6TH PASS              61.0    34.0    5.4   166.66    .204   20.740    .124    .207    3.840    55.55    41.66
1/07/83   100    60.00      7TH PASS              61.0    33.0    3.2   166.65    .198   20.130    .120    .201    6.290    93.75    70.31
1/07/83   100    60.00      8TH PASS              61.0    24.0    3.2   166.66    .144   14.640    .087    .146    4.575    93.75    70.31
1/07/83   100    60.00      9TH PASS              61.0    20.0    2.4   166.66    .120   12.200    .073    .122    5.083   125.00    93.75
1/07/83   100    60.00   RUBBER 6609 1ST PASS     71.7    24.0    5.3   166.66    .144   17.208    .103    .172    3.246    56.60    42.45
1/07/83   100    60.00      2ND PASS              71.7    39.0    5.8   166.66    .234   27.963    .167    .279    4.821    51.72    38.79
1/07/83   100    60.00      3RD PASS              71.7    29.0    4.6   166.66    .174   20.793    .124    .207    4.520    65.21    48.91
1/07/83   100    60.00      4TH PASS              71.7    43.0    8.0   166.66    .258   30.831    .184    .308    3.853    37.50    28.12
1/07/83   100    60.00      5TH PASS              71.7    31.0    4.7   166.66    .186   22.227    .133    .222    4.729    63.82    47.87
1/07/83   100    60.00      6TH PASS              71.7    37.0    5.8   166.65    .222   26.529    .159    .265    4.573    51.72    38.79
1/07/83   100    60.00      7TH PASS              71.7    47.0    4.1   166.66    .282   33.699    .202    .336    8.219    73.17    54.87
1/07/83   100    60.00      8TH PASS              71.7    35.0    4.9   166.65    .210   25.095    .150    .250    5.121    61.22    45.91
1/07/83   100    60.00      9TH PASS              71.7    51.0    4.0   166.66    .306   36.567    .219    .365    9.141    75.00    56.25
1/07/83   100    60.00     10TH PASS              71.7    17.0    6.1   166.65    .102   12.189    .073    .121    1.998    49.18    36.88
1/07/83   100    60.00     11TH PASS              71.7    32.0    4.7   166.66    .192   22.944    .137    .229    4.881    63.82    47.87
1/07/83   100    60.00     12TH PASS              71.7    26.0    3.5   166.65    .156   18.642    .111    .186    5.326    85.71    64.28
1/07/83   100    60.00     13TH PASS              71.7    23.0    2.7   166.66    .138   16.491    .098    .164    6.107   111.11    83.33
1/07/83   100    60.00     14TH PASS              71.7    24.0    2.7   166.66    .144   17.208    .103    .172    6.373   111.11    83.33
1/07/83   100    60.00     15TH PASS              71.7    20.0    2.6   166.66    .120   14.340    .086    .143    5.515   115.38    86.53
1/07/83   100    60.00     16TH PASS              71.7    35.0    3.2   166.66    .210   25.095    .150    .250    7.842    93.75    70.31
1/07/83   100    60.00     17TH PASS              71.7    20.0    2.5   166.66    .120   14.340    .086    .143    5.736   120.00    90.00
1/07/83   100    60.00   TALC PASS                71.7    15.0    2.7   166.65    .090   10.755    .064    .107    3.983   111.11    83.33
                 TOTALS                                  887.0  134.7  4833.14    .183  599.106

TAL PASSES   29                                        MIN    2.4                         MIN    .045    .075    1.998    36.58    27.43
TAL PRODUCTION TIME 07:19:36                           MAX    8.2                         MAX    .219    .365    9.141   125.00    93.75
ERAGE LBS CEMENT PER PASS   30.586                     AVG    4.6                         AVG    .123    .206    4.767    72.74    54.55
ERAGE LBS CEMENT PER SQUARE YARD 5.322
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                DAVID M TOLUENE ANALYSIS                                                    PAGE 20

                                                    X                          CEM    TOLUENE     TOL      TOL       TOL      FEET     F/FEET
 DATE      LEN    WIDTH       DESCRIPTION          TOL    LBS   MINS  SQ YDS   SYD     USED       SYD      LYD       MIN      MIN       MIN

11/04/83   100    80.00   RUBBER 3492 1ST PASS    56.8   19.0   9.8  222.22  .085   10.792     .048     .107     1.101    30.61     30.61
11/04/83   100    80.00       2ND PASS            56.8   25.0   5.2  222.22  .112   14.200     .063     .142     2.730    57.69     57.69
11/04/83   100    80.00       3RD PASS            56.8   14.0   5.2  222.22  .063    7.952     .035     .079     1.529    57.69     57.69
11/04/83   100    80.00   RUBBER 7002 1ST PASS    57.1   37.0   5.8  222.22  .166   21.127     .095     .211     3.642    51.72     51.72
11/04/83   100    80.00       2ND PASS            57.1   47.0   5.1  222.22  .211   26.837     .120     .268     5.262    58.82     58.82
11/04/83   100    80.00       3RD PASS            57.1   33.0   3.5  222.22  .148   18.843     .084     .188     5.383    85.71     85.71
11/04/83   100    80.00       4TH PASS            57.1   45.0   5.2  222.22  .202   25.695     .115     .256     4.941    57.69     57.69
11/04/83   100    80.00       5TH PASS            57.1   49.0   3.9  222.22  .220   27.979     .125     .279     7.174    76.92     76.92
11/04/83   100    80.00       6TH PASS            57.1   31.0   4.1  222.22  .139   17.701     .079     .177     4.317    73.17     73.17
11/04/83   100    80.00       7TH PASS            57.1   29.0   3.1  222.22  .130   16.559     .074     .165     5.341    96.77     96.77
11/04/83   100    80.00       8TH PASS            57.1   48.0   4.4  222.22  .216   27.408     .123     .274     6.229    68.18     68.18
11/04/83   100    80.00   BLANKET 1ST PASS        57.1   48.0   5.9  222.22  .216   27.408     .123     .274     4.645    50.84     50.84
11/04/83   100    80.00       2ND PASS            57.1   37.0   3.5  222.22  .166   21.127     .095     .211     6.036    85.71     85.71
11/04/83   100    80.00       3RD PASS            57.1   28.0   3.5  222.22  .126   15.988     .071     .159     4.568    85.71     85.71
11/04/83   100    80.00       4TH PASS            57.1   25.0   3.3  222.22  .112   14.275     .064     .142     4.325    90.90     90.90
11/04/83   100    80.00   RUBBER 6607 1ST PASS    67.0   43.0   7.2  222.22  .193   28.810     .129     .288     4.001    41.66     41.66
11/04/83   100    80.00       2ND PASS            67.0   38.0   5.6  222.22  .171   25.460     .114     .254     4.546    53.57     53.57
11/04/83   100    80.00       3RD PASS            67.0   32.0   4.4  222.22  .144   21.440     .096     .214     4.872    68.18     68.18
11/04/83   100    80.00       4TH PASS            67.0   25.0   3.8  222.22  .112   16.750     .075     .167     4.407    78.94     78.94
11/04/83   100    80.00       5TH PASS            67.0   26.0   3.3  222.22  .117   17.420     .078     .174     5.278    90.90     90.90
11/04/83   100    80.00       6TH PASS            67.0   23.5   3.1  222.22  .105   15.745     .070     .157     5.079    96.77     96.77
11/04/83   100    80.00       7TH PASS            67.0   13.5   2.6  222.22  .060    9.045     .040     .090     3.478   115.38    115.38
11/04/83   100    80.00       8TH PASS            67.0   14.0   2.5  222.22  .063    9.380     .042     .093     3.752   120.00    120.00
11/04/83   100    80.00   TALC PASS               67.0         15.6  222.22                                                19.23     19.23
                         TOTALS                        730.0  104.0 5111.06  .142  437.941

TOTAL PASSES 23                                            MIN   2.5                   MIN    .035     .079     1.101    30.61     30.61
TOTAL PRODUCTION TIME 06:34:07                             MAX   9.8                   MAX    .129     .288     7.174   120.00    120.00
AVERAGE LBS CEMENT PER PASS  31.739                        AVG   4.5                   AVG    .085     .188     4.462    73.63     73.63
AVERAGE LBS CEMENT PER SQUARE YARD 3.285
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                    DAVID S TOLUENE ANALYSIS                                                      PAGE 19
                                                 %                                 CEM  TOLUENE    TOL     TOL      TOL    FEET   F/FEET
  DATE     LEN  WIDTH      DESCRIPTION          TOL    LBS   MINS   SQ YDS   SYD     USED     SYD     LYD      MIN     MIN     MIN
11/03/83  100   80.00  RUBBER 3492 1ST PASS    56.8   21.0   5.7   222.22  .094   11.928   .053    .119    2.092   52.63   52.63
11/03/83  100   80.00    2ND PASS              56.8   15.0   5.3   222.22  .067    8.520   .038    .085    1.607   56.60   56.60
11/03/83  100   80.00    3RD PASS              56.8   12.0   5.5   222.22  .054    6.816   .030    .068    1.239   54.54   54.54
11/03/83  100   80.00  RUBBER 7002 1ST PASS    57.1   49.0   5.9   222.22  .220   27.979   .125    .279    4.742   50.84   50.84
11/03/83  100   80.00    2ND PASS              57.1   34.0   3.9   222.22  .153   19.414   .087    .194    4.977   76.92   76.92
11/03/83  100   80.00    3RD PASS              57.1   31.0   3.0   222.22  .139   17.701   .079    .177    5.900  100.00  100.00
11/03/83  100   80.00    4TH PASS              57.1   23.0   2.8   222.22  .103   13.133   .059    .131    4.690  107.14  107.14
11/03/83  100   80.00    5TH PASS              57.1   20.0   2.9   222.22  .090   11.420   .051    .114    3.937  103.44  103.44
11/03/83  100   80.00    6TH PASS              57.1   44.0   4.7   222.22  .198   25.124   .113    .251    5.345   63.82   63.82
11/03/83  100   80.00    7TH PASS              57.1   32.0   3.3   222.22  .144   18.272   .082    .182    5.536   90.90   90.90
11/03/83  100   80.00    8TH PASS              57.1   25.0   2.5   222.22  .112   14.275   .064    .142    5.710  120.00  120.00
11/03/83  100   80.00    9TH PASS              57.1   20.0   2.2   222.22  .090   11.420   .051    .114    5.190  136.36  136.36
11/03/83  100   80.00    10TH PASS             57.1   28.0   2.5   222.22  .126   15.988   .071    .159    6.395  120.00  120.00
11/03/83  100   80.00  BLANKET 1ST PASS        57.1   12.0   2.4   222.22  .054    6.852   .030    .068    2.855  125.00  125.00
11/03/83  100   80.00    2ND PASS              57.1   17.0   3.2   222.22  .076    9.707   .043    .097    3.033   93.75   93.75
11/03/83  100   80.00  RUBBER 6609 1ST PASS    69.3   15.0   2.9   222.22  .067   10.395   .046    .103    3.584  103.44  103.44
11/03/83  100   80.00    2ND PASS              69.3   15.0   2.4   222.22  .067   10.395   .046    .103    4.331  125.00  125.00
11/03/83  100   80.00    3RD PASS              69.3   24.0   3.3   222.22  .108   16.632   .074    .166    5.040   90.90   90.90
1/03/83   100   80.00    4TH PASS              69.3   24.0   3.1   222.22  .108   16.632   .074    .166    5.365   96.77   96.77
1/03/83   100   80.00    5TH PASS              69.3   22.0   2.9   222.22  .099   15.246   .068    .152    5.257  103.44  103.44
1/03/83   100   80.00    6TH PASS              69.3   40.0   4.5   222.22  .180   27.720   .124    .277    6.160   66.66   66.66
1/03/83   100   80.00    7TH PASS              69.3   31.0   4.9   222.22  .139   21.483   .096    .214    4.384   61.22   61.22
1/03/83   100   80.00    8TH PASS              69.3   32.0   4.0   222.22  .144   22.176   .099    .221    5.544   75.00   75.00
1/03/83   100   80.00    9TH PASS              69.3   27.0   2.9   222.22  .121   18.711   .084    .187    6.452  103.44  103.44
1/03/83   100   80.00    10TH PASS             69.3   19.0   4.8   222.22  .085   13.167   .059    .131    2.743   62.50   62.50
1/03/83   100   80.00    11TH PASS             69.3   21.0   4.0   222.22  .094   14.553   .065    .145    3.638   75.00   75.00
1/03/83   100   80.00    12TH PASS             69.3   26.0   3.2   222.22  .117   18.018   .081    .180    5.630   93.75   93.75
1/03/83   100   80.00    13TH PASS             69.3   19.0   3.7   222.22  .085   13.167   .059    .131    3.558   81.08   81.08
1/03/83   100   80.00  TALC PASS               69.3   20.0  14.7   222.22  .090   13.860   .062    .138     .942   20.40   20.40
                   TOTALS                            698.0 102.4  6222.16  .112  436.844

OTAL PASSES  28                                         MIN   2.2                     MIN   .030    .068    1.239   50.84   50.84
OTAL PRODUCTION TIME 07:39:25                           MAX   5.9                     MAX   .125    .279    6.452  136.36  136.36
VERAGE LBS CEMENT PER PASS   24.928                     AVG   3.6                     AVG   .069    .155    4.461   88.93   88.93
VERAGE LBS CEMENT PER SQUARE YARD 3.141
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                          DAVID M TOLUENE ANALYSIS                                                    PAGE 18

                                                      %                                 CEM   TOLUENE     TOL       TOL        TOL       FEET     F/FEET
 DATE     LEN   WIDTH       DESCRIPTION              TOL     LBS   MINS   SQ YDS    SYD     USED      SYD       LYD        MIN       MIN       MIN
11/02/83  100   80.00  RUBBER 8492 1ST PASS         56.8    24.0   6.0   222.22   .108    13.632    .061      .136      2.272     50.00     50.00
11/02/83  100   80.00      2ND PASS                 56.8    15.0   4.6   222.22   .067     8.520    .038      .085      1.852     65.21     65.21
11/02/83  100   80.00      3RD PASS                 56.8    13.0   3.9   222.22   .058     7.384    .033      .073      1.893     76.92     76.92
11/02/83  100   80.00  RUBBER 7002 1ST PASS         62.7    13.0   5.6   222.22   .058     8.151    .036      .081      1.455     53.57     53.57
11/02/83  100   80.00      2ND PASS                 62.7    13.0   3.3   222.22   .058     8.151    .036      .081      2.470     90.90     90.90
11/02/83  100   80.00      3RD PASS                 62.7    32.0   4.2   222.22   .144    20.064    .090      .200      4.777     71.42     71.42
11/02/83  100   80.00      4TH PASS                 62.7    25.0   5.1   222.22   .112    15.675    .070      .156      3.073     58.82     58.82
11/02/83  100   80.00      5TH PASS                 62.7     7.0   5.1   222.22   .031     4.389    .019      .043       .860     58.82     58.82
11/02/83  100   80.00      6TH PASS                 62.7    50.0   5.6   222.22   .225    31.350    .141      .313      5.598     53.57     53.57
11/02/83  100   80.00      7TH PASS                 62.7    40.0   4.6   222.22   .180    25.080    .112      .250      5.452     65.21     65.21
11/02/83  100   80.00      8TH PASS                 62.7    37.0   2.9   222.22   .166    23.199    .104      .231      7.999    103.44    103.44
11/02/83  100   80.00      9TH PASS                 62.7    28.0   2.6   222.22   .126    17.556    .079      .175      6.752    115.38    115.38
11/02/83  100   80.00     10TH PASS                 62.7    50.0   3.4   222.22   .225    31.350    .141      .313      9.220     88.23     88.23
11/02/83  100   80.00     11TH PASS                 62.7    38.0   3.4   222.22   .171    23.826    .107      .238      7.007     88.23     88.23
11/02/83  100   80.00     12TH PASS                 62.7  [illegible] 4.2 222.22 [illegible] [illegible] [illegible] [illegible] [illegible] 71.42 71.42
11/02/83  100   80.00     13TH PASS                 62.7    28.0   2.7   222.22   .126    17.556    .079      .175      6.502    111.11    111.11
11/02/83  100   80.00     14TH PASS                 62.7    25.0   2.8   222.22   .112    15.675    .070      .156      5.598    107.14    107.14
11/02/83  100   80.00  BLANKET 1ST PASS             62.7    25.0   3.8   222.22   .112    15.675    .070      .156      4.125     78.94     78.94
11/02/83  100   80.00  RUBBER 5503 1ST PASS         64.2    22.0   3.1   222.22   .099    14.124    .063      .141      4.556     96.77     96.77
11/02/83  100   80.00      2ND PASS                 64.2    23.0   2.8   222.22   .103    14.766    .066      .147      5.273    107.14    107.14
11/02/83  100   80.00      3RD PASS                 64.2    35.0   5.2   222.22   .157    22.470    .101      .224      4.321     57.69     57.69
11/02/83  100   80.00      4TH PASS                 64.2    19.0   3.5   222.22   .085    12.198    .054      .121      3.485     85.71     85.71
11/02/83  100   80.00      5TH PASS                 64.2    33.0   4.3   222.22   .148    21.186    .095      .211      4.926     69.76     69.76
11/02/83  100   80.00      6TH PASS                 64.2    28.0   4.8   222.22   .126    17.976    .080      .179      3.745     62.50     62.50
11/02/83  100   80.00      7TH PASS                 64.2    17.0   2.5   222.22   .076    10.914    .049      .109      4.365    120.00    120.00
11/02/83  100   80.00      8TH PASS                 64.2    22.0   3.0   222.22   .099    14.124    .063      .141      4.708    100.00    100.00
11/02/83  100   80.00  TALC PASS                    64.2    21.0  16.5   222.22   .094    13.482    .060      .134       .817     48.18     48.18
                   TOTALS                                  662.0 103.0  5777.72   .114   414.991

OTAL PASSES  26                                             MIN   2.5                  MIN      .049      .109      3.485     50.00     50.00
OTAL PRODUCTION TIME 07:00:04                               MAX   6.0                  MAX      .141      .313      9.220    120.00    120.00
VERAGE LBS CEMENT PER PASS  25.461                          AVG   3.9                  AVG      .071      .159      4.318     81.07     81.07
VERAGE LBS CEMENT PER SQUARE YARD 2.979
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                    DAVID M TOLUENE ANALYSIS                                                 PAGE 17
                                                 %                                  CEM   TOLUENE    TOL     TOL      TOL     FEET   F/FEET
 DATE     LEN  WIDTH      DESCRIPTION           TOL     LBS    MINS   SQ YDS   SYD    USED      SYD     LYD      MIN      MIN     MIN
11/01/83  100   80.00 RUBBER 1492 1ST PASS      59.6    31.0    5.9   222.22  .139   18.476    .083    .184    3.131    50.84    50.84
11/01/83  100   80.00    2ND PASS               59.6    17.0    4.1   222.22  .076   10.132    .045    .101    2.471    73.17    73.17
11/01/83  100   80.00    3RD PASS               59.6    14.0    4.0   222.22  .063    8.344    .037    .083    2.086    75.00    75.00
 1/01/83  100   80.00 RUBBER 7002 1ST PASS      62.7    27.0    4.3   222.22  .121   16.929    .076    .169    3.936    69.76    69.76
11/01/83  100   80.00    2ND PASS               62.7    29.0    3.0   222.22  .130   18.183    .081    .181    6.061   100.00   100.00
 1/01/83  100   80.00    3RD PASS               62.7    41.0    3.3   222.22  .184   25.707    .115    .257    7.790    90.90    90.90
11/01/83  100   80.00    4TH PASS               62.7    33.0    3.3   222.22  .148   20.691    .093    .206    6.270    90.90    90.90
 1/01/83  100   80.00    5TH PASS               62.7    47.0    4.8   222.22  .211   29.469    .132    .294    6.139    62.50    62.50
 1/01/83  100   80.00    6TH PASS               62.7    39.0    4.6   222.22  .175   24.453    .110    .244    5.315    65.21    65.21
 1/01/83  100   80.00    7TH PASS               62.7    36.0    2.7   222.22  .162   22.572    .101    .225    8.360   111.11   111.11
 1/01/83  100   80.00    8TH PASS               62.7    26.0    2.4   222.22  .117   16.302    .073    .163    6.792   125.00   125.00
 1/01/83  100   80.00    9TH PASS               62.7    26.0    2.1   222.22  .117   16.302    .073    .163    7.762   142.85   142.85
 1/01/83  100   80.00   10TH PASS               62.7    40.0    3.1   222.22  .180   25.080    .112    .250    8.090    96.77    96.77
 1/01/83  100   80.00   11TH PASS               62.7    31.0    1.7   222.22  .139   19.437    .087    .194   11.433   176.47   176.47
 1/01/83  100   80.00   12TH PASS               62.7    22.0    2.6   222.22  .099   13.794    .062    .137    5.305   115.38   115.38
 1/01/83  100   80.00   13TH PASS               62.7    62.0    4.0   222.22  .279   38.874    .174    .388    9.718    75.00    75.00
 1/01/83  100   80.00   14TH PASS               62.7    50.0    3.8   222.22  .225   31.350    .141    .313    8.250    78.94    78.94
 1/01/83  100   80.00 RUBBER 7002 1ST PASS      62.7    32.0    5.1   222.22  .144   20.064    .090    .200    3.934    58.82    58.82
 1/01/83  100   80.00    2ND PASS               62.7    24.0    3.7   222.22  .108   15.048    .067    .150    4.067    81.08    81.08
 1/01/83  100   80.00    3RD PASS               62.7    26.0    2.7   222.22  .117   16.302    .073    .163    6.037   111.11   111.11
 1/01/83  100   80.00    4TH PASS               62.7    19.0    2.7   222.22  .085   11.913    .053    .119    4.412   111.11   111.11
 1/01/83  100   80.00 RUBBER 5503 1ST PASS      64.2    22.0    3.5   222.22  .099   14.124    .063    .141    4.035    85.71    85.71
 1/01/83  100   80.00    2ND PASS               64.2    44.0    4.0   222.22  .198   28.248    .127    .282    7.062    75.00    75.00
 1/01/83  100   80.00    3RD PASS               64.2    31.0    3.5   222.22  .139   19.902    .089    .199    5.686    85.71    85.71
 1/01/83  100   80.00    4TH PASS               64.2    29.0    3.6   222.22  .130   18.618    .083    .186    5.171    83.33    83.33
 1/01/83  100   80.00    5TH PASS               64.2    39.0    3.6   222.22  .175   25.038    .112    .250    6.955    83.33    83.33
 1/01/83  100   80.00 RUBBER 5503 1ST PASS      64.2    20.0    2.9   222.22  .090   12.840    .057    .128    4.427   103.44   103.44
 1/01/83  100   80.00 TALC PASS                 64.2    20.0   16.7   222.22  .090   12.840    .057    .128     .768    17.96    17.96
 1/01/83  195   65.00 RUBBER 1492 1ST PASS      59.6    95.0   29.2   352.07  .269   56.620    .160    .290    1.939    20.03    16.27
 1/01/83  195   65.00 RUBBER 106 1ST PASS       70.4    64.0   18.1   352.07  .181   45.056    .127    .231    2.489    32.32    26.26
 1/01/83  195   65.00    2ND PASS               70.4    73.0   24.4   352.07  .207   51.392    .145    .263    2.106    23.97    19.46
 1/01/83  195   65.00    3RD PASS               70.4    97.0   33.6   352.07  .275   68.288    .193    .350    2.032    17.41    14.14
 1/01/83  195   65.00 TALC PASS                 70.4    74.0   26.3   352.07  .210   52.096    .147    .267    1.980    22.24    18.07
                 TOTALS                               1186.0  200.3  7408.22  .160  759.548

OTAL PASSES  31                                     MIN   1.7                     MIN    .037    .083    1.939    17.41    14.14
OTAL PRODUCTION TIME 10:27:03                       MAX  33.6                     MAX    .193    .388   11.433   176.47   176.47
VERAGE LBS CEMENT PER PASS  38.258                  AVG   6.4                     AVG    .097    .209    5.460    82.97    82.40
VERAGE LBS CEMENT PER SQUARE YARD 3.368
```

```
RUN ON 01/23/84 AT 14:11:22                        DAVID M TOLUENE ANALYSIS                                                PAGE 16

                                                    %                            CEM   TOLUENE     TOL      TOL        TOL     FEET    F/FEET
  DATE     LEN   WIDTH      DESCRIPTION            TOL     LBS    MINS  SQ YDS   SYD     USED      SYD      LYD        MIN      MIN      MIN

10/31/83    70   80.00   RUBBER 1492 1ST PASS     59.6    22.0    5.3  155.55  .141    13.112    .084     .187      2.473    39.62    39.62
10/31/83    70   80.00      2ND PASS              59.6    13.0    3.9  155.55  .083     7.748    .049     .110      1.986    53.84    53.84
10/31/83    70   80.00      3RD PASS              59.6    11.0    3.3  155.55  .070     6.556    .042     .093      1.986    63.63    63.63
10/31/83    70   80.00   RUBBER 7007 1ST PASS     60.5    29.0    4.6  155.55  .186    17.545    .112     .250      3.814    45.65    45.65
10/31/83    70   80.00      2ND PASS              60.5    28.0    2.8  155.55  .180    16.940    .108     .242      6.050    75.00    75.00
10/31/83    70   80.00      3RD PASS              60.5    36.0    3.5  155.55  .231    21.780    .140     .311      6.222    60.00    60.00
10/31/83    70   80.00      4TH PASS              60.5    34.0    4.6  155.55  .218    20.570    .132     .293      4.471    45.65    45.65
10/31/83    70   80.00      5TH PASS              60.5    28.0    3.3  155.55  .180    16.940    .108     .242      5.133    63.63    63.63
10/31/83    70   80.00      6TH PASS              60.5    26.0    2.3  155.55  .167    15.730    .101     .224      6.839    91.30    91.30
10/31/83    70   80.00      7TH PASS              60.5    44.0    4.2  155.55  .282    26.620    .171     .380      6.338    50.00    50.00
10/31/83    70   80.00      8TH PASS              60.5    46.0    6.1  155.55  .295    27.830    .178     .397      4.562    34.42    34.42
10/31/83    70   80.00      9TH PASS              60.5    29.0    2.8  155.55  .186    17.545    .112     .250      6.266    75.00    75.00
10/31/83    70   80.00      10TH PASS             60.5    21.0    2.5  155.55  .135    12.705    .081     .181      5.082    84.00    84.00
10/31/83    70   80.00      11TH PASS             60.5    41.0    3.7  155.55  .263    24.805    .159     .354      6.704    56.75    56.75
10/31/83    70   80.00      12TH PASS             60.5    31.0    2.5  155.55  .199    18.755    .120     .267      7.502    84.00    84.00
10/31/83    70   80.00      13TH PASS             60.5    20.0    3.1  155.55  .128    12.100    .077     .172      3.903    67.74    67.74
10/31/83    70   80.00   RUBBER 7002 1ST PASS     60.5    11.0    2.6  155.55  .070     6.655    .042     .095      2.559    80.76    80.76
10/31/83    70   80.00      2ND PASS              60.5    11.0    2.1  155.55  .070     6.655    .042     .095      3.169   100.00   100.00
10/31/83    70   80.00   RUBBER 5503 1ST PASS     64.8    41.0    5.2  155.55  .263    26.568    .170     .379      5.109    40.38    40.38
10/31/83    70   80.00      2ND PASS              64.8    34.0    4.3  155.55  .218    22.032    .141     .314      5.123    48.83    48.83
10/31/83    70   80.00      3RD PASS              64.8    23.0    2.6  155.55  .147    14.904    .095     .212      5.732    80.76    80.76
10/31/83    70   80.00      4TH PASS              64.8    23.0    2.4  155.55  .147    14.904    .095     .212      6.210    87.50    87.50
10/31/83    70   80.00      5TH PASS              64.8    20.0    3.0  155.55  .128    12.960    .083     .185      4.320    70.00    70.00
10/31/83    70   80.00      6TH PASS              64.8    16.0    2.2  155.55  .102    10.368    .066     .148      4.712    95.45    95.45
10/31/83    70   80.00      7TH PASS              64.8    18.0    2.2  155.55  .115    11.664    .074     .166      5.301    95.45    95.45
10/31/83    70   80.00   TALC PASS                64.8    16.0   10.1  155.55  .102    10.368    .066     .148      1.026    20.79    20.79
                 TOTALS                                  656.0   85.1 3888.75  .168   403.991

TOTAL PASSES  25                                   MIN    2.1                   MIN      .042     .093      1.986    34.42    34.42
TOTAL PRODUCTION TIME 05:44:30                     MAX    6.1                   MAX      .178     .397      7.502   100.00   100.00
AVERAGE LBS CEMENT PER PASS  26.240                AVG    3.4                   AVG      .103     .230      4.062    67.57    67.57
AVERAGE LBS CEMENT PER SQUARE YARD 4.217
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                    DAVID W TOLUENE ANALYSIS                                        PAGE 15

                                                 %                                  CEM   TOLUENE     TOL      TOL       TOL      FEET     F/FEET
 DATE      LEN   WIDTH        DESCRIPTION       TOL     LBS    MINS   SQ YDS   SYD     USED       SYD      LYD       MIN      MIN       MIN

10/27/83   100   80.00   RUBBER 1492 1ST PASS   57.2    25.0    5.3   222.22  .112   14.300     .064     .143     2.698    56.60     56.60
10/27/83   100   80.00       2ND PASS           57.2    18.0    4.2   222.22  .081   10.296     .046     .102     2.451    71.42     71.42
10/27/83   100   80.00       3RD PASS           57.2    13.0    3.9   222.22  .058    7.436     .033     .074     1.906    76.92     76.92
10/27/83   100   80.00   RUBBER 7002 1ST PASS   58.5    15.0    4.3   222.22  .067    8.775     .039     .087     2.040    69.76     69.76
10/27/83   100   80.00       2ND PASS           58.5    21.0    5.1   222.22  .094   12.285     .055     .122     2.408    58.82     58.82
10/27/83   100   80.00       3RD PASS           58.5    35.0   12.3   222.22  .157   20.475     .092     .204     1.664    24.39     24.39
10/27/83   100   80.00       4TH PASS           58.5    27.0    4.3   222.22  .121   15.795     .071     .157     3.673    69.76     69.76
10/27/83   100   80.00       5TH PASS           58.5    24.0    3.5   222.22  .108   14.040     .063     .140     4.011    85.71     85.71
10/27/83   100   80.00       6TH PASS           58.5    20.0    2.5   222.22  .090   11.700     .052     .117     4.680   120.00    120.00
10/27/83   100   80.00       7TH PASS           58.5    19.0    3.9   222.22  .085   11.115     .050     .111     2.850    76.92     76.92
10/27/83   100   80.00       8TH PASS           58.5    32.0    3.5   222.22  .144   18.720     .084     .187     5.348    85.71     85.71
10/27/83   100   80.00       9TH PASS           58.5    26.0    5.2   222.22  .117   15.210     .068     .152     2.925    57.69     57.69
10/27/83   100   80.00      10TH PASS           58.5    40.0    3.9   222.22  .180   23.400     .105     .234     6.000    76.92     76.92
10/27/83   100   80.00      11TH PASS           58.5    25.0    3.1   222.22  .112   14.625     .065     .146     4.717    96.77     96.77
10/27/83   100   80.00      12TH PASS           58.5    13.0    2.4   222.22  .058    7.605     .034     .076     3.168   125.00    125.00
10/27/83   100   80.00      13TH PASS           58.5    32.0    1.8   222.22  .144   18.720     .084     .187    10.400   166.66    166.66
10/27/83   100   80.00      14TH PASS           58.5    24.0    2.1   222.22  .108   14.040     .063     .140     6.685   142.85    142.85
10/27/83   100   80.00      15TH PASS           58.5    22.0    2.0   222.22  .099   12.870     .057     .128     6.435   150.00    150.00
10/27/83   100   80.00      16TH PASS           58.5    10.0    3.8   222.22  .045    5.850     .026     .058     1.539    78.94     78.94
10/27/83   100   80.00   RUBBER 6609 1ST PASS   65.6    10.0    3.4   222.22  .045    6.560     .029     .065     1.929    88.23     88.23
10/27/83   100   80.00       2ND PASS           65.6    17.0    4.1   222.22  .076   11.152     .050     .111     2.720    73.17     73.17
10/27/83   100   80.00       3RD PASS           65.6    16.0    3.2   222.22  .072   10.496     .047     .104     3.280    93.75     93.75
10/27/83   100   80.00       4TH PASS           65.6    18.0    2.5   222.22  .081   11.808     .053     .118     4.723   120.00    120.00
10/27/83   100   80.00       5TH PASS           65.6    15.0    2.1   222.22  .067    9.840     .044     .098     4.685   142.85    142.85
10/27/83   100   80.00       6TH PASS           65.6    32.0    4.2   222.22  .144   20.992     .094     .209     4.998    71.42     71.42
10/27/83   100   80.00       7TH PASS           65.6    25.0    3.1   222.22  .112   16.400     .073     .164     5.290    96.77     96.77
10/27/83   100   80.00       8TH PASS           65.6    23.0    2.7   222.22  .103   15.088     .067     .150     5.588   111.11    111.11
 0/27/83   100   80.00       9TH PASS           65.6    18.0    4.1   222.22  .081   11.808     .053     .118     2.880    73.17     73.17
 0/27/83   100   80.00      10TH PASS           65.6    19.0    2.6   222.22  .085   12.464     .056     .124     4.793   115.38    115.38
 0/27/83   100   80.00      11TH PASS           65.6    16.0    1.9   222.22  .072   10.496     .047     .104     5.524   157.89    157.89
 0/27/83   100   80.00      12TH PASS           65.6    15.5    2.1   222.22  .069   10.168     .045     .101     4.841   142.85    142.85
 0/27/83   100   80.00      13TH PASS           65.6    14.5    1.7   222.22  .065    9.512     .042     .095     5.595   176.47    176.47
 0/27/83   100   80.00      14TH PASS           65.6    28.0    3.1   222.22  .126   18.368     .082     .183     5.925    96.77     96.77
 0/27/83   100   80.00      15TH PASS           65.6    27.5    2.7   222.22  .123   18.040     .081     .180     6.681   111.11    111.11
 0/27/83   100   80.00      16TH PASS           65.6    20.5    2.5   222.22  .092   13.448     .060     .134     5.379   120.00    120.00
 0/27/83   100   80.00      17TH PASS           65.6     9.5    1.9   222.22  .042    6.232     .028     .062     3.280   157.89    157.89
 0/27/83   100   80.00      18TH PASS           65.6     9.5    2.1   222.22  .042    6.232     .028     .062     2.967   142.85    142.85
 0/27/83   100   80.00      19TH PASS           65.6     8.5    2.5   222.22  .038    5.576     .025     .055     2.230   120.00    120.00
 0/27/83   100   80.00      20TH PASS           65.6    11.5    2.6   222.22  .051    7.544     .033     .075     2.901   115.38    115.38
 0/27/83   100   80.00      21ST PASS           65.6    12.5    1.8   222.22  .056    8.200     .036     .082     4.555   166.66    166.66
 0/27/83   100   80.00      22ND PASS           65.6    11.5    1.8   222.22  .051    7.544     .033     .075     4.191   166.66    166.66
 0/27/83   100   80.00      23RD PASS           65.6    14.0    3.1   222.22  .063    9.184     .041     .091     2.962    96.77     95.77
 0/27/83   100   80.00      24TH PASS           65.6    13.0    2.5   222.22  .058    8.528     .038     .085     3.411   120.00    120.00
 0/27/83   100   80.00      25TH PASS           65.6    14.0    1.6   222.22  .063    9.184     .041     .091     5.740   187.50    187.50
 0/27/83   100   80.00      26TH PASS           65.6    13.5    1.6   222.22  .060    8.856     .039     .088     5.535   187.50    187.50
 0/27/83   100   80.00      27TH PASS           65.6    11.5    2.0   222.22  .051    7.544     .033     .075     3.772   150.00    150.00
 0/27/83   100   80.00      28TH PASS           65.6    11.0    1.8   222.22  .049    7.216     .032     .072     4.008   166.66    166.66
 0/27/83   100   80.00      29TH PASS           65.6    11.0    2.3   222.22  .049    7.216     .032     .072     3.137   130.43    130.43
 0/27/83   100   80.00   TALC PASS              65.6     9.5   15.3   222.22  .042    6.232     .028     .062      .407    19.60     19.60
                    TOTALS                             907.0  150.7   666.56  .999  562.953

OTAL PASSES   48                                     MIN   1.6                  MIN      .025     .055     1.539    24.39     24.39
OTAL PRODUCTION TIME 09:41:49                        MAX  12.3                  MAX      .105     .234    10.400   187.50    187.50
VERAGE LBS CEMENT PER PASS   18.895                  AVG   3.1                  AVG      .052     .116     4.148   112.29    112.29
VERAGE LBS CEMENT PER SQUARE YARD 4.081
```

```
UN ON 01/23/84 AT 14:11:22                          DAVID M TOLUENE ANALYSIS                                      PAGE 14

                                                 %                                CEM  TOLUENE      TOL      TOL      TOL     FEET   F/FEET
 DATE     LEN   WIDTH       DESCRIPTION         TOL    LBS    MINS   SQ YDS    SYD     USED        SYD      LYD      MIN      MIN      MIN

0/26/83   100   80.00   RUBBER 1492 1ST PASS   57.2   25.0    4.1   222.22   .112   14.300      .064     .143    3.487    73.17    73.17
10/26/83  100   80.00       2ND PASS           57.2   20.0    2.5   222.22   .090   11.440      .051     .114    4.576   120.00   120.00
0/26/83   100   80.00       3RD PASS           57.2   16.0    3.2   222.22   .072    9.152      .041     .091    2.860    93.75    93.75
10/26/83  100   80.00   RUBBER 7002 1ST PASS   58.5   64.0   10.4   222.22   .288   37.440      .168     .374    3.600    28.84    28.84
0/26/83   100   80.00       2ND PASS           58.5   47.0    5.5   222.22   .211   27.495      .123     .274    4.999    54.54    54.54
10/26/83  100   80.00       3RD PASS           58.5   77.0    5.5   222.22   .346   45.045      .202     .450    8.190    54.54    54.54
0/26/83   100   80.00       4TH PASS           58.5   10.0    5.3   222.22   .045    5.850      .026     .058    1.103    56.60    56.60
0/26/83   100   80.00       5TH PASS           58.5   33.0    4.5   222.22   .148   19.305      .086     .193    4.290    66.66    66.66
0/26/83   100   80.00       6TH PASS           58.5   50.0    4.4   222.22   .225   29.250      .131     .292    6.647    68.18    68.18
0/26/83   100   80.00       7TH PASS           58.5   37.0    4.0   222.22   .166   21.645      .097     .216    5.411    75.00    75.00
0/26/83   100   80.00       8TH PASS           58.5   27.0    2.8   222.22   .121   15.795      .071     .157    6.641   107.14   107.14
0/26/83   100   80.00   RUBBER 7002 1ST PASS   58.5   28.0    2.8   222.22   .126   16.380      .073     .163    5.850   107.14   107.14
0/26/83   100   80.00       2ND PASS           58.5   26.0    2.1   222.22   .117   15.210      .068     .152    7.242   142.85   142.85
0/26/83   100   80.00   RUBBER 6609 1ST PASS   69.6   53.0    6.2   222.22   .238   36.888      .165     .368    5.949    48.38    48.38
0/26/83   100   80.00       2ND PASS           69.6   32.0    3.7   222.22   .144   22.272      .100     .222    6.019    81.08    81.08
0/26/83   100   80.00       3RD PASS           69.6   31.0    3.1   222.22   .139   21.576      .097     .215    6.960    96.77    96.77
0/26/83   100   80.00       4TH PASS           69.6   27.0    2.7   222.22   .121   18.792      .084     .187    6.960   111.11   111.11
0/26/83   100   80.00       5TH PASS           69.6   28.0    3.1   222.22   .126   19.488      .087     .194    6.286    96.77    96.77
0/26/83   100   80.00       6TH PASS           69.6   18.0    2.3   222.22   .081   12.528      .056     .125    5.446   130.43   130.43
0/26/83   100   80.00       7TH PASS           69.6   19.0    3.3   222.22   .085   13.224      .059     .132    4.007    90.90    90.90
0/26/83   100   80.00       8TH PASS           69.6   18.0    2.5   222.22   .081   12.528      .056     .125    5.011   120.00   120.00
0/26/83   100   80.00       9TH PASS           69.6   15.0    2.7   222.22   .067   15.440      .046     .104    3.866   111.11   111.11
                  TOTALS                             701.0   86.7  4888.84   .143  436.043

OTAL PASSES  22                                        MIN    2.1                      MIN      .026     .058    1.103    28.84    28.84
OTAL PRODUCTION TIME 05:44:25                          MAX   10.4                      MAX      .202     .450    8.190   142.85   142.85
VERAGE LBS CEMENT PER PASS  31.863                     AVG    5.9                      AVG      .088     .197    6.260    87.95    87.95
VERAGE LBS CEMENT PER SQUARE YARD 3.154
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                         DAVID M TOLUENE ANALYSIS                                                PAGE 13

                                                   %                                CEM   TOLUENE     TOL      TOL       TOL      FEET    F/FEET
  DATE     LEN   WIDTH      DESCRIPTION           TOL     LBS    MINS   SQ YDS     SYD    USED       SYD      LYD       MIN      MIN      MIN

10/25/83   100   80.00  RUBBER 1492 1ST PASS      57.2    30.0   13.1   222.22    .135   17.160     .077     .171     1.309    22.90    22.90
10/25/83   100   80.00      2ND PASS              57.2    14.0    4.3   222.22    .063    8.008     .036     .080     1.862    69.76    69.76
10/25/83   100   80.00      3RD PASS              57.2    23.0    3.8   222.22    .103   13.156     .059     .131     3.462    78.94    78.94
10/25/83   100   80.00  RUBBER 7002 1ST PASS      58.2    44.0    7.2   222.22    .198   25.608     .115     .256     3.556    41.66    41.66
10/25/83   100   80.00      2ND PASS              58.2    48.0    8.1   222.22    .216   27.936     .125     .279     3.448    37.03    37.03
10/25/83   100   80.00      3RD PASS              58.2    49.0    4.9   222.22    .220   28.518     .128     .285     5.820    61.22    61.22
10/25/83   100   80.00      4TH PASS              58.2    33.0    3.3   222.22    .148   19.206     .086     .192     5.820    90.90    90.90
10/25/83   100   80.00      5TH PASS              58.2    51.0    4.4   222.22    .229   29.682     .133     .296     6.745    68.18    68.18
10/25/83   100   80.00      6TH PASS              58.2    39.0    4.7   222.22    .175   22.698     .102     .226     4.829    63.82    63.82
10/25/83   100   80.00      7TH PASS              58.2    78.0    4.1   222.22    .351   45.396     .204     .453    11.072    73.17    73.17
10/25/83   100   80.00      8TH PASS              58.2    37.0    3.5   222.22    .166   21.534     .096     .215     6.152    85.71    85.71
10/25/83   100   80.00      9TH PASS              58.2    19.0    2.8   222.22    .085   11.058     .049     .110     3.949   107.14   107.14
10/25/83   100   80.00  RUBBER 7002 1ST PASS      69.0    24.0    4.7   222.22    .108   16.560     .074     .165     3.523    63.82    63.82
10/25/83   100   80.00      2ND PASS              69.0    23.0    4.4   222.22    .103   15.870     .071     .158     3.606    68.18    68.18
10/25/83   100   80.00      3RD PASS              69.0    18.0    2.4   222.22    .081   12.420     .055     .124     5.175   125.00   125.00
10/25/83   100   80.00      4TH PASS              69.0    18.0    2.1   222.22    .081   12.420     .055     .124     5.914   142.85   142.85
10/25/83   100   80.00      5TH PASS              69.0    19.0    2.0   222.22    .085   13.110     .058     .131     6.555   150.00   150.00
10/25/83   100   80.00      6TH PASS              69.0    16.0    1.8   222.22    .072   11.040     .049     .110     6.133   166.66   166.66
10/25/83   100   80.00      7TH PASS              69.0    30.0    4.1   222.22    .135   20.700     .093     .207     5.048    73.17    73.17
10/25/83   100   80.00      8TH PASS              69.0    28.0    2.6   222.22    .126   19.320     .086     .193     7.430   115.38   115.38
10/25/83   100   80.00      9TH PASS              69.0    18.0    2.2   222.22    .081   12.420     .055     .124     5.645   136.36   136.36
10/25/83   100   80.00     10TH PASS              69.0    15.0    2.2   222.22    .067   10.350     .046     .103     4.704   136.36   136.36
10/25/83   100   80.00     11TH PASS              69.0    15.0    2.0   222.22    .067   10.350     .046     .103     5.175   150.00   150.00
10/25/83   100   80.00     12TH PASS              69.0    14.0    3.6   222.22    .063    9.560     .043     .096     2.683    83.33    83.33
10/25/83   100   80.00     13TH PASS              69.0    11.0    2.4   222.22    .049    7.590     .034     .075     3.162   125.00   125.00
10/25/83   100   80.00     14TH PASS              69.0    17.0    2.7   222.22    .076   11.730     .052     .117     4.344   111.11   111.11
                 TOTALS                                  731.0  103.4  5777.72    .126  453.500

TOTAL PASSES  26                                         MIN   1.0                       MIN     .034     .075     1.309    22.90    22.90
TOTAL PRODUCTION TIME 06:37:35                           MAX  13.1                       MAX     .204     .453    11.072   166.66   166.66
AVERAGE LBS CEMENT PER PASS  28.115                      AVG   3.9                       AVG     .077     .170     4.889    94.14    94.14
AVERAGE LBS CEMENT PER SQUARE YARD 3.289
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                         DAVID M TOLUENE ANALYSIS                                                  PAGE 12

                                              %                               CEM   TOLUENE     TOL      TOL       TOL      FEET    F/FEET
 DATE    LEN   WIDTH      DESCRIPTION        TOL     LBS    MINS   SQ YDS    SYD     USED       SYD      LYD       MIN      MIN      MIN

10/24/83  100   80.00  RUBBER 1492 1ST PASS  57.2    26.0    9.9  222.22   .117    14.872     .066     .148     1.502    30.30    30.30
0/24/83   100   80.00      2ND PASS          57.2    29.0    7.2  222.22   .130    16.588     .074     .165     2.303    41.66    41.66
0/24/83   100   80.00      3RD PASS          57.2    19.0    5.6  222.22   .085    10.868     .048     .108     1.940    53.57    53.57
0/24/83   100   80.00  RUBBER 7002 1ST PASS  59.8    45.0    7.2  222.22   .202    26.910     .121     .269     3.737    41.66    41.66
0/24/83   100   80.00      2ND PASS          59.8    42.0    5.2  222.22   .189    25.116     .113     .251     4.830    57.69    57.69
0/24/83   100   80.00      3RD PASS          59.8    40.0    4.4  222.22   .180    23.920     .107     .239     5.436    68.18    68.18
0/24/83   100   80.00      4TH PASS          59.8    48.0    4.9  222.22   .216    28.704     .129     .287     5.857    61.22    61.22
0/24/83   100   80.00      5TH PASS          59.8    42.0    4.2  222.22   .189    25.116     .113     .251     5.980    71.42    71.42
0/24/83   100   80.00      6TH PASS          58.2    44.0    3.3  222.22   .198    25.608     .115     .256     7.760    90.90    90.90
0/24/83   100   80.00      7TH PASS          58.2    36.0    4.1  222.22   .162    20.952     .094     .209     5.110    73.17    73.17
0/24/83   100   80.00      8TH PASS          58.2    27.0    3.4  222.22   .121    15.714     .070     .157     4.621    88.23    88.23
0/24/83   100   80.00      9TH PASS          58.2    25.0    2.6  222.22   .112    14.550     .065     .145     5.596   115.38   115.38
0/24/83   100   80.00     10TH PASS          58.2    21.0    2.7  222.22   .094    12.222     .054     .122     4.526   111.11   111.11
0/24/83   100   80.00  RUBBER 7002 1ST PASS  58.2    21.0    3.5  222.22   .094    12.222     .054     .122     3.492    85.71    85.71
0/24/83   100   80.00      2ND PASS          58.2    25.0    2.7  222.22   .112    14.550     .065     .145     5.388   111.11   111.11
0/24/83   100   80.00      3RD PASS          58.2    44.0    2.9  222.22   .198    25.608     .115     .256     8.830   103.44   103.44
0/24/83   100   80.00  RUBBER 5503 1ST PASS  65.4    26.0   65.0  222.22   .117    17.004     .076     .170      .261     4.61     4.61
0/24/83   100   80.00      2ND PASS          65.4    29.0    4.0  222.22   .130    18.966     .085     .189     4.741    75.00    75.00
0/24/83   100   80.00      3RD PASS          65.4    36.0    6.8  222.22   .162    23.544     .105     .235     3.462    44.11    44.11
0/24/83   100   80.00      4TH PASS          65.4    34.0    4.1  222.22   .153    22.236     .100     .222     5.423    73.17    73.17
0/24/83   100   80.00      5TH PASS          65.4    29.0    3.4  222.22   .130    18.966     .085     .189     5.578    88.23    88.23
0/24/83   100   80.00      6TH PASS          65.4    23.0    4.8  222.22   .103    15.042     .067     .150     3.133    62.50    62.50
                   TOTALS                           711.0  161.9 4888.84   .145   420.278

OTAL PASSES   22                                     MIN    2.6                    MIN     .048     .108      .261     4.61     4.61
OTAL PRODUCTION TIME 05:35:40                        MAX   65.0                    MAX     .129     .287     8.830   115.38   115.38
VERAGE LBS CEMENT PER PASS   32.318                  AVG    7.3                    AVG     .087     .194     4.523    70.56    70.56
VERAGE LBS CEMENT PER SQUARE YARD 3.199
```

Best Available Copy

```
UN ON 01/23/84 AT 14:11:22                         DAVID M TOLUENE ANALYSIS                                                PAGE 11
                                             %                           CEM  TOLUENE      TOL      TOL       TOL     FEET    F/FEET
 DATE      LEN    WIDTH        DESCRIPTION  TOL     LBS    MINS   SQ YDS  SYD    USED      SYD      LYD       MIN      MIN      MIN
VERAGE LBS CEMENT PER PASS  28.225                   AVG  3.4                       AVG     .082     .176     6.209    91.71    88.27
VERAGE LBS CEMENT PER SQUARE YARD 6.730
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                         DAVID M TOLUENE ANALYSIS                                             PAGE 10

                                              %                                 CEM   TOLUENE     TOL     TOL       TOL     FEET   F/FEET
  DATE     LEN   WIDTH     DESCRIPTION       TOL     LBS   MINS   SQ YDS      SYD     USED      SYD     LYD       MIN      MIN      MIN

09/27/83   100   77.00  RUBBER [illegible] 1ST PASS  67.5  36.0   3.4   213.88   .168   24.300    .113    .243     7.147    88.23    84.92
09/27/83   100   77.00     2ND PASS              67.5    22.0    4.3   213.88   .102   14.850    .069    .148     3.453    69.76    67.15
09/27/83   100   77.00     3RD PASS              67.5    16.5    3.9   213.88   .077   11.137    .052    .111     2.855    76.92    74.03
09/27/83   100   77.00  RUBBER 7002 1ST PASS     58.7    34.0    5.2   213.88   .158   19.958    .093    .199     3.838    57.69    55.52
09/27/83   100   77.00     2ND PASS              58.7    36.0    3.9   213.88   .168   21.132    .098    .211     5.418    76.92    74.03
09/27/83   100   77.00     3RD PASS              58.7    33.0    3.4   213.88   .154   19.371    .090    .193     5.697    88.23    84.92
09/27/83   100   77.00     4TH PASS              58.7    27.0    3.0   213.88   .126   15.849    .074    .158     5.283   100.00    96.25
09/27/83   100   77.00     5TH PASS              58.7    23.0    2.6   213.88   .107   13.501    .063    .135     5.192   115.38   111.05
09/27/83   100   77.00     6TH PASS              58.7    21.0    2.6   213.88   .098   12.327    .057    .123     4.741   115.38   111.05
09/27/83   100   77.00     7TH PASS              58.7    36.5    3.1   213.88   .170   21.425    .100    .214     6.911    96.77    93.14
09/27/83   100   77.00     8TH PASS              58.7    28.5    2.6   213.88   .133   16.729    .078    .167     6.434   115.38   111.05
09/27/83   100   77.00     9TH PASS              58.7    49.0    4.8   213.88   .229   28.763    .134    .287     5.992    62.50    60.15
09/27/83   100   77.00    10TH PASS              58.7    23.0    3.3   213.88   .107   13.501    .063    .135     4.091    90.90    87.50
09/27/83   100   77.00    11TH PASS              58.7    38.0    3.3   213.88   .177   22.306    .104    .223     6.759    90.90    87.50
09/27/83   100   77.00    12TH PASS              58.7    30.0    5.9   213.88   .140   17.610    .082    .176     2.984    50.84    48.94
09/27/83   100   77.00    13TH PASS              58.7    26.5    3.7   213.88   .123   15.555    .072    .155     4.204    81.08    78.04
09/27/83   100   77.00    14TH PASS              58.7    24.5    2.5   213.88   .114   14.381    .067    .143     5.752   120.00   115.50
09/27/83   100   77.00    15TH PASS              58.7    24.0    2.7   213.88   .112   14.088    .065    .140     5.217   111.11   106.94
09/27/83   100   77.00    16TH PASS              58.7    33.0    7.4   213.88   .154   19.371    .090    .193     2.617    40.54    39.02
9/27/83    100   77.00    17TH PASS              58.7    34.0    3.0   213.88   .158   19.958    .093    .199     6.652   100.00    96.25
9/27/83    100   77.00    18TH PASS              58.7    32.0    2.8   213.88   .149   18.784    .087    .187     6.708   107.14   103.12
9/27/83    100   77.00    19TH PASS              58.7    30.0    3.1   213.88   .140   17.610    .082    .176     5.680    96.77    93.14
9/27/83    100   77.00    20TH PASS              58.7    23.0    3.0   213.88   .107   13.501    .063    .135     4.500   100.00    96.25
9/27/83    100   77.00    21ST PASS              58.7    21.0    3.0   213.88   .098   12.327    .057    .123     4.109   100.00    96.25
9/27/83    100   77.00    22ND PASS              58.7    21.0    3.1   213.88   .098   12.327    .057    .123     3.976    96.77    93.14
9/27/83    100   77.00    23RD PASS              58.7    19.0    2.6   213.88   .088   11.153    .052    .111     4.289   115.38   111.05
9/27/83    100   77.00    24TH PASS              58.7    33.0    3.0   213.88   .154   19.371    .090    .193     6.457   100.00    96.25
9/27/83    100   77.00    25TH PASS              58.7    27.0    3.4   213.88   .126   15.849    .074    .158     4.661    88.23    84.92
9/27/83    100   77.00    26TH PASS              58.4    26.0    3.1   213.88   .121   15.184    .070    .151     4.898    96.77    93.14
9/27/83    100   77.00    27TH PASS              58.4    29.0    2.5   213.88   .135   16.936    .079    .169     6.774   120.00   115.50
9/27/83    100   77.00    28TH PASS              58.4    27.5    3.0   213.88   .128   16.060    .075    .160     5.353   100.00    96.25
9/27/83    100   77.00  RUBBER 6809 1ST PASS     68.2    17.0    3.4   213.88   .079   11.594    .054    .115     3.410    88.23    84.92
9/27/83    100   77.00     2ND PASS              68.2    35.0    4.1   213.88   .163   23.870    .111    .238     5.821    73.17    70.42
9/27/83    100   77.00     3RD PASS              68.2    28.0    3.4   213.88   .130   19.096    .089    .190     5.616    88.23    84.92
9/27/83    100   77.00     4TH PASS              68.2    31.0    3.4   213.88   .144   21.142    .098    .211     6.218    88.23    84.92
9/27/83    100   77.00     5TH PASS              68.2    26.0    2.4   213.88   .121   17.732    .082    .177     7.388   125.00   120.31
9/27/83    100   77.00     6TH PASS              68.2    41.0    5.4   213.88   .191   27.962    .130    .279     5.178    55.55    53.47
9/27/83    100   77.00     7TH PASS              68.2    29.0    5.6   213.88   .135   19.778    .092    .197     3.531    53.57    51.56
9/27/83    100   77.00     8TH PASS              68.2    28.0    3.3   213.88   .130   19.096    .089    .190     5.786    90.90    87.50
9/27/83    100   77.00     9TH PASS              68.2    27.5    2.5   213.88   .128   18.755    .087    .187     7.213   115.38   111.05
9/27/83    100   77.00    10TH PASS              68.2    48.0    3.9   213.88   .224   32.736    .153    .327     8.393    76.92    74.03
9/27/83    100   77.00    11TH PASS              68.2    40.0    3.6   213.88   .187   27.280    .127    .272     7.577    83.33    80.20
9/27/83    100   77.00    12TH PASS              68.2    31.0    3.3   213.88   .144   21.142    .098    .211     6.406    90.90    87.50
9/27/83    100   77.00    13TH PASS              68.2    28.0    3.2   213.88   .130   19.096    .089    .190     5.967    93.75    90.23
9/27/83    100   77.00    14TH PASS              68.2    38.0    3.8   213.88   .177   25.916    .121    .259     6.820    78.94    75.98
9/27/83    100   77.00    15TH PASS              68.2    37.0    3.1   213.88   .172   25.234    .117    .252     8.140    96.77    93.14
9/27/83    100   77.00    16TH PASS              68.2    11.0    3.2   213.88   .051    7.502    .035    .075     2.344    93.75    90.23
9/27/83    100   77.00    17TH PASS              68.2    10.5    3.3   213.88   .049    7.161    .033    .071     2.170    90.90    87.50
9/27/83    100   77.00    18TH PASS              68.2    17.5    3.2   213.88   .081   11.935    .055    .119     3.729    93.75    90.23
9/27/83    100   77.00    19TH PASS              68.2    18.0    2.6   213.88   .084   12.276    .057    .122     4.721   115.38   111.05
9/27/83    100   77.00    20TH PASS              68.2    14.0    2.6   213.88   .065    9.548    .044    .095     3.672   115.38   111.05
9/27/83    100   77.00  TALC PASS                68.2    18.0   10.8   213.88   .084   12.276    .057    .122     1.136    27.77    26.73
                      TOTALS                          1439.5  176.6   907.88   .999  904.065

OTAL PASSES  51                                         MIN   2.4                      MIN     .033    .071     2.170    40.54    39.02
OTAL PRODUCTION TIME 09:51:16                           MAX   7.4                      MAX     .153    .327     8.393   125.00   120.31
```

AVG

```
UN ON 01/23/84 AT 14:11:22                        DAVID M TOLUENE ANALYSIS                                               PAGE  9

                                                   %                                 CEM   TOLUENE     TOL     TOL       TOL     FEET   F/FEET
 DATE      LEN  WIDTH      DESCRIPTION            TOL    LBS    MINS   SQ YDS   SYD     USED       SYD     LYD       MIN      MIN     MIN
09/26/83   98   78.50  RUBBER 5492 1ST PASS       67.5   36.0   6.7   213.68   .168    24.300    .113    .247     3.626    43.88    43.05
09/26/83   98   78.50       2ND PASS              67.5   21.0   4.6   213.68   .098    14.175    .066    .144     3.081    63.91    62.71
09/26/83   98   78.50       3RD PASS              67.5   14.0   4.2   213.68   .065     9.450    .044    .096     2.250    70.00    68.68
09/26/83   98   78.50  RUBBER 7002 1ST PASS       60.2   28.0   5.3   213.68   .131    16.856    .078    .172     3.180    55.47    54.43
09/26/83   98   78.50       2ND PASS              60.2   33.0   3.4   213.68   .154    19.866    .092    .202     5.842    86.47    84.84
09/26/83   98   78.50       3RD PASS              60.2   45.0   5.7   213.68   .210    27.090    .126    .276     4.752    51.57    50.61
09/26/83   98   78.50       4TH PASS              60.2   37.0   4.3   213.68   .173    22.274    .104    .227     5.180    68.37    67.08
09/26/83   98   78.50       5TH PASS              60.2   33.0   3.3   213.68   .154    19.866    .092    .202     6.020    89.09    87.41
09/26/83   98   78.50       6TH PASS              60.2   49.0   3.2   213.68   .229    29.498    .138    .301     9.218    91.87    90.15
09/26/83   98   78.50       7TH PASS              60.2   24.0   4.5   213.68   .112    14.448    .067    .147     3.210    65.33    64.10
09/26/83   98   78.50       8TH PASS              60.2   55.5   2.4   213.68   .259    33.411    .156    .340    13.921   122.50   120.20
09/26/83   98   78.50       9TH PASS              60.2   31.5   5.6   213.68   .147    18.963    .088    .193     3.386    52.50    51.51
09/26/83   98   78.50      10TH PASS              60.2   36.0   3.4   213.68   .168    21.672    .101    .221     6.374    86.47    84.84
09/26/83   98   78.50      11TH PASS              60.2   28.5   4.5   213.68   .133    17.157    .080    .175     3.812    65.33    64.10
09/26/83   98   78.50      12TH PASS              60.2   27.0   2.6   213.68   .126    16.254    .076    .165     6.251   113.07   110.95
09/26/83   98   78.50      13TH PASS              60.2   19.0   2.4   213.68   .088    11.438    .053    .116     4.765   122.50   120.20
09/26/83   98   78.50      14TH PASS              60.2   22.0   2.5   213.68   .102    13.244    .061    .135     5.297   117.60   115.39
09/26/83   98   78.50  RUBBER 7002 1ST PASS       58.7   21.5   2.5   213.68   .100    12.620    .059    .128     5.048   117.60   115.39
09/26/83   98   78.50       2ND PASS              58.7   20.5   2.7   213.68   .095    12.033    .056    .122     4.456   108.88   106.84
9/26/83    98   78.50       3RD PASS              58.7   19.0   2.7   213.68   .088    11.153    .052    .113     4.130   108.88   106.84
9/26/83    98   78.50       4TH PASS              58.7   17.0   2.3   213.68   .079     9.979    .046    .101     4.338   127.82   125.42
9/26/83    98   78.50       5TH PASS              58.7   17.0   2.3   213.68   .079     9.979    .046    .101     4.338   127.82   125.42
9/26/83    98   78.50       6TH PASS              58.7   26.0   2.4   213.68   .121    15.262    .071    .155     6.359   122.50   120.20
9/26/83    98   78.50  RUBBER 5503 1ST PASS       64.2   19.0   2.6   213.68   .088    12.198    .057    .124     4.691   113.07   110.95
9/26/83    98   78.50       2ND PASS              64.2   18.0   2.7   213.68   .084    11.556    .054    .117     4.280   108.88   106.84
9/26/83    98   78.50       3RD PASS              64.2   28.0   3.0   213.68   .131    17.976    .084    .183     5.992    98.00    96.16
9/26/83    98   78.50       4TH PASS              64.2   23.0   2.7   213.68   .107    14.766    .069    .150     5.468   108.88   106.84
9/26/83    98   78.50       5TH PASS              64.2   21.0   2.7   213.68   .098    13.482    .063    .137     4.993   108.88   106.84
9/26/83    98   78.50       6TH PASS              64.2   18.0   2.9   213.68   .084    11.556    .054    .117     3.984   101.37    99.47
9/26/83    98   78.50       7TH PASS              64.2   20.0   3.2   213.68   .093    12.840    .060    .131     4.012    91.87    90.15
9/26/83    98   78.50       8TH PASS              64.2   19.0   2.4   213.68   .088    12.198    .057    .124     5.082   122.50   120.20
9/26/83    98   78.50       9TH PASS              64.2   18.0   2.4   213.68   .084    11.556    .054    .117     4.815   122.50   120.20
9/26/83    98   78.50      10TH PASS              64.2   16.0   2.3   213.68   .074    10.272    .048    .104     4.466   127.82   125.42
9/26/83    98   78.50      11TH PASS              64.2   16.0   2.4   213.68   .074    10.272    .048    .104     4.280   122.50   120.20
9/26/83    98   78.50      12TH PASS              64.2   16.0   2.7   213.68   .074    10.272    .048    .104     3.804   108.88   106.84
9/26/83    98   78.50      13TH PASS              64.2   17.0   2.3   213.68   .079    10.914    .051    .111     4.745   127.82   125.42
9/26/83    98   78.50      14TH PASS              64.2   16.0   2.5   213.68   .074    10.272    .048    .104     4.108   117.60   115.39
9/26/83    98   78.50  TALC PASS                  64.2   18.0  15.2   213.68   .084    11.556    .054    .117      .760    19.34    18.97
                    TOTALS                             925.5  120.3  7906.16   .117   671.118

OTAL PASSES  37                                           MIN    2.3                      MIN   .044    .096     2.250    43.88    43.05
OTAL PRODUCTION TIME 07:57:46                             MAX    6.7                      MAX   .156    .340    13.921   127.82   125.42
VERAGE LBS CEMENT PER PASS  25.013                        AVG    3.2                      AVG   .071    .156     4.960    96.91    97.06
VERAGE LBS CEMENT PER SQUARE YARD 4.331
```

```
RUN ON 01/23/84 AT 14:11:22                  DAVID M TOLUENE ANALYSIS                                              PAGE  8

                                                %                        CEM   TOLUENE     TOL     TOL     TOL     FEET   F/FEET
 DATE     LEN   WIDTH      DESCRIPTION         TOL    LBS   MINS  SQ YDS  SYD    USED      SYD     LYD     MIN     MIN     MIN

09/23/83  100   80.75  RUBBER 1492 1ST PASS   57.8   34.5   5.2  224.30  .153   19.941    .088    .199   3.834   67.69   68.23
09/23/83  100   80.75       2ND PASS          57.8   21.5   4.1  224.30  .095   12.427    .055    .124   3.030   73.17   73.85
09/23/83  100   80.75       3RD PASS          57.8   16.0   3.4  224.30  .071    9.248    .041    .092   2.720   88.23   89.06
09/23/83  100   80.75  RUBBER 7002 1ST PASS   60.2   26.0   5.8  224.30  .115   15.652    .069    .156   2.698   51.72   52.21
09/23/83  100   80.75       2ND PASS          60.2   53.0   6.8  224.30  .236   31.906    .142    .319   4.692   44.11   44.53
09/23/83  100   80.75       3RD PASS          60.2   38.0   4.5  224.30  .169   22.876    .101    .228   5.083   66.66   67.29
 9/23/83  100   80.75       4TH PASS          60.2   33.0   3.3  224.30  .147   19.866    .088    .198   6.020   90.90   91.76
 9/23/83  100   80.75       5TH PASS          60.2   30.0   2.9  224.30  .133   18.060    .080    .180   6.227  103.44  104.42
 9/23/83  100   80.75       6TH PASS          60.2   55.0   5.9  224.30  .245   33.110    .147    .331   5.611   50.84   51.32
 9/23/83  100   80.75       7TH PASS          60.2   33.0   5.1  224.30  .147   19.866    .088    .198   3.895   58.82   59.37
 9/23/83  100   80.75       8TH PASS          60.2   50.5   3.0  224.30  .225   30.401    .135    .304  10.133  100.00  100.94
 9/23/83  100   80.75       9TH PASS          60.2   25.0   4.0  224.30  .111   15.050    .067    .150   3.762   75.00   75.70
 9/23/83  100   80.75      10TH PASS          60.2   31.0   2.7  224.30  .138   18.662    .083    .186   6.911  111.11  112.15
 9/23/83  100   80.75      11TH PASS          60.2   32.0   2.9  224.30  .142   19.264    .085    .192   6.642  103.44  104.42
 9/23/83  100   80.75      12TH PASS          60.2   39.5   2.3  224.30  .176   23.779    .106    .237  10.338  130.43  131.66
 9/23/83  100   80.75      13TH PASS          60.2   20.0   3.2  224.30  .089   12.040    .053    .120   3.762   93.75   94.63
 9/23/83  100   80.75      14TH PASS          60.2   17.0   3.5  224.30  .075   10.234    .045    .102   2.924   85.71   86.52
 9/23/83  100   80.75      15TH PASS          60.2   11.0   3.7  224.30  .049    6.622    .029    .066   1.789   81.08   81.84
 9/23/83  100   80.75      16TH PASS          60.2   10.5   2.8  224.30  .046    6.321    .028    .063   2.257  107.14  108.15
 9/23/83  100   80.75      17TH PASS          60.2   11.5   2.2  224.30  .051    6.923    .030    .069   3.146  136.36  137.64
 9/23/83  100   80.75  RUBBER 6609 1ST PASS   68.5   34.0   5.7  224.30  .151   23.290    .103    .232   4.085   62.63   63.12
 9/23/83  100   80.75       2ND PASS          68.5   55.0   5.9  224.30  .245   37.675    .167    .376   6.385   50.84   51.32
 9/23/83  100   80.75       3RD PASS          68.5   35.0   2.9  224.30  .156   23.975    .106    .239   8.267  103.44  104.42
 9/23/83  100   80.75       4TH PASS          68.5   30.0   2.6  224.30  .133   20.550    .091    .205   7.903  115.38  116.46
 9/23/83  100   80.75       5TH PASS          68.5   28.0   2.3  224.30  .124   19.180    .085    .191   8.339  130.43  131.66
 9/23/83  100   80.75       6TH PASS          68.5   29.0   2.9  224.30  .129   19.865    .088    .198   6.850  103.44  104.42
 9/23/83  100   80.75       7TH PASS          68.5   54.0   4.6  224.30  .240   36.990    .164    .369   8.041   65.21   65.83
 9/23/83  100   80.75       8TH PASS          68.5   37.0   3.1  224.30  .164   25.345    .112    .253   8.175   96.77   97.68
 9/23/83  100   80.75       9TH PASS          68.5   29.0   3.3  224.30  .129   19.865    .088    .198   6.019   90.90   91.76
 9/23/83  100   80.75      10TH PASS          68.5   55.0   4.9  224.30  .245   37.675    .167    .376   7.688   61.22   61.80
 9/23/83  100   80.75      11TH PASS          68.5   43.0   3.6  224.30  .191   29.455    .131    .294   8.181   83.33   84.11
 9/23/83  100   80.75      12TH PASS          68.5   20.0   3.0  224.30  .089   13.700    .061    .137   4.566  100.00  100.94
 9/23/83  100   80.75      13TH PASS          68.5   28.0   2.2  224.30  .124   19.180    .085    .191   8.718  136.36  137.64
 9/23/83  100   80.75      14TH PASS          68.5   28.0   2.4  224.30  .124   19.180    .085    .191   7.991  125.00  126.17
 9/23/83  100   80.75      15TH PASS          68.5   14.0   1.9  224.30  .062    9.590    .042    .095   5.047  157.89  159.37
 9/23/83  100   80.75      16TH PASS          68.5   15.0   1.9  224.30  .071   10.960    .048    .109   5.768  157.89  159.37
 9/23/83  100   80.75      17TH PASS          68.5   13.0   2.3  224.30  .057    8.905    .039    .089   3.871  130.43  131.66
 9/23/83  100   80.75      18TH PASS          68.5   19.0   3.4  224.30  .084   13.015    .058    .130   3.827   88.23   89.06
 9/23/83  100   80.75  TALC PASS              68.5   22.0  11.6  224.30  .098   15.070    .067    .150   1.299   25.86   26.10
                TOTALS                             1155.0 136.2 8523.40  .135  740.543

OTAL PASSES  38                                      MIN   1.9                     MIN    .028    .063   1.789   44.11   44.53
OTAL PRODUCTION TIME 08:10:04                        MAX   6.8                     MAX    .167    .376  10.338  157.89  159.37
VERAGE LBS CEMENT PER PASS  30.394                   AVG   3.5                     AVG    .086    .194   5.663   93.65   94.53
VERAGE LBS CEMENT PER SQUARE YARD 5.149
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                DAVID M TOLUENE ANALYSIS                                          PAGE  7

                                                %                            CEM   TOLUENE   TOL    TOL     TOL    FEET   F/FEET
 DATE     LEN   WIDTH    DESCRIPTION           TOL    LBS   MINS  SQ YDS    SYD    USED     SYD    LYD     MIN    MIN     MIN

09/22/83  100   81.75  RUBBER 1492 1ST PASS   57.8   36.0   6.2  227.08   .158   20.808   .091   .208   3.356   48.38   49.44
09/22/83  100   81.75     2ND PASS            57.8   26.0   4.8  227.08   .114   15.028   .066   .150   3.130   62.50   63.86
09/22/83  100   81.75     3RD PASS            57.8   18.0   5.1  227.08   .079   10.404   .045   .104   2.040   58.82   60.11
09/22/83  100   81.75  RUBBER 7002 1ST PASS   57.4   27.0   3.8  227.08   .118   15.498   .068   .154   4.078   78.94   80.67
09/22/83  100   81.75     2ND PASS            57.4   30.0   4.5  227.08   .132   17.220   .075   .172   3.826   66.66   68.12
09/22/83  100   81.75     3RD PASS            57.4   41.5   4.3  227.08   .182   23.821   .104   .238   5.539   69.76   71.29
09/22/83  100   81.75     4TH PASS            57.4   38.0   3.4  227.08   .167   21.812   .096   .218   6.415   88.23   90.16
09/22/83  100   81.75     5TH PASS            57.4   33.5   3.2  227.08   .147   19.229   .084   .192   6.009   93.75   95.80
09/22/83  100   81.75     6TH PASS            57.4   53.0   6.2  227.08   .233   30.422   .133   .304   4.906   48.38   49.44
09/22/83  100   81.75     7TH PASS            57.4   40.0   3.3  227.08   .176   22.960   .101   .229   6.957   90.90   92.90
09/22/83  100   81.75     8TH PASS *          57.4   35.0   3.0  227.08   .154   20.090   .088   .200   6.696  100.00  102.19
09/22/83  100   81.75     9TH PASS            57.4   45.5   3.9  227.08   .200   26.117   .115   .261   6.696   76.92   78.60
09/22/83  100   81.75     10TH PASS           57.4   40.5   2.7  227.08   .178   23.247   .102   .232   8.610  111.11  113.54
09/22/83  100   81.75     11TH PASS           57.4   36.0   3.7  227.08   .158   20.664   .090   .206   5.584   81.08   82.85
09/22/83  100   81.75     12TH PASS           57.4   32.0   3.1  227.08   .140   18.368   .080   .183   5.925   96.77   98.89
09/22/83  100   81.75  RUBBER 7002 1ST PASS   54.5   58.5   6.1  227.08   .257   31.882   .140   .318   5.226   49.18   50.25
09/22/83  100   81.75     2ND PASS            54.5   46.0   4.1  227.08   .202   25.070   .110   .250   6.114   73.17   74.77
09/22/83  100   81.75     3RD PASS            54.5   41.5   3.7  227.08   .182   22.617   .099   .226   6.112   81.08   82.85
09/22/83  100   81.75     4TH PASS            54.5   29.0   3.5  227.08   .127   15.805   .069   .158   4.515   85.71   87.59
09/22/83  100   81.75  RUBBER 6607 1ST PASS   67.3   44.0   5.1  227.08   .193   29.612   .130   .296   5.806   58.82   60.11
09/22/83  100   81.75     2ND PASS            67.3   35.0   4.0  227.08   .154   23.555   .103   .235   5.888   75.00   76.64
09/22/83  100   81.75     3RD PASS            67.3   30.0   4.3  227.08   .132   20.190   .088   .201   4.695   69.76   71.29
09/22/83  100   81.75  RUBBER 6607 1ST PASS   65.8   21.0   3.0  227.08   .092   13.818   .060   .138   4.606  100.00  102.19
09/22/83  100   81.75     2ND PASS            65.8   28.5   3.8  227.08   .125   18.753   .082   .187   4.935   78.94   80.67
09/22/83  100   81.75     3RD PASS            65.8   14.0   2.7  227.08   .061    9.212   .040   .092   3.411  111.11  113.54
09/22/83  100   81.75     4TH PASS            65.8   51.5   5.5  227.08   .226   33.887   .149   .338   6.161   54.54   55.74
09/22/83  100   81.75     5TH PASS            65.8   44.0   4.1  227.08   .193   28.952   .127   .289   7.061   73.17   74.77
09/22/83  100   81.75     6TH PASS            65.8   35.0   3.8  227.08   .154   23.030   .101   .230   6.060   78.94   80.67
09/22/83  100   81.75     7TH PASS            65.8   17.0   4.3  227.08   .074   11.186   .049   .111   2.601   69.76   71.29
09/22/83  100   81.75  TALC PASS              65.8   24.0  17.0  227.08   .105   15.792   .069   .157    .928   17.64   18.03
               TOTALS                             1027.0 119.2 6585.32   .155  613.257

OTAL PASSES  29                                         MIN  2.7                    MIN    .040   .092   2.040   48.38   49.44
OTAL PRODUCTION TIME 07:42:55                           MAX  6.2                    MAX    .149   .338   8.610  111.11  113.54
VERAGE LBS CEMENT PER PASS  35.413                      AVG  4.1                    AVG    .092   .211   6.274   76.94   78.62
VERAGE LBS CEMENT PER SQUARE YARD 4.522
```

* % Tol Changed
From 57.4% to
54.5% on This
Pass

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                  DAVID M TOLUENE ANALYSIS                                              PAGE  6

                                                  %                              CEM  TOLUENE   TOL    TOL     TOL    FEET   F/FEET
  DATE    LEN   WIDTH       DESCRIPTION          TOL    LBS   MINS  SQ YDS   SYD   USED     SYD    LYD     MIN    MIN     MIN

09/21/83  100   46.00   RUBBER 1492 1ST PASS    57.8   20.0   6.5  127.77  .156  11.560   .090   .115   1.778   46.15   26.53
09/21/83  100   46.00     2ND PASS              57.8   11.5   4.1  127.77  .090   6.647   .052   .066   1.621   73.17   42.07
09/21/83  100   46.00     3RD PASS              57.8    8.0   4.4  127.77  .062   4.624   .036   .046   1.050   68.18   39.20
09/21/83  100   46.00   RUBBER 7002 1ST PASS    57.4   18.0   4.5  127.77  .140  10.332   .080   .103   2.296   66.66   38.33
09/21/83  100   46.00     2ND PASS              57.4   22.0   2.9  127.77  .172  12.628   .098   .126   4.354  103.44   59.48
09/21/83  100   46.00     3RD PASS              57.4   18.0   3.0  127.77  .140  10.332   .080   .103   3.444  100.00   57.50
09/21/83  100   46.00     4TH PASS              57.4   13.0   2.4  127.77  .101   7.462   .058   .074   3.109  125.00   71.87
09/21/83  100   46.00   RUBBER 7002 1ST PASS    57.4   42.0   5.0  127.77  .328  24.108   .188   .241   4.821   60.00   34.50
09/21/83  100   46.00     2ND PASS              57.4   13.0   4.8  127.77  .101   7.462   .058   .074   1.554   62.50   35.93
09/21/83  100   46.00     3RD PASS              57.4    9.0   4.0  127.77  .070   5.166   .040   .051   1.291   75.00   43.12
09/21/83  100   46.00     4TH PASS              57.4   11.0   2.2  127.77  .086   6.314   .049   .063   2.870  136.36   78.40
09/21/83  100   46.00     5TH PASS              57.4    9.0   3.4  127.77  .070   5.166   .040   .051   1.519   88.23   50.73
09/21/83  100   46.00     6TH PASS              57.4   11.0   2.7  127.77  .086   6.314   .049   .063   2.338  111.11   63.88
09/21/83  100   46.00     7TH PASS              57.4    9.0   1.9  127.77  .070   5.166   .040   .051   2.718  157.89   90.78
09/21/83  100   46.00     8TH PASS              57.4   20.0   3.2  127.77  .156  11.480   .089   .114   3.587   93.75   53.90
09/21/83  100   46.00     9TH PASS              57.4   12.0   2.8  127.77  .093   6.888   .053   .068   2.460  107.14   61.60
09/21/83  100   46.00    10TH PASS              57.4   12.0   2.0  127.77  .093   6.888   .053   .068   3.444  150.00   86.25
09/21/83  100   46.00    11TH PASS              57.4   11.0   2.3  127.77  .086   6.314   .049   .063   2.745  130.43   75.00
09/21/83  100   46.00    12TH PASS              57.4    9.0   2.0  127.77  .070   5.166   .040   .051   2.583  150.00   86.25
09/21/83  100   46.00    13TH PASS              57.4   10.0   2.0  127.77  .078   5.740   .044   .057   2.870  150.00   86.25
09/21/83  100   46.00    14TH PASS              57.4    7.0   1.9  127.77  .054   4.018   .031   .040   2.114  157.89   90.78
09/21/83  100   46.00    15TH PASS              57.4    8.0   1.8  127.77  .062   4.592   .035   .045   2.551  166.66   95.83
09/21/83  100   46.00    16TH PASS              57.4   18.0   2.9  127.77  .140  10.332   .080   .103   3.562  103.44   59.48
09/21/83  100   46.00    17TH PASS              57.4   14.0   2.3  127.77  .109   8.036   .062   .080   3.493  130.43   75.00
09/21/83  100   46.00    18TH PASS              57.4   13.0   2.0  127.77  .101   7.462   .058   .074   3.731  150.00   86.25
09/21/83  100   46.00   RUBBER 7002 1ST PASS    57.4   12.0   2.0  127.77  .093   6.888   .053   .068   3.444  150.00   86.25
09/21/83  100   46.00     2ND PASS              57.4   12.0   2.0  127.77  .093   6.888   .053   .068   3.444  150.00   86.25
09/21/83  100   46.00     3RD PASS              57.4    9.0   2.6  127.77  .070   5.166   .040   .051   1.987  115.38   66.34
09/21/83  100   46.00   RUBBER 6007 1ST PASS    67.3   18.0   4.1  127.77  .140  12.114   .094   .121   2.954   73.17   42.07
09/21/83  100   46.00     2ND PASS              67.3   12.0   2.7  127.77  .093   8.076   .063   .080   2.991  111.11   63.88
09/21/83  100   46.00     3RD PASS              67.3   13.0   2.4  127.77  .101   8.749   .068   .087   3.645  125.00   71.87
09/21/83  100   46.00     4TH PASS              67.3   26.0   3.5  127.77  .203  17.498   .136   .174   4.999   85.71   49.28
09/21/83  100   46.00     5TH PASS              67.3   29.0   3.5  127.77  .226  19.517   .152   .195   5.576   85.71   49.28
09/21/83  100   46.00     6TH PASS              67.3   14.0   2.9  127.77  .109   9.422   .073   .094   3.248  103.44   59.48
09/21/83  100   46.00     7TH PASS              67.3    6.0   1.9  127.77  .046   4.038   .031   .040   2.125  157.89   90.78
09/21/83  100   46.00     8TH PASS              67.3   10.0   2.4  127.77  .078   6.730   .052   .067   2.804  125.00   71.87
09/21/83  100   46.00     9TH PASS              67.3   10.0   2.2  127.77  .078   6.730   .052   .067   3.059  136.36   78.40
09/21/83  100   46.00    10TH PASS              67.3    9.5   2.5  127.77  .074   6.393   .050   .063   2.557  120.00   69.00
09/21/83  100   46.00    11TH PASS              67.3    9.0   3.1  127.77  .070   6.057   .047   .060   1.953   96.77   55.64
09/21/83  100   46.00    12TH PASS              67.3    4.5   1.0  127.77  .035   3.028   .023   .030   3.028  300.00  172.50
09/21/83  100   46.00   TALC PASS               67.3    8.0  14.9  127.77  .062   5.384   .042   .053    .361   20.13   11.57
                TOTALS                                542.5 115.8 5110.60  .106 327.491

 OTAL PASSES  40                                     MIN   1.0                   MIN    .023   .030   1.050   46.15   26.53
 OTAL PRODUCTION TIME 07:42:04                       MAX   6.5                   MAX    .188   .241   5.576  300.00  172.50
 VERAGE LBS CEMENT PER PASS  13.562                  AVG   2.8                   AVG    .063   .081   2.892  117.47   67.54
 VERAGE LBS CEMENT PER SQUARE YARD 4.245
```

Best Available Copy

```
UN ON 01/23/84 AT 14:11:22                    DAVID M TOLUENE ANALYSIS                                                      PAGE  5

                                                   %                              CEM  TOLUENE     TOL     TOL       TOL     FEET   F/FEET
 DATE    LEN  WIDTH        DESCRIPTION            TOL    LBS   MINS   SQ YDS     SYD    USED       SYD     LYD       MIN      MIN     MIN

9/20/83   97  77.75  RUBBER 1492 1ST PASS        57.8   29.5   5.1    209.49    .140   17.051     .081    .175     2.795    47.70    46.36
9/20/83   97  77.75     2ND PASS                 57.8   21.0   4.4    209.49    .100   12.138     .057    .125     2.758    66.13    64.27
9/20/83   97  77.75     3RD PASS                 57.8   16.5   4.0    209.49    .078    9.537     .045    .098     2.384    72.75    70.70
9/20/83   97  77.75  RUBBER 7002 1ST PASS        57.4   51.0   4.8    209.49    .243   29.274     .139    .301     6.098    60.62    58.91
9/20/83   97  77.75     2ND PASS                 57.4   49.0   4.4    209.49    .233   28.126     .134    .289     6.392    66.13    64.27
9/20/83   97  77.75     3RD PASS                 57.4   32.5   3.5    209.49    .155   18.655     .089    .192     5.330    83.14    80.80
9/20/83   97  77.75     4TH PASS                 57.4   26.0   3.1    209.49    .124   14.924     .071    .153     4.814    93.87    91.22
9/20/83   97  77.75     5TH PASS                 57.4   44.0   2.6    209.49    .210   25.256     .120    .260     9.713   111.92   108.77
9/20/83   97  77.75     6TH PASS                 57.4   28.5   2.7    209.49    .136   16.359     .078    .168     6.058   107.77   104.74
9/20/83   97  77.75     7TH PASS                 57.4   32.5   2.4    209.49    .155   18.655     .089    .192     7.772   121.25   117.83
9/20/83   97  77.75     8TH PASS                 57.4   12.0   2.6    209.49    .057    6.888     .032    .071     2.649   111.92   108.77
9/20/83   97  77.75     9TH PASS                 57.4   15.0   3.0    209.49    .071    8.610     .041    .088     2.870    97.00    94.27
9/20/83   97  77.75    10TH PASS                 57.4   23.5   3.4    209.49    .112   13.489     .064    .139     3.967    85.58    83.17
9/20/83   97  77.75  RUBBER 6609 1ST PASS        18.7   32.5   4.1    209.49    .155    6.077     .029    .062     1.482    70.97    68.97
9/20/83   97  77.75  RUBBER 6609 1ST PASS        67.4   30.0   4.7    209.49    .143   20.220     .096    .208     4.302    61.91    60.17
9/20/83   97  77.75     2ND PASS                 67.4   28.0   4.0    209.49    .133   18.872     .090    .194     4.718    72.75    70.70
9/20/83   97  77.75     3RD PASS                 67.4   21.0   3.6    209.49    .100   14.154     .067    .145     3.931    80.83    78.55
9/20/83   97  77.75     4TH PASS                 67.4   38.5   4.1    209.49    .183   25.949     .123    .267     6.329    70.97    68.97
9/20/83   97  77.75     5TH PASS                 67.4   33.5   3.1    209.49    .159   22.579     .107    .232     7.283    93.87    91.22
9/20/83   97  77.75     6TH PASS                 67.4   26.0   4.3    209.49    .124   17.524     .083    .180     4.075    67.67    65.76
9/20/83   97  77.75     7TH PASS                 67.4   16.0   2.4    209.49    .076   10.784     .051    .111     4.493   121.25   117.83
9/20/83   97  77.75     8TH PASS                 67.4   15.5   2.3    209.49    .073   10.447     .049    .107     4.542   126.52   122.96
9/20/83   97  77.75     9TH PASS                 67.4   17.5   2.5    209.49    .083   11.795     .056    .121     4.718   116.40   113.12
9/20/83   97  77.75    10TH PASS                 67.4   17.0   5.5    209.49    .081   11.458     .054    .118     2.083    52.90    51.42
9/20/83   97  77.75    TALC PASS                 67.4   17.5   6.2    209.49    .083   11.795     .056    .121     1.902    46.93    45.61
                  TOTALS                               656.5  87.6   5027.76    .130  388.521

OTAL PASSES  24                                          MIN  2.3                        MIN   .029    .062     1.482    47.70    45.36
OTAL PRODUCTION TIME 06:53:11                            MAX  6.2                        MAX   .139    .301     9.713   126.52   122.96
VERAGE LBS CEMENT PER PASS  27.354                       AVG  3.6                        AVE   .076    .166     4.648    85.90    83.48
VERAGE LBS CEMENT PER SQUARE YARD 3.133
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                           DAVID M TOLUENE ANALYSIS                                          PAGE  4

                                                      %                                CEM   TOLUENE     TOL     TOL       TOL     FEET    F/FEET
 DATE      LEN   WIDTH        DESCRIPTION            TOL     LBS   MINS    SQ YDS      SYD    USED       SYD     LYD       MIN      MIN      MIN

09/19/83   95    80.50   RUBBER 1492 1ST PASS       55.3    35.0   5.9    212.42     .164   19.355     .091    .203     3.280    48.30    48.60
09/19/83   95    80.50     2ND PASS                 55.3    22.0   4.3    212.42     .103   12.166     .057    .128     2.829    66.27    66.69
09/19/83   95    80.50     3RD PASS                 55.3    15.0   3.7    212.42     .070    8.295     .039    .087     2.241    77.02    77.50
09/19/83   95    80.50   RUBBER 7002 1ST PASS       59.3    34.5   6.1    212.42     .162   20.458     .096    .215     3.353    46.72    47.01
09/19/83   95    80.50     2ND PASS                 59.3    51.0   5.4    212.42     .240   30.243     .142    .318     5.600    52.77    53.10
09/19/83   95    80.50     3RD PASS                 59.3    25.0   4.0    212.42     .117   14.825     .069    .156     3.706    71.25    71.69
09/19/83   95    80.50     4TH PASS                 59.3    30.5   4.3    212.42     .143   18.086     .085    .190     4.206    66.27    66.69
09/19/83   95    80.50     5TH PASS                 59.3    33.5   4.1    212.42     .157   19.865     .093    .209     4.845    69.51    69.94
09/19/83   95    80.50     6TH PASS                 59.3    46.5   3.2    212.42     .218   27.574     .129    .290     8.616    89.06    89.61
09/19/83   95    80.50     7TH PASS                 59.3    40.0   4.5    212.42     .188   23.720     .111    .249     5.271    63.33    63.72
09/19/83   95    80.50     8TH PASS                 59.3    49.0   3.9    212.42     .230   29.057     .136    .305     7.450    73.07    73.63
09/19/83   95    80.50     9TH PASS                 59.3    47.0   4.1    212.42     .221   27.871     .131    .293     6.797    69.51    69.94
09/19/83   95    80.50    10TH PASS                 59.3    41.0   2.1    212.42     .193   24.313     .114    .255    11.577   135.71   136.65
09/19/83   95    80.50    11TH PASS                 59.3    35.0   3.1    212.42     .164   20.755     .097    .218     6.695    91.93    92.50
09/19/83   95    80.50    12TH PASS                 59.3    27.5   2.9    212.42     .129   16.307     .076    .171     5.623    98.27    98.88
09/19/83   95    80.50   RUBBER 7002 1ST PASS       59.3    19.5   2.6    212.42     .091   11.563     .054    .121     4.447   109.61   110.29
09/19/83   95    80.50     2ND PASS                 59.3    18.0   2.5    212.42     .084   10.674     .050    .112     4.269   114.00   114.70
09/19/83   95    80.50     3RD PASS                 59.3    16.5   2.5    212.42     .077    9.784     .046    .102     3.913   114.00   114.70
09/19/83   95    80.50   RUBBER 6609 1ST PASS       68.2    36.5   4.4    212.42     .171   24.893     .117    .262     5.657    64.77    65.17
09/19/83   95    80.50     2ND PASS                 68.2    23.5   2.5    212.42     .110   16.027     .075    .168     6.410   114.00   114.70
09/19/83   95    80.50     3RD PASS                 68.2    27.5   2.1    212.42     .129   18.755     .088    .197     8.930   135.71   136.55
09/19/83   95    80.50     4TH PASS                 68.2    23.0   2.5    212.42     .108   15.656     .073    .165     6.274   114.00   114.70
09/19/83   95    80.50     5TH PASS                 68.2    22.0   2.2    212.42     .103   15.004     .070    .157     6.820   129.54   130.35
09/19/83   95    80.50   RUBBER 6609 1ST PASS       68.2    44.0   4.2    212.42     .207   30.008     .141    .315     7.144    67.85    68.27
09/19/83   95    80.50     2ND PASS                 68.2    24.0   2.7    212.42     .112   16.368     .077    .172     6.062   105.55   106.21
09/19/83   95    80.50     3RD PASS                 68.2    21.0   2.9    212.42     .098   14.322     .067    .150     4.938    98.27    98.88
09/19/83   95    80.50     4TH PASS                 68.2    31.0   3.0    212.42     .145   21.142     .099    .222     7.047    95.00    95.59
09/19/83   95    80.50     5TH PASS                 68.2    18.5   2.5    212.42     .087   12.617     .059    .132     5.046   114.00   114.70
09/19/83   95    80.50     6TH PASS                 68.2    26.5   2.5    212.42     .124   18.073     .085    .190     7.229   114.00   114.70
09/19/83   95    80.50     7TH PASS                 68.2    20.5   3.0    212.42     .096   13.981     .065    .147     4.660    95.00    95.59
09/19/83   95    80.50   RUBBER 6609 1ST PASS       68.2    18.0   5.8    212.42     .084   12.276     .057    .129     2.116    49.13    49.44
09/19/83   95    80.50   TALC PASS                  68.2    18.5  12.7    212.42     .087   12.617     .059    .132      .993    22.44    22.58
                  TOTALS                                   922.5 109.5   6585.02     .140  574.063

TOTAL PASSES  31                                               MIN   2.1                       MIN     .039    .087     2.116    46.72    47.01
TOTAL PRODUCTION TIME 06:49:30                                 MAX   6.1                       MAX     .142    .318    11.577   135.71   136.55
AVERAGE LBS CEMENT PER PASS  29.758                            AVG   3.5                       AVG     .086    .194     5.582    88.82    89.37
AVERAGE LBS CEMENT PER SQUARE YARD 4.342
```

X2.6

X9.3

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                          DAVID M TOLUENE ANALYSIS                                                   PAGE  3

                                                   %                               CEM   TOLUENE    TOL      TOL       TOL      FEET    F/FEET
  DATE     LEN  WIDTH       DESCRIPTION           TOL    LBS    MINS   SQ YDS   SYD    USED      SYD      LYD       MIN      MIN      MIN

09/16/83   75   45.75   RUBBER 8402 1ST PASS  56.4   15.0    5.7    95.31   .157    8.460    .088     .112     1.484    39.47    22.57
09/16/83   75   45.75        2ND PASS          56.4   10.0    4.3    95.31   .104    5.640    .059     .075     1.311    52.32    29.92
09/16/83   75   45.75        3RD PASS          56.4    6.5    3.3    95.31   .068    3.666    .038     .048     1.110    68.18    38.99
09/16/83   75   45.75   RUBBER 7002 1ST PASS  58.8   16.5    6.1    95.31   .173    9.702    .101     .129     1.590    36.88    21.09
09/16/83   75   45.75        2ND PASS          58.8   24.5    5.9    95.31   .257   14.406    .151     .192     2.441    38.13    21.80
09/16/83   75   45.75        3RD PASS          58.8   18.5    5.3    95.31   .194   10.878    .114     .145     2.052    42.45    24.27
09/16/83   75   45.75        4TH PASS          58.8   15.5    3.2    95.31   .162    9.114    .095     .121     2.848    70.31    40.20
09/16/83   75   45.75        5TH PASS          58.8   12.0    2.8    95.31   .125    7.056    .074     .094     2.520    80.35    45.95
09/16/83   75   45.75        6TH PASS          58.8   10.5    2.6    95.31   .110    6.174    .064     .082     2.374    86.53    49.48
09/16/83   75   45.75        7TH PASS          58.8   19.5    4.0    95.31   .204   11.466    .120     .152     2.866    56.25    32.16
09/16/83   75   45.75        8TH PASS          58.8   14.0    3.2    95.31   .146    8.232    .086     .109     2.572    70.31    40.20
09/16/83   75   45.75        9TH PASS          58.8   16.5    4.2    95.31   .173    9.702    .101     .129     2.310    53.57    30.63
09/16/83   75   45.75       10TH PASS          58.8   13.5    3.9    95.31   .141    7.938    .083     .105     2.035    57.69    32.99
09/16/83   75   45.75       11TH PASS          58.8    9.0    3.6    95.31   .094    5.292    .055     .070     1.470    62.50    35.74
09/16/83   75   45.75       12TH PASS          58.8   22.0    4.2    95.31   .230   12.936    .135     .172     3.080    53.57    30.63
09/16/83   75   45.75       13TH PASS          58.8   17.0    3.1    95.31   .178    9.996    .104     .133     3.224    72.58    41.50
09/16/83   75   45.75       14TH PASS          58.8   18.5    2.5    95.31   .194   10.878    .114     .145     4.351    90.00    51.46
09/16/83   75   45.75       15TH PASS          58.8   11.5    2.4    95.31   .120    6.762    .070     .090     2.817    93.75    53.61
09/16/83   75   45.75       16TH PASS          58.8    8.5    3.9    95.31   .089    4.998    .052     .066     1.281    57.69    32.99
09/16/83   75   45.75       17TH PASS          58.8    9.5    3.2    95.31   .099    5.586    .058     .074     1.745    70.31    40.20
09/16/83   75   45.75   RUBBER 6607 1ST PASS  64.8    7.5    3.5    95.31   .078    4.860    .050     .064     1.388    64.28    36.76
09/16/83   75   45.75        2ND PASS          64.8   17.5    4.5    95.31   .183   11.340    .118     .151     2.520    50.00    28.59
09/16/83   75   45.75        3RD PASS          64.8   15.0    4.0    95.31   .157    9.720    .101     .129     2.430    56.25    32.16
09/16/83   75   45.75        4TH PASS          64.8   14.0    3.8    95.31   .146    9.072    .095     .121     2.387    59.21    33.86
09/16/83   75   45.75        5TH PASS          64.8    9.0    3.3    95.31   .094    5.832    .061     .077     1.767    68.18    38.99
09/16/83   75   45.75        6TH PASS          64.8    8.0    5.6    95.31   .083    5.184    .054     .069      .925    40.17    22.97
09/16/83   75   45.75        7TH PASS          64.8    7.0    4.5    95.31   .073    4.536    .047     .060     1.008    50.00    28.59
09/16/83   75   45.75        8TH PASS          64.8    7.5    3.4    95.31   .078    4.860    .050     .064     1.429    66.17    37.84
09/16/83   75   45.75   TALC PASS              64.8    8.0   10.8    95.31   .083    5.184    .054     .069      .480    20.83    11.91
                     TOTALS                          374.0  110.0  2668.68   .140  224.286

TOTAL PASSES  28                                     MIN   2.4                          MIN     .038     .048      .925    36.88    21.09
TOTAL PRODUCTION TIME 06:36:37                       MAX   6.1                          MAX     .151     .192     4.351    93.75    53.61
AVERAGE LBS CEMENT PER PASS  13.357                  AVG   3.9                          AVG     .083     .106     2.119    60.96    34.86
AVERAGE LBS CEMENT PER SQUARE YARD 3.924
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                    DAVID W TOLUENE ANALYSIS                                                      PAGE  2

                                                  %                                CEM  TOLUENE    TOL     TOL      TOL     FEET   F/FEET
 DATE     LEN  WIDTH      DESCRIPTION            TOL   LBS   MINS  SQ YDS  SYD   USED     SYD     LYD      MIN      MIN     MIN

9/15/83   100  61.75  RUBBER 1492 1ST PASS      56.4   30.5   8.6  171.52 .177   17.202   .100    .172    2.000    34.88   26.92
9/15/83   100  61.75     2ND PASS               56.4   14.5   5.2  171.52 .084    8.178   .047    .081    1.572    57.69   44.53
9/15/83   100  61.75     3RD PASS               56.4   13.5   4.6  171.52 .078    7.614   .044    .076    1.655    65.21   50.34
9/15/83   100  61.75  RUBBER 7002 1ST PASS      58.8   70.5   6.4  171.52 .411   41.454   .241    .414    6.477    46.87   36.18
9/15/83   100  61.75     2ND PASS               58.8   39.0   7.8  171.52 .227   22.932   .133    .229    2.940    38.46   29.68
9/15/83   100  61.75     3RD PASS               58.8   30.5   4.3  171.52 .177   17.934   .104    .179    4.170    69.76   53.85
9/15/83   100  61.75     4TH PASS               58.8   26.5   3.4  171.52 .154   15.582   .090    .155    4.582    88.23   68.10
9/15/83   100  61.75     5TH PASS               58.8   23.5   3.0  171.52 .137   13.818   .080    .138    4.606   100.00   77.19
9/15/83   100  61.75     6TH PASS               58.8   21.0   2.8  171.52 .122   12.348   .071    .123    4.410   107.14   82.70
9/15/83   100  61.75     7TH PASS               58.8   40.5   6.8  171.52 .236   23.814   .138    .238    3.502    44.11   34.05
9/15/83   100  61.75     8TH PASS               58.8   28.5   5.0  171.52 .166   16.758   .097    .167    3.351    60.00   46.31
9/15/83   100  61.75     9TH PASS               58.8   21.0   4.8  171.52 .122   12.348   .071    .123    2.572    62.50   48.24
9/15/83   100  61.75     10TH PASS              58.8   21.0   3.3  171.52 .122   12.348   .071    .123    3.741    90.90   70.17
9/15/83   100  61.75     11TH PASS              58.8   40.0   6.0  171.52 .233   23.520   .137    .235    3.920    50.00   38.59
9/15/83   100  61.75     12TH PASS              58.8   31.5   3.8  171.52 .183   18.522   .107    .185    4.874    78.94   60.93
9/15/83   100  61.75     13TH PASS              58.8   25.0   4.7  171.52 .145   14.700   .085    .147    3.127    63.82   49.27
9/15/83   100  61.75     14TH PASS              58.8   25.5   3.6  171.52 .148   14.994   .087    .149    4.165    83.33   64.32
9/15/83   100  61.75     15TH PASS              58.8   18.5   3.5  171.52 .107   10.878   .063    .108    3.108    85.71   66.16
9/15/83   100  61.75     16TH PASS              58.8   21.0   3.7  171.52 .122   12.348   .071    .123    3.337    81.08   62.58
9/15/83   100  61.75     17TH PASS              58.8   14.5   2.7  171.52 .084    8.526   .049    .085    3.157   111.11   85.76
9/15/83   100  61.75  RUBBER 6607 1ST PASS      66.5   14.0   4.1  171.52 .081    9.310   .054    .093    2.270    73.17   56.48
9/15/83   100  61.75     2ND PASS               66.5   28.0   6.1  171.52 .163   18.620   .108    .186    3.052    49.18   37.96
9/15/83   100  61.75     3RD PASS               66.5   23.5   6.2  171.52 .137   15.627   .091    .156    3.005    67.40   44.53
9/15/83   100  61.75     4TH PASS               66.5   17.0   6.0  171.52 .099   11.305   .065    .113    1.884    50.00   38.59
9/15/83   100  61.75  RUBBER 6077 1ST PASS      64.8   16.0   4.9  171.52 .093   10.368   .060    .103    2.115    61.22   47.25
9/15/83   100  61.75     2ND PASS               64.8   16.5   3.6  171.52 .096   10.692   .062    .106    2.970    83.33   64.32
9/15/83   100  61.75     3RD PASS               64.8   13.0   4.2  171.52 .075    8.424   .049    .084    2.005    71.42   55.13
9/15/83   100  61.75     4TH PASS               64.8   12.5   3.6  171.52 .072    8.100   .047    .081    2.250    83.33   64.32
9/15/83   100  61.75     5TH PASS               64.8   13.5   2.8  171.52 .078    8.748   .051    .087    3.124   107.14   82.70
9/15/83   100  61.75  TALC PASS                 64.8   16.0  15.2  171.52 .093   10.368   .060    .103     .682    19.73   15.23
             TOTALS                                   710.5 134.5 4974.08 .142  427.612

OTAL PASSES  29                                         MIN   2.7                      MIN   .044    .076    1.572    34.88   26.92
OTAL PRODUCTION TIME 07:30:01                           MAX   8.6                      MAX   .241    .414    6.477   111.11   85.76
VERAGE LBS CEMENT PER PASS  24.500                      AVG   4.6                      AVG   .085    .146    3.239    70.90   54.72
VERAGE LBS CEMENT PER SQUARE YARD 4.142
```

Best Available Copy

```
RUN ON 01/23/84 AT 14:11:22                  DAVID W TOLUENE ANALYSIS                                              PAGE 25
                                         %                              CEM  TOLUENE    TOL    TOL     TOL   FEET  F/FEET
 DATE    LEN   WIDTH      DESCRIPTION   TOL    LBS    MINS   SQ YDS    SYD   USED      SYD    LYD     MIN   MIN    MIN
             GRAND TOTALS                   19281.0  2984.1 126091.55        11995.663

                         GRAND TOTAL PASSES 708
                         GRAND TOTAL AVERAGE LBS CEMENT PER PASS  27.233
                         GRAND TOTAL AVERAGE LBS CEMENT PER SQUARE YARD  .152
```

$$\text{AVG - TOL/MIN} = \frac{11995.663}{2984.1} = 4.01$$

$$\text{AVG - TOL/PASS} = \frac{11995.663}{708} = 16.94$$

EXHIBIT III

May 30, 1984

TO: R. H. Baddeley

FROM: M. A. Ware

The following three pages is the data you requested regarding David 'M' Company in Orlando. A detailed report covering same will follow at a later date.

M. A. Ware

MAW:bjw

SUMMARY

Date: May 25, 1984
Roll Length: 50 yards (resurface blanket)
Roll Width: 79"
Plys: 3-ply

Product Code: 4-Black Special
Operator: Mack

Magnehelic Setting: .07-.08
Duct Temp: 135°F
Flow ACFM: 5698
Flow SCFM: 5076

Pass	Rubber	% VOC	Cement Lbs/Pass	Toluene Lbs/Pass	Min/ Pass	Avg Lbs Tol/ Min	Ft/Min Tach	Ft/Min Calc	ppm Meter	% LEL Meter	% LEL Calc
1	B 1280	58.5%	9.5	Mixture of Toluene, MEK & Monochlorobenzene	3.3	N.A.	40-42	45.5	N.A.	N.A.	N.A.
2	B 1280		10.0	"	3.2	N.A.	44-45	46.9	N.A.	N.A.	N.A.
3	7002 (1)	58.7%	11.0	6.5	3.5	1.9	39-41	43.0	1313	10.3	10.8
4	7002		26.0	15.3	4.4	3.5	29-30	34.1	2000	15.7	19.8
5	7002		34.0	20.0	5.1	3.9	24-26	29.4	2313	18.2	22.1
6	7002		30.5	17.9	4.4	4.1	30-31	34.1	2625	20.7	23.2
7	7002		21.5	12.6	3.2	3.9	41-42	46.9	2625	20.7	22.1
8	7002		17.5	10.3	3.3	3.1	41-42	45.5	2625	20.7	17.6
9	7002		14.0	8.2	2.5	3.3	54-55	60.0	2627	20.7	18.7
10	7002		26.5	15.6	4.4	3.5	30-31	34.1	2625	20.7	19.8
11	7002		17.5	10.3	3.1	3.3	41-42	48.4	2625	20.7	18.7
12	7002		14.0	8.2	1.8	4.6	72-73	83.3	3250	25.6	26.0
13	7002		11.5	6.8	1.8	3.8	72-75	83.3	2938	23.2	21.5
14	7002		12.0	7.0	2.2	3.2	72-75	68.2	2938	23.2	18.1
15	7002 (1) Talc Pass		11.5	6.8	7.2	.94	Not on Tach	20.8	1125	8.9	5.3

Avg Lbs Tol/Hr: 42.0
Avg Lbs Tol/Pass: 11.2
Total Production Time: 3:27:45

Avg Min/Pass: 3.6

Avg Lbs/Min: 3.3
Avg % LEL: 19.2%

SUMMARY

Date: May 24, 1984
Roll Length: 100 yards
Roll Width: 62"
Plys: One

Product Code: One Ply Red
Operator: Mack

Magnehelic Setting: .07-.08
Duct Temp: 135°F
Flow ACFM (a 135°F): 5698
Flow SCFM (a 70°F): 5076

Pass	Rubber	% VOC	Cement Lbs/Pass	Toluene Lbs/Pass	Min/Pass	Avg Lbs Tol/Min	Ft/Min Tach	Ft/Min Calc	ppm Meter	% LEL Meter	% LEL Calc
1	7002	Tol 59.7%	57.0	34.0	10.37	3.28	29-30	28.9	2125	16.7	18.6
2	7002		40.5	24.2	10.3	2.35	29-30	28.9	1687	13.3	13.3
3	7002		40.5	24.2	10.7	2.26	29-30	28.0	1625	12.8	12.8
4	7002		28.0	16.7	9.1	1.83	34-36	33.0	1594	12.6	10.4
5	7002		28.0	16.7	9.0	1.86	29-36	33.3	1625	12.8	10.5
6	7002		25.5	15.2	7.8	1.95	40-42	38.5	1500	11.8	11.0
7	7002		20.0	11.9	7.5	1.59	40-43	40.0	1438	11.3	9.0
8	7002 (1)&(2)	59.8%	35.5	21.2	8.8	2.41	40-41	34.1	1625	12.8	13.6
9	7002 (2)		31.0	9.9	5.8	1.71	55-56	52.0	2313	18.2	9.7
10	7002 (2)		31.0	18.5	5.6	3.30	54-55	53.6	2000	15.7	18.7
11	3303 (1) Face	69.7%	25.5	17.8	8.9	2.00	34-36	33.7	2125	16.7	11.3
12	3303 (1)		37.0	25.8	7.5	3.44	40-41	40.0	2438	19.2	17.9
13	3303 (1)		35.0	24.4	7.3	3.34	40-42	41.1	2313	18.2	18.4
14	3303 (1)		37.0	25.8	5.7	4.53	55-57	52.6	2314	18.2	25.7
15	3303 (1)		22.0	15.3	5.6	2.73	54-55	53.6	2314	18.2	15.5
16	3303 (1) Dry Pass		--	--	--	--	---	--	--		
17	3303 (1) Talc Pass		27.0	18.8	13.6	1.38	Not on Tach Readout	--	1313	10.3	7.81

Avg Lbs Tol/Hr: 49.8
Avg Lbs Tol/Pass: 20.03
Total Production Time: 6:26:52

Avg Min/Pass: 8.35

Avg Lbs/Min: 2.5
Avg % LEL: 14.9%

SUMMARY

Date: May 23, 1984
Roll Length: 100 yards
Roll Width: 82"
Plys: 4-ply conv.

Product Code: 2 Green Spec.
Operator: Mack

Magnehelic Setting: .07-.08
Duct Temp: 135°F
Flow ACFM (a 135°F): 5698
Flow SCFM (a 70°F): 5076

Pass	Rubber	% VOC	Cement Lbs/Pass	Toluene Lbs/Pass	Min/ Pass	Avg Lbs Tol/ Min	Ft/Min Tach	Ft/Min Calc	ppm Meter	% LEL Meter	% LEL Calc
1	1492-Subface	Tol/MEK 52.3%	29.5	15.4	5.8	2.66	56-57	51.7	1625	12.8	15.0
2	1492		21.0	11.0	6.0	1.83	54-56	50.0	1500	11.8	10.4
3	7002 (1)	Tol 60.1%	36.5	21.9	6.3	3.48	45-50	47.6	2375	18.7	19.7
4	7002 (1)		43.5	26.1	7.3	3.58	40-43	41.0	2625	20.6	20.27
5	7002 (1)		37.0	22.2	4.9	4.53	64-73	61.2	2625	20.6	25.7
6	7002 (1)		53.5	32.1	7.2	4.46	40-42	41.7	2875	22.6	25.3
7	7002 (1)		45.5	27.3	6.2	4.40	54-55	48.4	3250	25.6	24.9
8	7002 (1)		64.0	38.5	7.5	5.13	40-43	40.0	3000	23.6	29.0
9	7002 (2)		47.5	28.5	7.3	3.90	41-42	41.0	3000	23.6	20.4
10	7002 (2)		51.5	31.0	5.8	5.34	53-56	51.7	3260	25.7	30.2
11	7002 (2)		50.5	30.4	7.4	4.10	40-42	40.5	3000	23.6	23.2
12	7002 (2)		50.0	30.1	4.9	6.14	62-67	61.2	3260	25.7	34.8
13	7002 (2)		37.0	22.2	4.3	5.16	70-75	69.7	3260	25.7	29.2
14	2202-Face Green	Tol 67.0%	40.5	27.1	11.6	2.34	24-25	25.8	2625	20.6	13.3
15	2202		40.5	27.1	9.8	2.77	29-30	30.6	2625	20.6	15.7
16	2202		45.5	30.4	7.1	4.28	40-43	42.2	3000	23.6	24.2
17	2202		36.5	24.5	5.7	4.30	54-56	52.6	3000	23.6	24.3
18	2202		54.0	36.2	8.4	4.31	35-37	35.7	3000	23.6	24.4
19	2202		38.0	25.5	7.1	3.59	40-42	42.2	3000	23.6	20.3
20	2202		23.0	15.4	6.8	2.26	40-42	44.1	2125	16.7	12.8
21	2202		28.0	18.8	7.0	2.68	40-42	42.8	(No Reading)		15.2
22	2202-Talc Pass		23.0	15.4	13.3	1.16	---	22.6	1312	10.33	6.57

Avg Lbs Tol/Hr: 73.1
Avg Lbs Tol/Pass: 25.32
Total Production Time: 7:37:00

Avg Min/Pass: 7.2

Avg Lbs/Min: 3.51
Avg % LEL: 20%

DAVID M COMPANY
201 VALENTINE WAY
LONGWOOD, FLORIDA 32750

Case No. 84-0044

LONGWOOD
JUN 29'84
S.POSTAGE

CERTIFIED
P 211 559 779
MAIL

Department of Environmental Regulation
Bureau of Air Quality Management
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32301-8241

DER
JUL 2 1984
BAQM

P 408 530 377

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED—
NOT FOR INTERNATIONAL MAIL

(See Reverse)

Sent to Mr. Michael A. Ware	
Street and No.	
P.O., State and ZIP Code	
Postage	$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to whom and Date Delivered	
Return Receipt Showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	$
Postmark or Date 11/23/83	

PS Form 3800, Feb. 1982

PS Form 3811, Jan. 1979

RETURN RECEIPT, REGISTERED, INSURED AND CERTIFIED MAIL

● SENDER: Complete items 1, 2, and 3.
Add your address in the "RETURN TO" space on reverse.

1. The following service is requested (check one.)
   - ☒ Show to whom and date delivered............ ——¢
   - ☐ Show to whom, date and address of delivery....... ——¢
   - ☐ RESTRICTED DELIVERY Show to whom and date delivered.................. ——¢
   - ☐ RESTRICTED DELIVERY. Show to whom, date, and address of delivery.$ ——

   (CONSULT POSTMASTER FOR FEES)

2. ARTICLE ADDRESSED TO:

Mr. Michael A. Ware
2010 Indiana Street
Racine, Wisconsin 53405

3. ARTICLE DESCRIPTION:

REGISTERED NO.	CERTIFIED NO.	INSURED NO.
	P408530377	

(Always obtain signature of addressee or agent)

I have received the article described above.

SIGNATURE ☐Addressee ☐Authorized agent

Sally E. Cooke 11/28/83

4. DATE OF DELIVERY

11/25/85

POSTMARK

RACINE, WI WEST RACINE STA.
NOV 28 1983

5. ADDRESS (Complete only if requested)

6. UNABLE TO DELIVER BECAUSE:

CLERK'S INITIALS

☆GPO : 1979-300-459

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

November 22, 1983

Mr. Michael A. Ware
Graphics Division Environmental
  Coordinator
Wheelabrator-Frye Inc.
2010 Indiana Street
Racine, Wisconsin 53405

Dear Mr. Ware:

The Department has reviewed your November 1, 1983 reply to our letter requesting additional information to complete the application for permit to construct the air pollution control devices required at David "M" Company. As noted in your letter, some of the requested information is not available at this time. Until we receive:

1) a description of the proposed control equipment selected for the storage tanks and the estimated emissions from the storage tanks;
2) the equipment specifications and talc emissions from the proposed baghouse;
3) the specifications on the control device selected for the manufacturing equipment and its design emissions of criteria pollutants,

your application will be incomplete and we will be unable to process it. Your Overall Compliance Schedule shows some of this information may not be available until September 1, 1984.

The Department finds it normal permitting procedure is not appropriate because of the delay involved in selecting, purchasing and installing the control equipment needed to bring the emissions from David "M" Company into compliance with state and federal regulations. Therefore, the Department's Bureau of Air Quality Management staff will meet with the Enforcement Section and draft a Consent Order to address this situation. We tentatively plan to have a copy of the proposed Order to you during December, 1983. After review of the proposed Order, the Department would expect your Company to accept it or meet with us to resolve any differences that may exist.

If you have any questions on this matter, please call Willard Hanks (904/488-1344) or Tom Bessa (305/894-7955).

Sincerely,

C. H. Fancy, P.E.
Bureau of Air Quality
Management

CHF/WH/s
cc: Tom Bessa, St. Johns River District

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices And/Or To Other Than The Addressee		
To:	Loctn.:	
To:	Loctn.:	
To:	Loctn.:	
From:	Date:	
Reply Optional ☐	Reply Required ☐	Info. Only ☐
Date Due:	Date Due:	

TO: Nancy Wright

THRU: Bill Thomas BT

FROM: Willard Hanks wmh

DATE: November 14, 1983

SUBJ: David "M" Company

Michael Ware, representing David "M" Company, replied to BAQM's September 2, 1983 "incompleteness letter" on November 1, 1983. He was unable to answer all the questions in our September 2 letter. His reply included an Overall Compliance Schedule (attached) which shows some of the information required to complete the application will not be available until after September 1, 1984.

Their reply included expected emissions from the controlled plant, the minimum efficiency of the control device, and a schedule of when the control device will be installed and in operation. A permit to construct cannot be drafted without more information from the Company.

Under these circumstances, it appears a "Consent Order" is needed. The Consent Order should include:

1. A requirement for reporting the status of each step listed in the Overall Compliance Schedule.
2. DER's option to "speed up" the schedule, if justified.
3. A requirement that air pollution control devices be installed on the storage tanks ASAP. They are minor sources of VOCs, and the selection of control equipment is nearer to being completed. The control equipment for the tanks would be installed without a permit to construct in this circumstance.
4. Limit operations of the plant to 16 hr/day.
5. Set a deadline for the application for permit to construct to be complete, based on their proposed schedule.
6. Set a deadline for the equipment to be installed and in operation.
7. Set a deadline for the application for permit to operate to be submitted.

A letter needs to be sent to the Company by November 30, 1983 to officially confirm their application is still incomplete. A proposed draft letter is attached.

WH/ks
cc: Tom Bessa, St. Johns River District 2 sent copy 11/22/83

October 19, 1983

ESTIMATED
OVERALL COMPLIANCE SCHEDULE
DAVID M COMPANY VOC CONTROL PROJECT

PHASE	
Data Accumulation	January 1, 1984
Spreader Enclosure - (1) For Temperature Evaluation	January 15, 1984
Process Modifications and Development	April 1, 1984
Methods Comparison/Analysis - Thermal Incineration Vs. Recovery	May 15, 1984
Final Specification Development	July 1, 1984
Final Specification/Quotations and Analysis	September 1, 1984
Appropriations Request Development and Approval	December 1, 1984
Oven Enclosure and Exhaust System Installation	March 1, 1985
Solvent Recovery Delivery and Installation	August 1, 1985
Operational Shakedown, Debugging and Compliance Testing	December 1, 1985

Wheelabrator-Frye Inc.
Graphic Supplies Division
7520 University
Des Moines, Iowa 50311
Tel. (515) 274-4901

November 1, 1983

DER
NOV 02 1983
BAQM

Mr. Willard Hanks
Engineer
State of Florida
Department of Environmental Regulation
2600 Blair Stone Road
Twin Towers Building
Tallahassee, FL 32301

Dear Mr. Hanks:

I'd like to take this opportunity to thank you, Bill Thomas and Nancy Wright for the courtesies extended myself and Herb Mycroft during the course of our recent meeting in Tallahassee. In accordance with our conversations at that time, please find enclosed additional data gathered pursuant to Mr. C.H. Fancy's request for same dated September 2, 1983.

Should you require further information and/or assistance in processing David "M" Company's air pollution permit application, please don't hesitate to contact me directly.

Sincerely,

Michael A. Ware

Michael A. Ware
Graphics Div. Env. Coord.
Chemicals & Coatings Group
Wheelabrator-Frye, Inc.

MAW;bjw
Encl.

cc: Wayne Brady
Jerry Spangler
Herb Mycroft
Bob Baddeley
J. H. Gamble
T. J. Lucas

11/1/83

SUPPLEMENT TO DAVID 'M' COMPANY APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

Prepared By: Michael A. Ware

1. What will be the maximum production and operation time (hour/day) of the plant?

   The maximum uncontrolled emissions of the plant will be 300 tons/year based upon a two shift, 16 hours/day operation. The potential emissions incorporating an end of pipe control device capable of delivering 90% removal efficiency would approximate 30 tons/year. The 300 ton/year two shift operation is based upon the following historical information:

YEAR	OPERATING HOURS/DAY	ESTIMATED % NORMAL BUSINESS VOLUME	ANNUAL EMISSIONS
1982	10	90%	271 Tons
1983	16	80%	255 Tons (Annualized Estimate)

2. What percent of the maximum production was the emission and raw material data in the application based upon?

   The application was based upon 80% of the historically derived 300 tons/year uncontrolled emission number and reflected current economic conditions which approximate 70-80% of the usual demand for lithographic printing blankets. Should blanket demand return to 100% of the normal level, 300 tons uncontrolled and/or 30 tons controlled would approximate annual emissions without subtracting rubber cement containing VOC's which are disposed of at Emille, Alabama.

3. Will solvents other than MEK and Toluene be used at this plant?

   Yes, small amounts of Naptha and Isopropyl Alcohol will be used at this facility for the purpose of manually cleaning blankets during inspection. The additional fugitive type emissions from the use of these materials will approximate

5,000 lbs/yr	Ispropyl Alcohol
2,000 lbs/yr	Naptha

4. How many gallons per year of each solvent will be consumed at the maximum production of the plant?

   Approximately 75,000 gallons Toluene and 9,000 gallons MEK will be used at the maximum production of the plant. Were the use of MEK to be discontinued in order to facilitate efficient recovery of Toluene, approximately 83,000 gallons of Toluene would be used annually at the maximum production of the plant.

5. How will the solvents be shipped to the plant? Submit a drawing showing the storage area and piping to the mixing area.

   The solvents will be shipped via bulk tanker and Appendix I is a conceptualization of the storage area and piping to the mixing area.

6. a) How many storage tanks will be built at the plant?

      Five, two for #2 diesel fuel, two for Toluene storage and one for MEK storage.

   b) What air pollution control equipment will be used to minimize VOC emissions from the tanks?

      A coaxial vapor recovery system of the type 1 or 2 nature will be installed to minimize VOC emissions during off loading. In addition, an OPW 523, or 523 - S pressure vacuum vent will be installed on each tank vent line to minimize VOC emissions during storage. Appendix II contains example information on coaxial vapor recovery and OPW 523 and 523-S vents like those proposed for installation.

   c) What will be emissions be from the tanks? Submit emissions calculation.

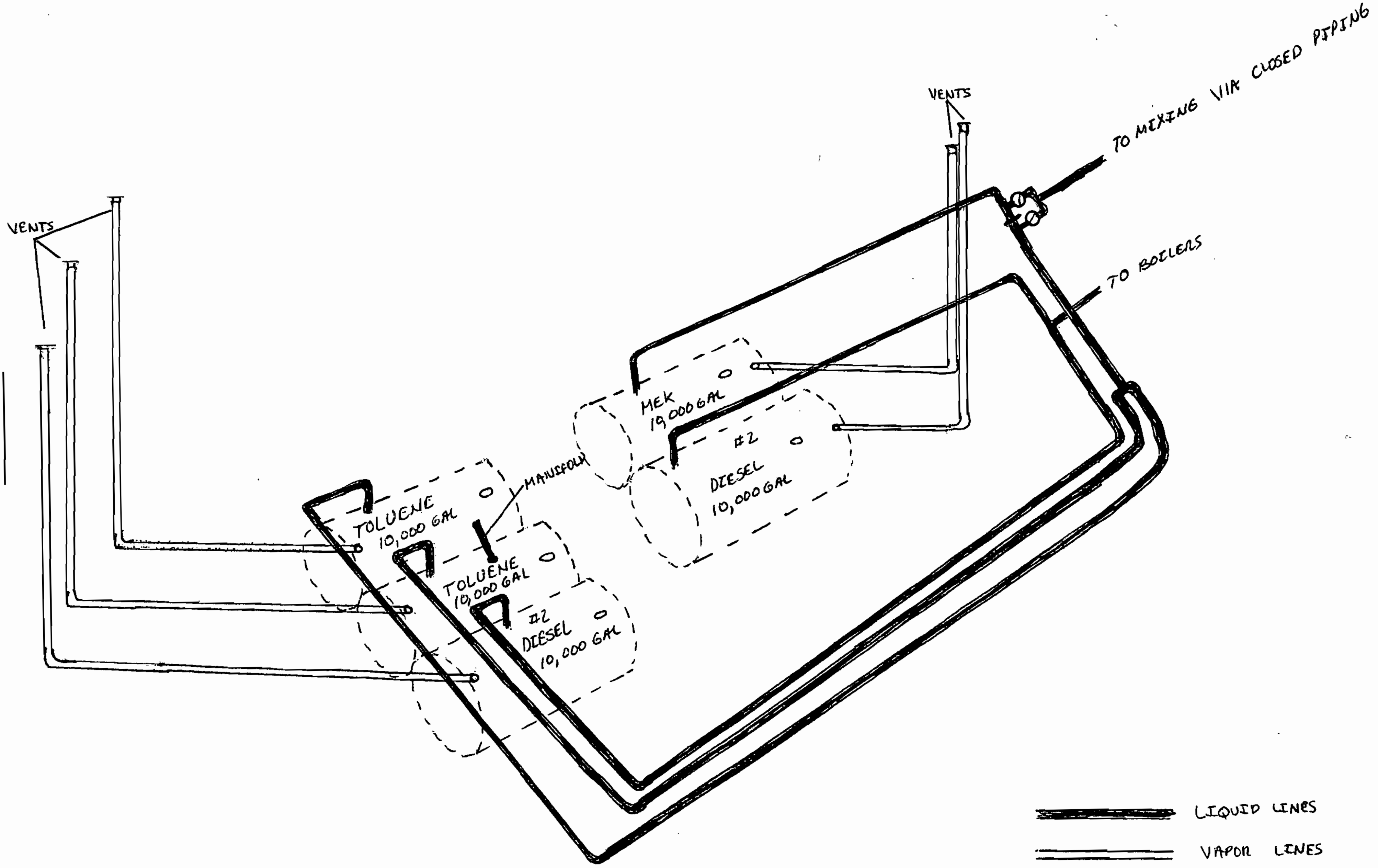
      The equipment supplier has not as yet provided information concerning expected emissions from tanks equipped with coaxing recovery and pressure vents. We will endeavor to obtain this information as soon as possible.

7. What will be the mixing ratio of solvent to rubber in lbs/lb?

   The chart below outlines the mixing ratio of solvent to rubber on a 100 lb. batch basis.

APPENDIX I

EXISTING SOLVENT STORAGE / DELIVERY SYSTEM



TANKS: UNDERGROUND

PLUMBING: UNDERGROUND TO PUMPS

SECTION B

Coaxial Vapor Recovery Equipment

FOR USE IN STAGE I AND STAGE II SYSTEMS

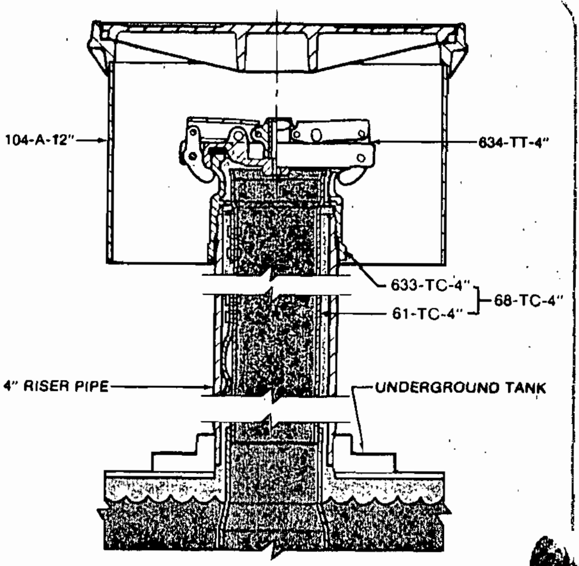
System C

TYPE 1 - 68-TC - 3" & 4" Series Fittings (Non Poppeted)

TYPE 2 - 68-TCP - 3" & 4" Series Fittings (Poppeted)

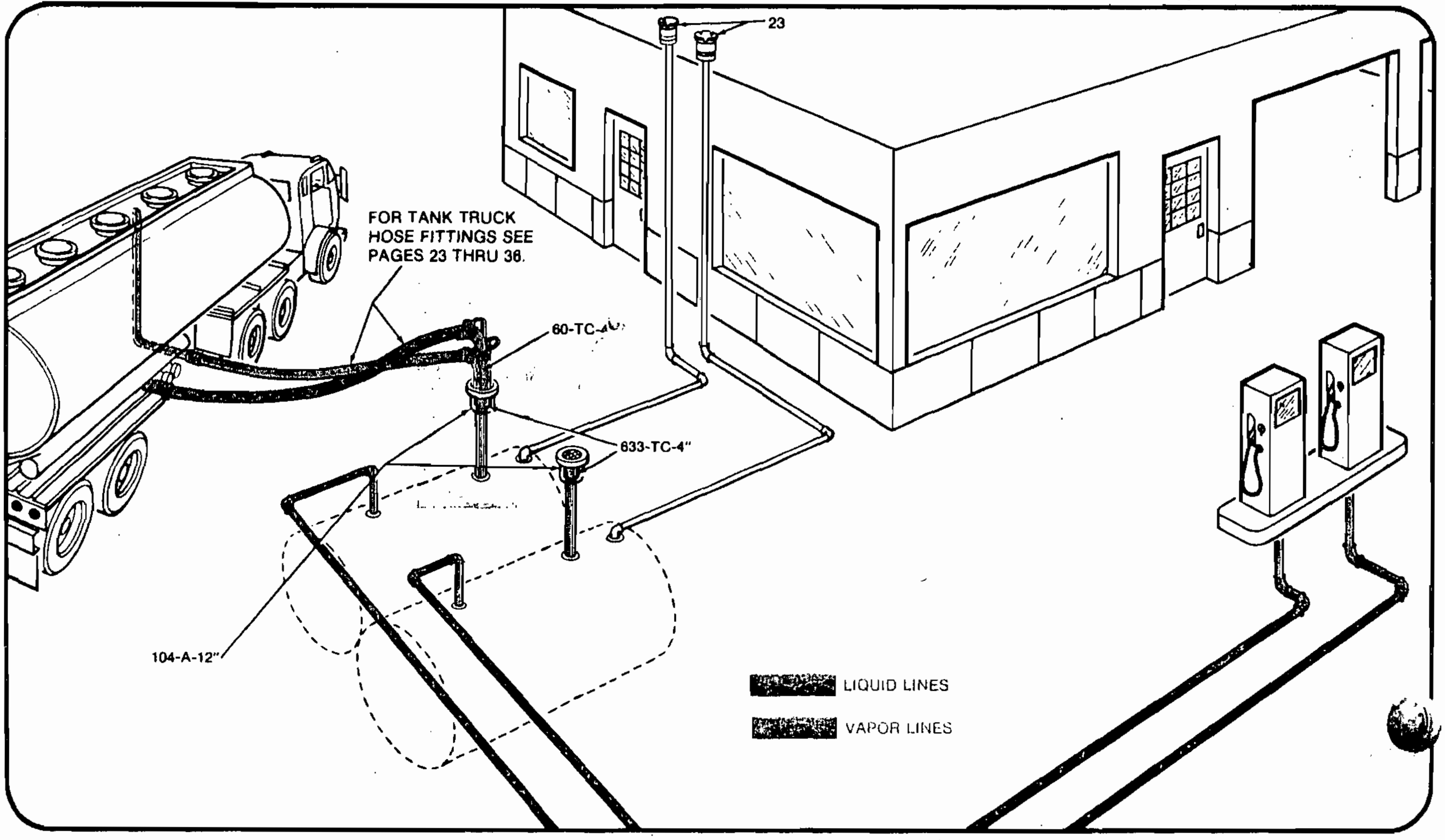
An easy, inexpensive means to convert existing conventional 3" & 4" size underground storage tank fill pipes to coaxial installations. Normally little to no digging or tearing up of concrete is necessary. Simply remove existing tight fill adaptor and fill pipe (if installation is so equipped), inserting Type 1 or Type 2 coaxial fill tube and adaptor as required.

NOTE: Type 2 poppeted fittings are certified by California Air Resources Board (CARB)

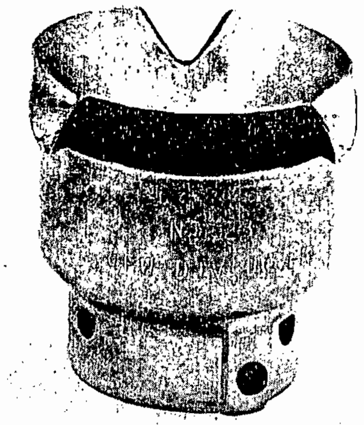


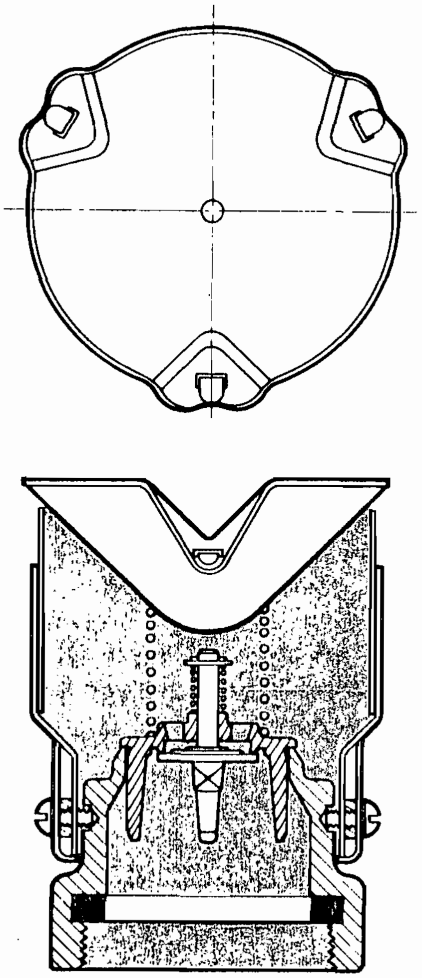
TYPE 1 68-TC - 4" SERIES (NON-POPPETED) FITTINGS

SHOWN BELOW IS A TYPE 1 - 68TC-4" TYPICAL INSTALLATION

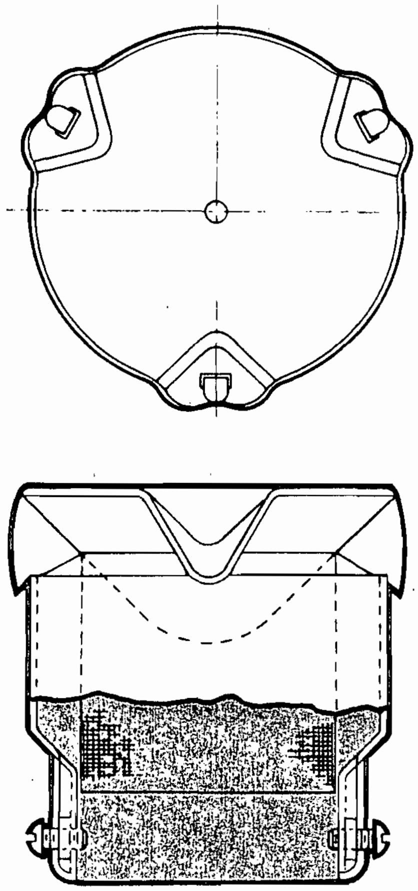


OPW 23





OPW 523



OPW 23

OPW 523

OPW 23, 523, 523-S VENTS

The OPW 23 Vent has an aluminum body and a 40-mesh brass screen. The OPW 23 is an open vent and directs vapors upward in accordance with NFPA Code 30. Set screws make installation easy. Available in 1½″, 2″ and 3″ sizes.

The OPW 523 Pressure Vacuum Vent is an upward vapor discharge vent and is available with either an 8 oz. or 12 oz. pressure setting and a ½ oz. vacuum setting.

The 523 is available in 2″ size, and is attached to the 2″ threaded vent pipe.

The OPW 523-S Pressure Vacuum Vent is similar to the 523 above, except it is attached to the vent line with set screws rather than pipe threads. A gasket is provided.

Available in 2″ size.

The rated maximum flow pressure drop for all OPW 523 Vents is 28 oz. per square inch at 7000 SCFH.

COMPOUND	# SAMPLES ANALYZED	AVG LBS. TOLUENE/100 LBS.	AVG LBS RUBBER/ 100 LBS.
7002	48	58.9	41.1
5503	22	63.7	36.3
1101	48	47.8	52.2
6607	40	63.4	36.6
1100	23	49.3	50.7
1492	20	61.2	38.8
6609	31	66.5	33.5
106E	1	63.3	36.7
7001	2	62.1	37.9
108	12	32.7	67.3
1280	12	57.1	42.9
106	9	65.6	34.4
105	13	33.8	66.2
3303	2	64.9	35.1
7007	7	62.0	38

Note: Encompasses all but 3 compounds currently used in production and would be a suitable cross section of those compounds used most frequently.

8. How many pounds of volatile organic compounds will be in a gallon of applied coating?

The chart below delineates lbs. solvent/gallon of applied coating for the most frequently used compounds.

COMPOUND	HI	LO	AVERAGE	NUMBER TESTED
7007	5.6	4.8	5.3	16
5503	6.1	5.4	5.7	8
6607	5.8	4.6	5.2	21
1492	5.4	4.6	5.2	4
3303	5.3	5.6	5.4	2
1280	5.1	4.9	5.0	2
1100	5.6	4.6	4.9	9
1101	5.0	4.3	4.7	16
105	4.1	3.8	3.9	9

* The above examples are typical of those compounds current in use, however, they do not include all compounds currently in use.

9. a) How will Talc be received, stored and conveyed to the process?

Talc is received, stored and conveyed to the process in 55 pound bags.

b) What air pollution control equipment or operation practices will be used to minimize Talc emissions?

Appendix III contains a drawing of the bag house and ancillary piping and collectors to be used in the talcing operation for the purpose of dust collection.

c) How much Talc will be emitted to the atmosphere?

Talc emissions will be fugitive since the collector will be located in-doors. The dust collector supplier is being contacted in order to ascertain estimated collection and removal efficiencies for the purpose of a fugitive emissions estimate. We will transmit that information to you as soon as it becomes available.

10. Will solvent laden air discharged from the plant contain any particulates or oil mist?

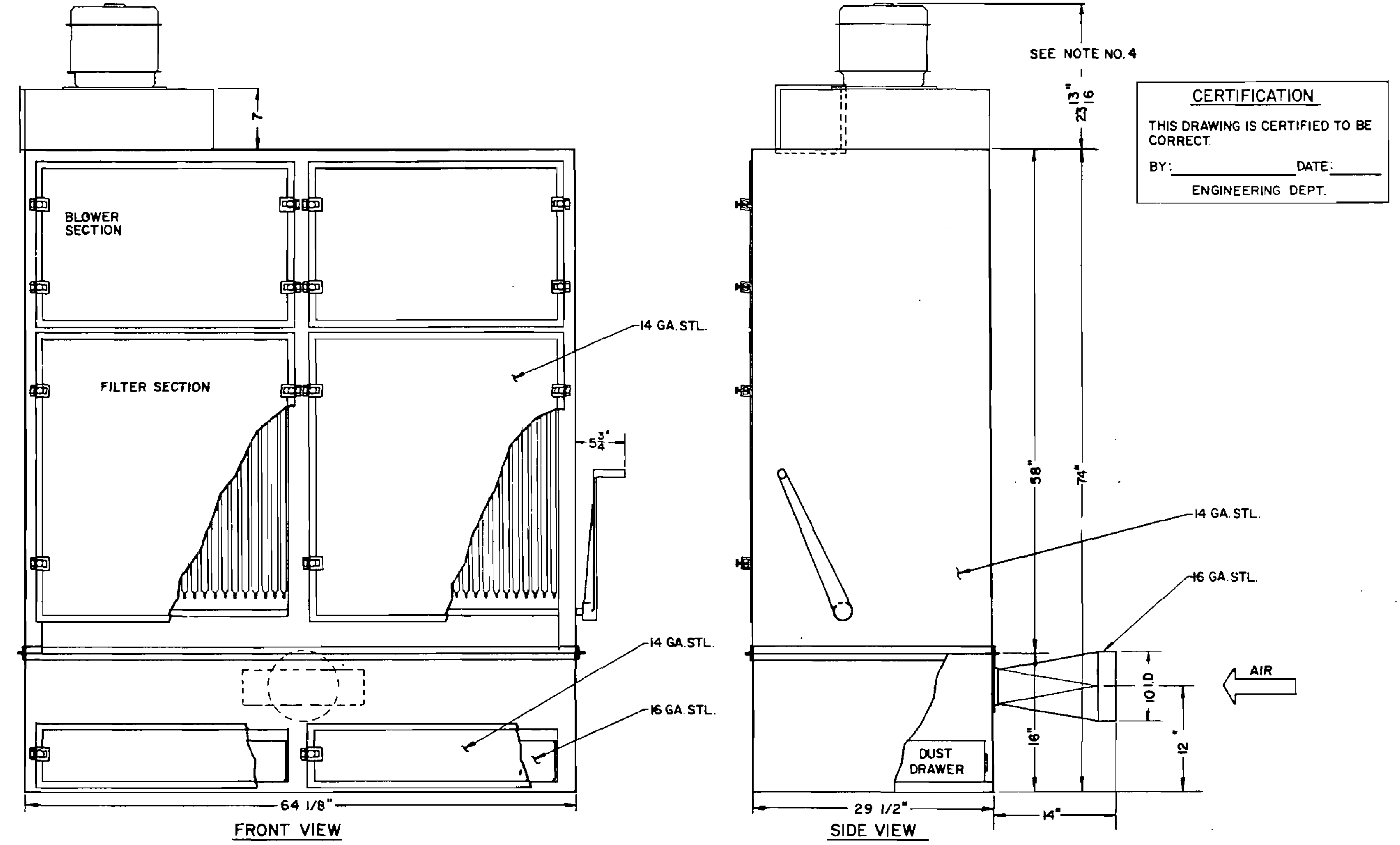
The solvent laden air will contain only fugitive particulates and no oil mist. Should solvent recovery be the selected control device, air discharged will be filtered at an efficient removal level of 99.0%+ of particles $\geq$ .3 microns in diameter.

11. a) What will be the particulate and VOC emissions from emission point No. 2 mills?

Particulate and VOC emissions combined from the milling operation would approximate 1.7 - 8.0 lbs/day. These numbers were generated by weighing all the individual components to be added to a batch before milling and then weighing the total batch post milling and noting the lost material. The plasticizers used in the milling process are not appreciably volatile. Appendix IV contains several example data sheets on plasticizers commonly used in the milling operation and Appendix V contains volatility data on many plasticizers used in the rubber industry.

b) What control equipment will be used to limit particulate emissions from the mills?

Since nearly all rubber compounds are compounded from masterbatches, particulate emissions are quite low and as such no control devide is currently proposed for the operation, see (11a) above.



CERTIFICATION

THIS DRAWING IS CERTIFIED TO BE CORRECT.

BY:________________ DATE:________

ENGINEERING DEPT.

····MULTIPLE RATING TABLES····

C.F.M.	F.P.M.	EXT. S.P.	C.F.M.	F.P.M.	EXT. S.P.
3625	6654	4.65	1912	3351	12 15
3365	6179	5.70			
2995	5491	7.38			
2390	4386	9 95			

SPECIFICATIONS

1. MOTOR SHALL BE 10 HP ON NO. 124-20 5-10 3600 RPM, 230-460/60/3.
2. DUST STORAGE CAPACITY SHALL BE 4.4 CU. FT.
3. FILTER AREA SHALL BE 400 SQ. FT. (40 FILTERS 30" x 24" EACH.)
4. NET WT. 1100 SHIPPING WT. 1475

NOTES

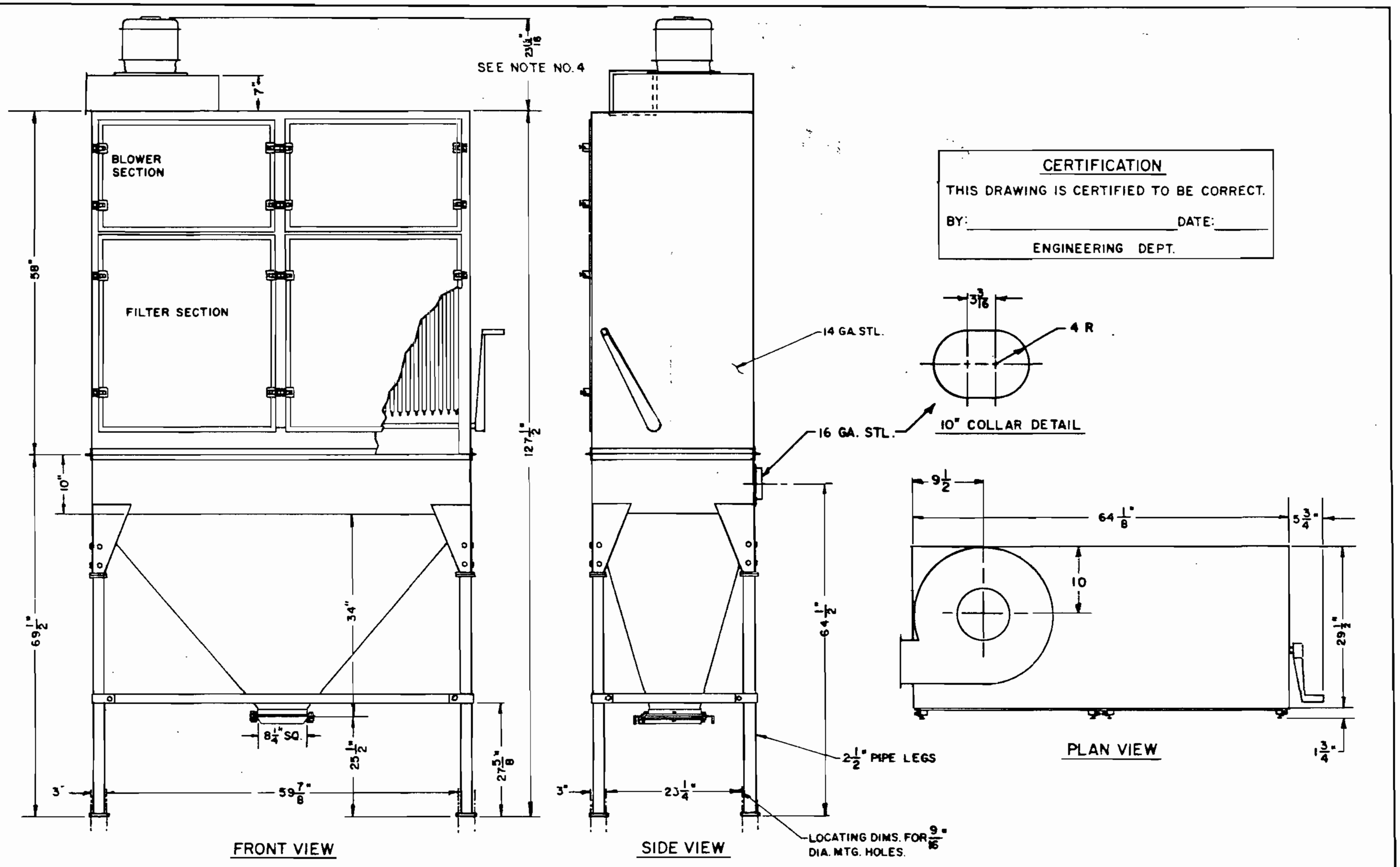
1. THIS DRAWING IS FOR A 124-20-5-10 DUST COLLECTOR ANY DEPARTURE FROM THIS DESIGN SHALL REQUIRE SPECIAL FABRICATION AND AN INCREASE IN COST.
2. THIS DRAWING IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES UNLESS PROPERLY SIGNED BY TORIT.
3. ALLOW A MIN. CLEARANCE OF 5" HEAD ROOM FOR REMOVAL OF MOTOR & WHEEL ASS'Y
4. MOTOR HEIGH BASED ON STOCK, CAN VARY WITH MFRS.

TORIT DIVISION, DONALDSON COMPANY, INC.
P.O. BOX 1299 - MINNEAPOLIS, MINNESOTA 55440

SPECIFICATION CONTROL DRAWING
NO. 124-20-5-10 DUST COLLECTOR

DRAWN: T. [illegible]
APP'D:

DRWG. NO: 124-020
REV. E 2-25-72



CERTIFICATION

THIS DRAWING IS CERTIFIED TO BE CORRECT.

BY: ____________________ DATE: ________

ENGINEERING DEPT.

MULTIPLE RATING TABLES

C.F.M.	F.P.M.	EXT. S.P.	C.F.M.	F.P.M.	EXT. S.P.
3625	6654	4.65	1912	3351	12.15
* 3365	6179	5.70 *			
2995	5491	7.38			
2390	4386	9.95			

SPECIFICATIONS

1. MOTOR SHALL BE 10 HP 3600 RPM, 230-460/60/3.
2. HOPPER CAPACITY SHALL BE 16.0 CU. FT.
3. FILTER AREA SHALL BE 400 SQ. FT. (40 FILTERS 30" X 24" EACH)
4. INLET LOCATION: CENTERED ON BACK OR CENTERED ON EITHER END
5. NET WT. 1070 SHIPPING WT. 1365
   1100 1405

NOTES

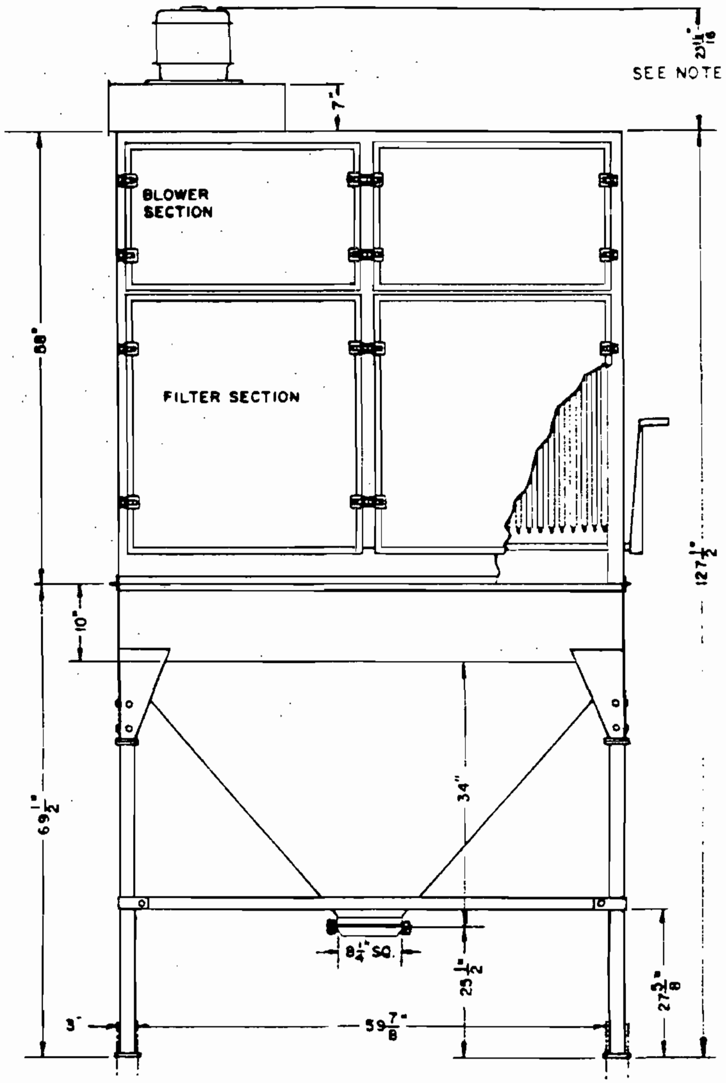
1. THIS DRAWING IS FOR A 124-20-5-10H DUST COLLECTOR. ANY DEPARTURE FROM THIS DESIGN SHALL REQUIRE SPECIAL FABRICATION AND AN INCREASE IN COST
2. THIS DRAWING IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES UNLESS PROPERLY SIGNED BY TORIT.
3. ALLOW A MIN. CLEARANCE OF 5" HEAD ROOM FOR REMOVAL OF MOTOR AND WHEEL ASY
4. MOTOR HEIGHT BASED ON STOCK CAN VARY WITH MFRS.

TORIT DIVISION, DONALDSON COMPANY, INC.
P.O. BOX 1299 · MINNEAPOLIS, MINNESOTA 55440

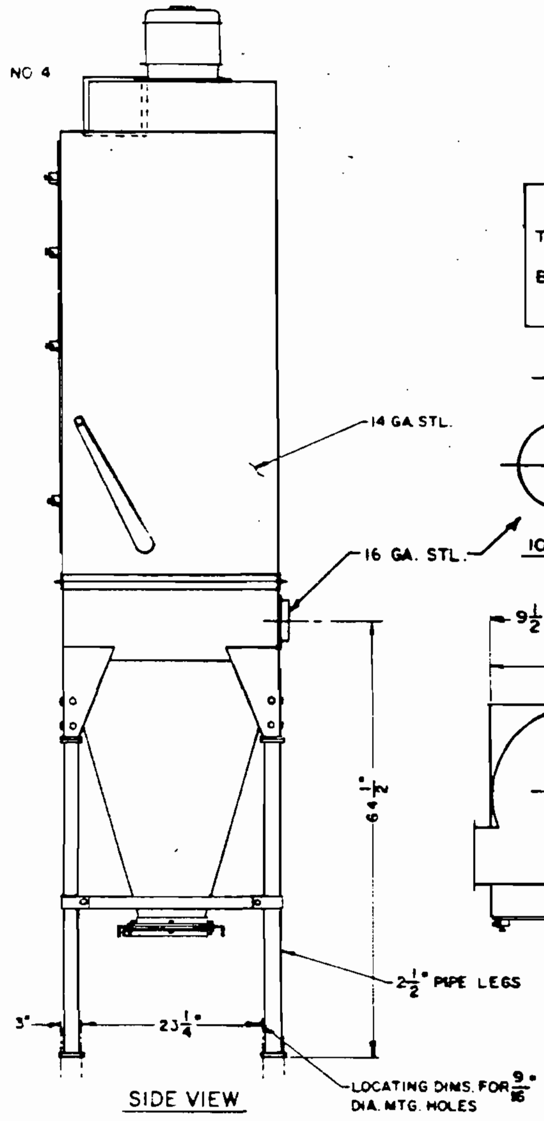
SPECIFICATION CONTROL DRAWING
NO. 124-20-5-10H DUST COLLECTOR

DRAWN: T. Miller
APP'D:

DRWG. NO. 124-021
REV. C 1-82



FRONT VIEW



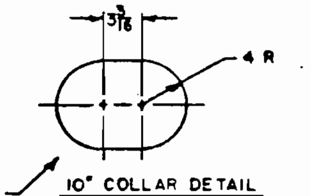
SIDE VIEW

CERTIFICATION

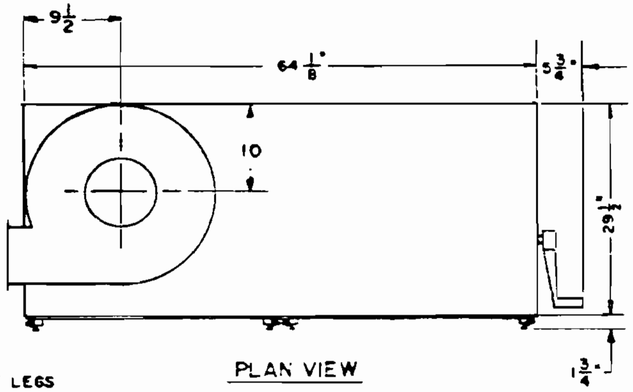
THIS DRAWING IS CERTIFIED TO BE CORRECT.

BY: ____________________ DATE: __________

ENGINEERING DEPT.



10" COLLAR DETAIL



PLAN VIEW

MULTIPLE RATING TABLES

C.F.M.	F.P.M.	EXT. S.P.	C.F.M.	F.P.M.	EXT. S.P.
3625	6654	4.65	1912	3351	12.15
* 3365	6179	5.70 *			
2995	5491	7.38			
2390	4386	9.95			

SPECIFICATIONS

1. MOTOR SHALL BE 10 HP 3500 RPM, 230-460/60/3.
2. HOPPER CAPACITY SHALL BE 16.0 CU. FT.
3. FILTER AREA SHALL BE 400 SQ. FT. (40 FILTERS 30" X 24" EACH)
4. INLET LOCATION CENTERED ON BACK OR CENTERED ON EITHER END
5. NET WT. 1070 SHIPPING WT. 1365
   1100 1405

NOTES

1. THIS DRAWING IS FOR A 124-20-5-10H DUST COLLECTOR. ANY DEPARTURE FROM THIS DESIGN SHALL REQUIRE SPECIAL FABRICATION AND AN INCREASE IN COST
2. THIS DRAWING IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES UNLESS PROPERLY SIGNED BY TORIT.
3. ALLOW A MIN. CLEARANCE OF 5" HEAD ROOM FOR REMOVAL OF MOTOR AND WHEEL ASY
4. MOTOR HEIGHT BASED ON STOCK CAN VARY WITH MFRS.

TORIT DIVISION, DONALDSON COMPANY, INC.
P.O. BOX 1299 · MINNEAPOLIS, MINNESOTA 55440

SPECIFICATION CONTROL DRAWING
NO. 124-20-5-10H DUST COLLECTOR

DRAWN:
APP'D:
DRWG. NO: 124-021
REV C 1-82

g bromobenzene and
tion.
om in air.
nsfer agent: fungistat
plant disease control:
ant for polyesters.

OOH.
rystals: b.p. sublimes:
n hot water. alcohol.

) $(C_6H_5)_2CHCN$.
powder: m.p. 73–
very soluble in alcohol.
cetic acid: synthesis of

e. See diphenadione.

niline) $(C_6H_5)_2NH$.
h crystals. Soluble in
hol. and ether; insolu-
. 52.85°C: b.p. 302°C;
on temp. 1173°F: com-

mula weights of aniline
n autoclave. The prod-
chloric acid to remove
residue is distilled.
e and fused.
lined paper bags: fiber

kin. Tolerance. 10 mg

nd accelerators: solid
dyes: pharmaceuticals:
preservation of apples:
alytical chemistry.

damsite: phenarsazine
1)C_6H_4.
stals. Sublimes readily.
410°C (dec): insoluble
. xylene. carbon tetra-

enylamine with arsenic

alation and ingestion:

d treating.
Poison label. Not ac-
Rail) Tear gas label.

$C_6H_5)_2$.
48–250°C: insoluble in-
luble in toluene.

ngth shifter in solution

enyl.

$_4C_6H_4NHC_6H_5$.
soluble in water: slightly
atic hydrocarbons. Sen-

d fuming sulfuric acid.

See benzidine.
d nitrites.

ethyl acetate
Use: Polymerization inhibitor.

diphenylbromoarsine $(C_6H_5)_2AsBr$.
Properties: White crystals. M.p. 54–56°C.
Derivation: (a) Hydrobromic acid and diphenylarsenious oxide are heated together for about 4 hours at 115–120°C: (b) by action of arsenic tribromide on triphenyl arsine at 300–350°C.
Hazard: Highly toxic: strong irritant.
Shipping regulations: (Rail. Air) Arsenical compounds, solids, n.o.s., Poison label.

1,3-diphenyl-2-buten-1-one. See dypnone.

diphenylcarbazide $(C_6H_5NHNH)_2CO$.
Properties: White crystals or flakes. Insoluble in water; soluble in alcohol and benzene. M.p. 173°C. Decomposes in light.
Derivation: Phenylhydrazine and urea.
Use: Determination of copper and other metals.

diphenylcarbinol. See benzhydrol.

diphenyl carbonate $(C_6H_5O)_2CO$.
Properties: White, crystalline solid. Can be halogenated and nitrated in characteristic manner. Readily undergoes hydrolysis and ammonolysis. Soluble in acetone, hot alcohol, benzene, carbon tetrachloride, ether, glacial acetic acid and other organic solvents; insoluble in water. B.p. 302°C; m.p. 78°C; sp. gr. 1.1215 (87/4°C).
Grade: Technical.
Uses: Plasticizer and solvent; synthesis of polycarbonate resins.

diphenylchloroarsine $(C_6H_5)_2AsCl$.
Properties: Colorless crystals or dark-brown liquid, which slowly becomes semi-solid. Decomposed by water (slowly). Soluble in carbon tetrachloride, chloropicrin. phenyldichloroarsine; practically insoluble in water. Sp. gr. 1.363 (40°C) (solid), or 1.358 (45°C) (liquid): b.p. 333°C (in CO_2 atmosphere); m.p. 41°C.
Derivation: Benzene and arsenic trichloride are heated in presence of aluminum chloride.
Grade: Technical.
Hazard: Highly toxic by inhalation; strong irritant to tissue.
Use: Military poison gas.
Shipping regulations: (Rail) Tear Gas label. (Air) Poison label. Not accepted on passenger planes.

diphenyldecyl phosphite $(C_6H_5O)_2POC_{10}H_{21}$.
Properties: Nearly water-white liquid; sp. gr. 1.023 (25/15.5°C); m.p. 18°C; refractive index 1.5160 (n 25/D). Combustible.
Uses: Chemical intermediate; stabilizer for polyvinyl and polyolefin resins.

diphenyldichlorosilane $(C_6H_5)_2SiCl_2$.
Properties: Colorless liquid; b.p. 305°C; f.p. −22°C; sp. gr. 1.19 (20°C): refractive index (n 25/D) 1.5773; flash point (COC) 288°F. Readily hydrolyzed by moisture, with liberation of hydrochloric acid. Combustible.
Derivation: (a) Reaction of powdered silicon and chlorobenzene in the presence of copper powder as catalyst; (b) reaction of phenylmagnesium chloride with silicon tetrachloride.
Grade: Technical.
Hazard: Highly toxic: strong irritant to tissue.
Use: Intermediate for silicone lubricants.

Properties: Colorless oil.
Derivation: Reaction of didodecyldichlorosilane with phenyl lithium.
Hazard: Probably toxic.
Use: High-temperature lubricant.

diphenyldimide. See azobenzene.

diphenyldimethoxysilane $(C_6H_5)_2Si(OCH_3)_2$.
Properties: Liquid: sp. gr. 1.080 (25°C): b.p. 191°C (53 mm): refractive index 1.5404 (25°C). Soluble in acetone. benzene. methyl alcohol: combustible.
Hazard: Probably toxic.
Uses: Treatment of powders. glass, paper, and fabrics.

diphenyleneimine. See carbazole.

alpha-**diphenylenemethane.** See fluorene.

diphenylene oxide (dibenzofuran) $C_{12}H_8O$ (tricyclic).
Properties: Crystalline solid: m.p. 87°C: b.p. 288°C: insoluble in water: slightly soluble in alcohol. ether and benzene.
Derived from coal-tar.
Hazard: Probably toxic.
Use: Insecticide.

1,1-diphenylethane. See uns-diphenylethane.

1,2-diphenylethane. See sym-diphenylethane.

uns-**diphenylethane** (1,1-diphenylethane) $(C_6H_5)_2CHCH_3$.
Properties: Colorless liquid. Soluble in chloroform. ether. carbon disulfide. B.p. 286°C: sp. gr. 1.004 (20°C): f.p. −21.5°C. Flash point 264°F: combustible.
Derivation: Action of acetaldehyde on benzene in presence of concentrated sulfuric acid.
Uses: Solvent for nitrocellulose; organic synthesis.

sym-**diphenylethane** (bibenzyl: dibenzyl; 1.2-diphenylethane) $C_6H_5CH_2CH_2C_6H_5$.
Properties: White. crystalline needles or small plates. Soluble in alcohol. chloroform, ether. carbon disulfide: insoluble in water. Sp. gr. 0.9782: b.p. 284°C: m.p. 52°C.
Derivation: (a) By treating benzyl chloride with metallic sodium. (b) Action of benzyl chloride on benzylmagnesium chloride.
Use: Organic synthesis.

diphenyl ether. See diphenyl oxide.

diphenylethylene. See stilbene.

N,N-diphenylethylenediamine (ethyl diphenyldiamine) $C_6H_5NHCH_2CH_2NHC_6H_5$.
Properties: Cream-colored solid: sp. gr. 1.14; softening point 54°C: insoluble in water; soluble in acetone. ethylene dichloride. benzene, and gasoline.
Use: Antioxidant in rubber compounding.

diphenylglycolic acid. See benzilic acid.

diphenylguanidine (DPG: melaniline) $HN{:}C(NHC_6H_5)_2$.
Properties: White powder: bitter taste: slight odor: sp. gr. 1.13: m.p. 147°C: decomposes above 170°C: soluble in ethyl alcohol. carbon tetrachloride. chloroform. hot benzene and toluene: slightly soluble in water.
Derivation: Treatment of aniline with cyanogen chloride.

1,6-diphenylhexatriene (DPH)
$C_6H_5HC{:}CHCH{:}CHCCH{:}CHC_6H_5$.
Use: Wavelength shifter in solution scintillation counting.

diphenyl isophthalate (DPIP)
$C_6H_5OOCC_6H_4COOC_6H_5$.
Properties: White solid; m.p. 138–139°C. Combustible.
Use: Manufacture of polybenzimidazoles. high temperature-resistant polymers.

diphenylketone. See benzophenone.

diphenylmethane (benzylbenzene) $(C_6H_5)_2CH_2$.
Properties: Long colorless needles. Soluble in alcohol and ether: insoluble in water. Sp. gr. 1.0056: m.p. 26.5°C: b.p. 264.7°C. Flash point 266°F: combustible.
Derivation: Condensation of benzyl chloride and benzene in presence of aluminum chloride.
Hazard: Probably irritant and narcotic in high concentrations.
Uses: Organic synthesis: dyes; perfumery.

diphenylmethane-4,4′-diisocyanate (MDI; methylene-di-paraphenylene isocyanate; methylenebis(phenyl isocyanate) $CH_2(C_6H_4NCO)_2$.
Properties: Light-yellow, fused solid; solidification point 37°C: sp. gr. (70°C) 1.197; soluble in acetone, benzene. kerosine and nitrobenzene; combustible.
Derivation: para. para′-Diaminodiphenylmethane and phosgene.
Hazard: Highly toxic by inhalation of fumes. Strong irritant. Tolerance. 0.02 ppm in air.
Uses: Preparation of polyurethane resin and spandex fibers: bonding rubber to rayon and nylon.

diphenylmethanol. See benzhydrol.

diphenylmethyl bromide (benzhydryl bromide) $BrCH(C_6H_5)_2$.
Properties: Solid: m.p. 45°C; b.p. 193°C (26 mm). Decomposes in hot water: soluble in alcohol: very soluble in benzene.
Hazard: Strong irritant to eyes and skin.
Use: Organic synthesis.
Shipping reguations: (Air) Corrosive label. (Rail) Corrosive material. n.o.s., White label.

diphenylmethylchlorosilane $(C_6H_5)_2(CH_3)SiCl$.
Properties: Colorless liquid; sp. gr. 1.107 (25°C); b.p. 295°C: flash point 135°F. Combustible.
Derivation: Grignard reactoin of diphenyldichlorosilane with methylmagnesium chloride.
Hazard: Moderate fire risk. Probably toxic.
Use: Intermediate: end stopper for silicone oils.

diphenylnaphthylenediamine $C_{10}H_6(NHC_6H_5)_2$.
Properties: Silvery, crystalline plates. Slightly soluble in alcohol: insoluble in water. M.p. 164°C.
Derivation: By heating 2,7-dihydroxynaphthalene with aniline and aniline hydrochloride.
Use: Organic synthesis.

diphenylnitrosamine. See N-nitrosodiphenylamine.

2,5-diphenyloxazole (DPO) $\overline{OOC_6H_5{:}C}C_6H_5$.
Properties: White. fluffy solid; m.p. 70–72°C.
Grade: Scintillation.

types; curing and hardening of polymers (e.g., core-binding resins); corrosion inhibitor; propellant.
Shipping regulations: (Rail) Flammable liquids, n.o.s., Red label. (Air) Flammable Liquid label.

triethylborane (triethylborine; boron triethyl). $(C_2H_5)_3B$.
Properties: Colorless liquid. Sp. gr. (25°C); flash point −32°F; f.p. −93°C; b.p. 95°C; refractive index 1.3971; heat of combustion 20,000 Btu/lb. Miscible with most organic solvents; immiscible with water.
Derivation: Reaction of triethylaluminum and boron halide, or diborane and ethylene.
Hazard: Flammable, dangerous fire risk. Ignites spontaneously in air. Highly toxic by inhalation; strong irritant. Reacts violently with water and oxidizing materials.
Uses: Igniter or fuel for jet and rocket engines; fuel additive; olefin polymerization catalyst; intermediate.
Shipping regulations: (Rail) Pyrophoric liquid, n.o.s., Red label. (Air) Not acceptable.

triethyl borate (ethyl borate) $(C_2H_5)_3BO_3$.
Properties: Colorless liquid; mild odor. Hydrolyzes rapidly, depositing boric acid in finely divided crystalline form. B.p. 120°C; sp. gr. 0.863–0.864 (20/20°C); flash point 51.8°F (C.C.); wt/gal 7.20 lb. (20°C); refractive index 1.37311 (20°C).
Uses: Antiseptics; disinfectants; antiknock agent.
Hazard: Flammable, dangerous fire risk. Moderately toxic.
Shipping regulations: (Rail) Flammable liquid, n.o.s., Red label. (Air) Flammable Liquid label. (Air) Legal label name, ethyl borate.

triethylborine. See triethylborane.

triethyl citrate (ethyl citrate) $C_3H_5(COOC_2H_5)_3$.
Properties: Colorless, mobile liquid. Bitter taste; b.p. 294°C; b.p. (1 mm) 126–127°C; sp. gr. 1.136 (25°C); refractive index 1.4405 (24.5°C); pour point −50°F; solubility in water 6.5 g/100 cc; solubility in oil 0.8 g/100 cc. Flash point 303°F (COC); combustible. Low toxicity.
Derivation: Esterification of citric acid.
Grades: Technical; refined; F.C.C.
Containers: Metal drums and cans; tank cars.
Uses: Solvent and plasticizer for nitrocellulose and natural resins; softener; paint removers; agglutinant; perfume base; food additive (not over 0.25%).

triethylenediamine $N(CH_2CH_2)_3N$. Catalyst used in the production of polyurethanes. Combustible.

triethylene glycol (TEG) $HO(C_2H_4O)_3H$.
Properties: Colorless, hygroscopic, practically odorless liquid. Sp. gr. 1.1254 (20/20°C); b.p. 287.4°C; vapor pressure less than 0.01 mm (20°C); flash point 350°F (C.C.); wt/gal 9.4 lb (20°C); freezing point −7.2°C; viscosity 0.478 poise (20°C). Autoignition temp. 700°F. Soluble in water; immiscible with benzene, toluene and gasoline. Combustible; low toxicity.
Derivation: From ethylene and oxygen, as a by-product of ethylene glycol manufacture.
Grades: Technical; C.P.
Containers: 1-, 5-gal cans; 55-gal drums; tank cars.
Uses: Solvent and plasticizer in vinyl, polyester and polyurethane resins; dehydration of natural gas; humectant in printing inks; extraction solvent ("Udex" process).

triethylene glycol diacetate
$CH_3COOCH_2CH_2OCH_2CH_2OCH_2CH_2OOCCH_3$.
Properties: Colorless liquid. Sp. gr. (25°C) 1.112; refractive index n (25°C) 1.437; b.p. 300°C; f.p. less than −60°C. Combustible; low toxicity.
Use: Plasticizer.

triethylene glycol dibenzoate
$C_6H_5CO(OCH_2CH_2)_3OOCC_6H_5$.
Properties: Crystals; b.p. 210–223°C; m.p. 46°C; flash point 457°F (TOC); sp. gr. 1.168. Combustible. Low toxicity.
Uses: Plasticizer for vinyl resins; adhesives.

triethylene glycol dicaprylate (triethylene glycol dioctoate) $C_7H_{15}COO(CH_2CH_2O)_3OCC_7H_{15}$.
Properties: Clear liquid; sp. gr. 0.973 (20°C); acidity 0.3% max. (caprylic); moisture 0.05% max; f.p. −3°C; b.p. 243°C (5 mm). Soluble in most organic solvents. Combustible; low toxicity.
Uses: Low-temperature plasticizer for elastomers.

triethylene glycol dichloride. See triglycol dichloride.

triethylene glycol didecanoate
$C_9H_{19}COO(C_2H_4O)_3OCC_9H_{19}$.
Properties: Colorless liquid. B.p. 237°C (2.0 mm); sp. gr. 0.9584 (20/20°C); viscosity 28.6 cp (20°C). Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol di(2-ethylbutyrate)
$C_5H_{11}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_5H_{11}$.
Properties: Light-colored liquid; sp. gr. 0.9946 (20/20°C); 8.3 lb/gal (20°C); b.p. 196°C (5 mm); vapor pressure 5.8 mm Hg (200°C); solubility in water 0.02% by wt (20°C); viscosity 10.3 cp (20°C). Flash point 385°F. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol di(2-ethylhexoate)
$C_7H_{15}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_7H_{15}$.
Properties: Light-colored liquid; sp. gr. 0.9679 (20/20°C); 8.1 lb/gal (20°C); b.p. 219°C (5 mm); vapor pressure 1.8 mm Hg (200°C); insoluble in water; viscosity 15.8 cp (20°C). Flash point 405°F. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dihydroabietate
$C_{19}H_{31}COO(C_2H_4O)_3OCC_{19}H_{31}$.
Properties: Liquid. Sp. gr. (25°C) 1.080–1.090; refractive index (20°C) 1.5180; vapor pressure (225°C) 2.5; flash point 226°C; insoluble in water. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dimethyl ether
$CH_3(OCH_2CH_2)_3OCH_3$.
Properties: Water-white liquid; mild ether odor; sp. gr. (20/20°C) 0.9862; refractive index 1.4233 (n 20/D); flash point 232°F; b.p. (760 mm) 216.0°C; (100 mm) 153.6°C; f.p. −46°C. Autoignition temp. 1166°F. Completely soluble in water and hydrocarbons at 20°C. May contain peroxides. Combustible. Low toxicity.
Containers: Glass bottles; cans; 55-gal drums.
Uses: Solvent for gases; coupling immiscible liquids.

triethylene glycol dioctoate. See triethylene glycol dicaprylate.

triethylene glycol dipelargonate
$C_8H_{17}COO(C_2H_4O)_3OCC_8H_{17}$.
Properties: Clear liquid; sp. gr. 0.964 (20/20°C); b.p. 251°C (5 mm); f.p. +1 to −4°C; refractive index 1.4470 (23°C); flash point 410°F. Almost insoluble in water; soluble in most organic solvents. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dipropionate
$C_2H_5CO(OCH_2CH_2)_3OOCC_2H_5$.
Properties: Colorless liquid. Sp. gr. (25°C) 1.066; refractive index (25°C) 1.436; b.p. (2 mm) 138–142°C; f.p. less than −60°C; solubility in water, 6.70% by weight. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol monobutyl ether. See butoxytriglycol.

triethylenemelamine (tretamine; TEM; 2,4,6-tris(1-aziridinyl)-s-triazine)
$\underline{\mathrm{NC[N(CH_2)_2]NC[N(CH_2)_2]NC}}\mathrm{[N(CH_2)_2]}$.
Properties: White, crystalline, odorless powder; m.p. 160°C (polymerizes); polymerizes readily with heat or moisture; soluble in alcohol, water, methanol, chloroform, and acetone.
Grade: N.F.
Hazard: Highly toxic.
Uses: Medicine (see nitrogen mustards); insecticide; chemosterilant.

triethylenephosphoramide (tepa; tris-(1-aziridinyl)phosphine oxide; APO) $(\underline{\mathrm{NCH_2CH_2}})_3\mathrm{PO}$.
Properties: Colorless crystals; m.p. 41°C; soluble in water, alcohol and ether. Combustible.
Derivation: From ethyleneimine.
Hazard: Highly toxic. Strong irritant to skin and tissue.
Uses: Medicine (see nitrogen mustards); insect sterilant. Also used with tetrakis(hydroxymethyl)phosphonium chloride (THPC) to form a condensation polymer suitable for flameproofing cotton. See also tris[1-(2-methyl)aziridinyl]phosphine oxide.
Shipping regulations: (Rail) White label. (Air) Corrosive label. Legal label name: tris(1-aziridinyl)-phosphine oxide.
See also tepa.

triethylenetetramine $NH_2(C_2H_4NH)_2C_2H_4NH_2$.
Properties: Moderately viscous yellowish liquid. Less volatile than diethylenetriamine but resembles it in many other properties. Soluble in water. B.p. 277.5°C; sp. gr. 0.9818 (20/20°C); m.p. 12°C; flash point 275°F (C.C.); wt 8.2 lb/gal (20°C). Combustible. Autoignition temp. 640°F.
Grades: Technical; anhydrous.
Containers: Cans; drums; tank cars.
Hazard: Strong irritant to tissue. Causes skin burns and eye damage.
Uses: Detergents and softening agents; synthesis of dyestuffs, pharmaceuticals and rubber accelerators.
Shipping regulations: (Air) Corrosive label.

tri(2-ethylhexyl)phosphate $[C_4H_9CH(C_2H_5)CH_2]_3PO_4$.
Properties: Light-colored liquid; sp. gr. 0.9260 (20/20°C); 7.70 lb/gal (20°C); b.p. 220°C (5 mm); vapor pressure 1.9 mm Hg (200°C); insoluble in water; viscosity 14.1 cp (20°C); pour point −74°C; flash point 405°F. Combustible; low toxicity.
Use: Plasticizer.

tri(2-ethylhexyl) phosphite $(C_8H_{17}O)_3P$.
Properties: Straw-colored liquid; sp. gr. 0.897 (25/15°C); m.p., glass at low temperature; refractive index 1.451 (n 25/D); flash point 340°F (COC). Combustible; low toxicity.
Uses: Plasticizer; intermediate.

tri(2-ethylhexyl) trimellitate $C_6H_3(COOC_8H_{17})_3$.
Properties: Clear liquid, mild odor; sp. gr. 0.992 (20/

20°
f.p.
wt/
Use:

triethy

triethy
etho

triethy
Prope
145.
0.89
in wa
Deriva
form
cyani
Conta
Hazar
Uses:

triethyl
Proper
very
with
solver
with
at ele
−56.4
index
bustib
Grades
Contai
Hazard
than c
Uses: S
manuf
Shippin
liquid,
senger

triethyl p
Propert
b.p. 15
point
and eth
Contain
Hazard
Uses: S
grease

O,O,O-**tri**
phate)
Properti
B.p. (1
225°F (
Containe
Hazard:
Uses: Pl
hydraul
Shipping
liquid,
senger p

triethyl tr
Propertie
fractive
160°C;
Combu
Use: Plas

g., core-
uids, n.o.s.,

); flash
refractive
Btu/lb.
miscible with

and boron

Ignites
inhalation:
water and oxi-

ocket engines; fuel
catalyst, intermedi-

liquid, n.o.s.,

Hydrolyzes
divided crys-
0.864 (20
wt gal 7.20 lb.

agent.
risk. Moderately

mable liquid, n.o.s.,
label. (Air) Legal

Bitter taste; b.p.
sp. gr. 1.136 (25°C);
pour point −50°F;
solubility in oil 0.8
combustible.

acid.

tank cars.
nitrocellulose and
movers; agglutinant;
over 0.25%).

Catalyst used in
Combustible.

practically odor-
b.p. 287.4°C;
(20°C); flash point
freezing point
(20°C). Autoignition
immiscible with ben-
bustible; low toxicity.
xygen, as a by-product

drums; tank cars.
vinyl, polyester and
tion of natural gas;
action solvent ("Udex"

fractive index n (25°C) 1.437; b.p. 300°C; f.p. less than −60°C. Combustible; low toxicity.
Use: Plasticizer.

triethylene glycol dibenzoate $C_6H_5CO(OCH_2CH_2)_3OOCC_6H_5$.
Properties: Crystals; b.p. 210–223°C; m.p. 46°C; flash point 457°F (TOC); sp. gr. 1.168. Combustible. Low toxicity.
Uses: Plasticizer for vinyl resins; adhesives.

triethylene glycol dicaprylate (triethylene glycol dioctoate) $C_7H_{15}COO(CH_2CH_2O)_3OCC_7H_{15}$.
Properties: Clear liquid; sp. gr. 0.973 (20°C); acidity 0.3% max. (caprylic); moisture 0.05% max; f.p. −3°C; b.p. 243°C (5 mm). Soluble in most organic solvents. Combustible; low toxicity.
Uses: Low-temperature plasticizer for elastomers.

triethylene glycol dichloride. See triglycol dichloride.

triethylene glycol didecanoate $C_9H_{19}COO(C_2H_4O)_3OCC_9H_{19}$.
Properties: Colorless liquid. B.p. 237°C (2.0 mm); sp. gr. 0.9584 (20/20°C); viscosity 28.6 cp (20°C). Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol di(2-ethylbutyrate) $C_5H_{11}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_5H_{11}$.
Properties: Light-colored liquid; sp. gr. 0.9946 (20/20°C); 8.3 lb/gal (20°C); b.p. 196°C (5 mm); vapor pressure 5.8 mm Hg (200°C); solubility in water 0.02% by wt (20°C); viscosity 10.3 cp (20°C). Flash point 385°F. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol di(2-ethylhexoate) $C_7H_{15}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_7H_{15}$.
Properties: Light-colored liquid; sp. gr. 0.9679 (20/20°C); 8.1 lb/gal (20°C); b.p. 219°C (5 mm); vapor pressure 1.8 mm Hg (200°C); insoluble in water; viscosity 15.8 cp (20°C). Flash point 405°F. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dihydroabietate $C_{19}H_{31}COO(C_2H_4O)_3OCC_{19}H_{31}$.
Properties: Liquid. Sp. gr. (25°C) 1.080–1.090; refractive index (20°C) 1.5180; vapor pressure (225°C) 2.5; flash point 226°C; insoluble in water. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dimethyl ether $CH_3(OCH_2CH_2)_3OCH_3$.
Properties: Water-white liquid; mild ether odor; sp. gr. (20/20°C) 0.9862; refractive index 1.4233 (n 20/D); flash point 232°F; b.p. (760 mm) 216.0°C; (100 mm) 153.6°C; f.p. −46°C. Autoignition temp. 1166°F. Completely soluble in water and hydrocarbons at 20°C. May contain peroxides. Combustible. Low toxicity.
Containers: Glass bottles; cans; 55-gal drums.
Uses: Solvent for gases; coupling immiscible liquids.

triethylene glycol dioctoate. See triethylene glycol dicaprylate.

triethylene glycol dipelargonate $C_8H_{17}COO(C_2H_4O)_3OCC_8H_{17}$.
Properties: Clear liquid; sp. gr. 0.964 (20/20°C); b.p. 251°C (5 mm); f.p. +1 to −4°C; refractive index 1.4470 (23°C); flash point 410°F. Almost insoluble in water; soluble in most organic solvents. Combustible. Low toxicity

triethylene glycol dipropionate $C_2H_5CO(OCH_2CH_2)_3OOCC_2H_5$.
Properties: Colorless liquid. Sp. gr. (25°C) 1.066; refractive index (25°C) 1.436; b.p. (2 mm) 138–142°C; f.p. less than −60°C; solubility in water, 6.70% by weight. Combustible. Low toxicity.
Use: Plasticizer.

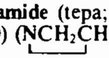
triethylene glycol monobutyl ether. See butoxytriglycol.

triethylenemelamine (tretamine; TEM; 2,4,6-tris(1-aziridinyl)-s-triazine)

$NC[N(CH_2)_2]NC[N(CH_2)_2]NC[N(CH_2)_2]$.

Properties: White, crystalline, odorless powder; m.p. 160°C (polymerizes); polymerizes readily with heat or moisture; soluble in alcohol, water, methanol, chloroform, and acetone.
Grade: N.F.
Hazard: Highly toxic.
Uses: Medicine (see nitrogen mustards); insecticide; chemosterilant.

triethylenephosphoramide (tepa; tris-(1-aziridinyl)phosphine oxide; APO) $(NCH_2CH_2)_3PO$.



Properties: Colorless crystals; m.p. 41°C; soluble in water, alcohol and ether. Combustible.
Derivation: From ethyleneimine.
Hazard: Highly toxic. Strong irritant to skin and tissue.
Uses: Medicine (see nitrogen mustards); insect sterilant. Also used with tetrakis(hydroxymethyl)phosphonium chloride (THPC) to form a condensation polymer suitable for flameproofing cotton. See also tris[1-(2-methyl)aziridinyl]phosphine oxide.
Shipping regulations: (Rail) White label. (Air) Corrosive label. Legal label name: tris(1-aziridinyl)-phosphine oxide.
See also tepa.

triethylenetetramine $NH_2(C_2H_4NH)_2C_2H_4NH_2$.
Properties: Moderately viscous yellowish liquid. Less volatile than diethylenetriamine but resembles it in many other properties. Soluble in water. B.p. 277.5°C; sp. gr. 0.9818 (20/20°C); m.p. 12°C; flash point 275°F (C.C.); wt 8.2 lb/gal (20°C). Combustible. Autoignition temp. 640°F.
Grades: Technical; anhydrous.
Containers: Cans; drums; tank cars.
Hazard: Strong irritant to tissue. Causes skin burns and eye damage.
Uses: Detergents and softening agents; synthesis of dyestuffs, pharmaceuticals and rubber accelerators.
Shipping regulations: (Air) Corrosive label.

tri(2-ethylhexyl)phosphate $[C_4H_9CH(C_2H_5)CH_2]_3PO_4$.
Properties: Light-colored liquid; sp. gr. 0.9260 (20/20°C); 7.70 lb/gal (20°C); b.p. 220°C (5 mm); vapor pressure 1.9 mm Hg (200°C); insoluble in water; viscosity 14.1 cp (20°C); pour point −74°C; flash point 405°F. Combustible; low toxicity.
Use: Plasticizer.

tri(2-ethylhexyl) phosphite $(C_8H_{17}O)_3P$.
Properties: Straw-colored liquid; sp. gr. 0.897 (25/15°C); m.p., glass at low temperature; refractive index 1.451 (n 25/D); flash point 340°F (COC). Combustible; low toxicity.
Uses: Plasticizer; intermediate.

tri(2-ethylhexyl) trimellitate $C_6H_3(COOC_8H_{17})_3$.
Properties: Clear liquid, mild odor; sp. gr. 0.992 (20/20°C); distillation range at 3 mm, 278–284°C (5–95%); f.p., a gel at −35°C; refractive index 1.4846 (23°C); wt/gal 8.26 lb (20°C). Combustible; low toxicity.
Use: Plasticizer.

triethylmethane. See 3-ethylpentane.

triethylmethyl malonaldehyde diacetal. See 1,1,3-triethoxy-3-methoxypropane.

triethyl orthoformate (triethoxymethane) $CH(OC_2H_5)_3$.
Properties: Colorless liquid; pungent odor; b.p. 145.9°C; refractive index 1.39218 (18.8°C); sp. gr. 0.895 (20/20°C). Soluble in alcohol, ether; decomp. in water. Flash point 86°F (C.C.). Low toxicity.
Derivation: Reaction of sodium ethylate with chloroform or reaction of hydrochloric acid with hydrogen cyanide in ethyl alcohol solution.
Containers: 55-gal steel drums.
Hazard: Flammable, moderate fire risk.
Uses: Organic synthesis; pharmaceuticals.

triethyl phosphate (TEP) $(C_2H_5)_3PO_4$.
Properties: Colorless, high-boiling liquid. Mild odor; very stable at ordinary temperatures. Compatible with many gums and resins. Soluble in most organic solvents; completely miscible in water. When mixed with water is quite stable at room temperature, but at elevated temperatures it hydrolyzes slowly. F.p. −56.4°C; b.p. 216°C, flash point 240°F; refractive index 1.4055 (20°C); wt/gal 8.90 lb (68°F). Combustible.
Grades: Technical; 97%.
Containers: Drums; tank cars; tank trucks.
Hazard: May cause nerve damage but to less extent than other cholinesterase-inhibiting compounds.
Uses: Solvent; plasticizer for resins, plastics, gums; manufacture of pesticides; catalyst; lacquer remover.
Shipping regulations: (Rail, Air) Organic phosphate, liquid, n.o.s., Poison label. Not acceptable on passenger planes.

triethyl phosphite $(C_2H_5)_3PO_3$.
Properties: Colorless liquid; sp. gr. 0.9687 (20°C); b.p. 156.6°C; refractive index 1.413 (n 25/D); flash point 130°F; insoluble in water; soluble in alcohol and ether. Combustible.
Containers: Glass bottles; 5-, 55-gal drums.
Hazard: Moderate fire risk. May be toxic.
Uses: Synthesis; plasticizers; stabilizers; lube and grease additives.

O,O,O-triethyl phosphorothioate (triethyl thiophosphate) $(C_2H_5O)_3PS$.
Properties: Colorless liquid with characteristic odor. B.p. (10 mm) 93.5–94°C; sp. gr. 1.074; flash point 225°F (COC); combustible.
Containers: Bottles; drums.
Hazard: Toxic by ingestion; cholinesterase inhibitor.
Uses: Plasticizer; lubricant additive; antifoam agent; hydraulic fluid; intermediate.
Shipping regulations: (Rail, Air) Organic phosphate, liquid, n.o.s., Poison label. Not acceptable on passenger planes.

triethyl tricarballylate $(C_2H_5OCOCH_2)_2CHCOOC_2H_5$.
Properties: Colorless liquid. Sp. gr. (20°C) 1.087; refractive index (26°C) 1.4234; b.p. (5 mm) 158–160°C; solubility in water (20°C) 0.62% by weight. Combustible.
Use: Plasticizer.

ner intermediate; sol-
parts and precision

ethyl)trimethylammo-
OH]$_3$ · $C_6H_5O_7$.
on); drums.

chloroethylene (q.v.).

cobaltic oxide.

tricyclamol chloride

oluble in alcohol; in-
9 (48°C); b.p. 234°C
ble.

ners.

OOH. A saturated
in natural fats or oils.
crystalline solid; m.p.
ed in medical research
as chromatography.

$C_6H_4)_3BO_3$.
sp. gr. 1.065 (25°C);
x 1.5480 (24°C); flash
in all proportions in
hydrolyzes on contact

sis.

phate; TCP)
f isomers.
, odorless liquid. Sta-
refractive index 1.556
); wt/gal 9.7 lb; crys-
Miscible with all the
s, also with vegetable
point 437°F; autoigni-

osphorus oxychloride.
, tank cars.
ngestion and skin ab-
highly toxic; its toler-
of air.
chloride, polystyrene,
for plastics; air filter
aterproofing; additive
s; hydraulic fluid and

P.
slight phenolic odor.
(20/4°C) 1.115; flash
uble in water; miscible
, ether, and kerosine.

for plastics and resins.

$H_8N \cdot CH_3Cl$. 1-Cyclo-

der; faint characteristic odor; soluble in alcohol and in water.
Use: Medicine.

tricyclic. An organic compound comprised of three (only) ring structures, which may be the same or different, e.g., anthracene.

sym-**tricyclodecane.** See adamantane.

tricyclohexyl borate. See boric acid ester.

n-tridecane $CH_3(CH_2)_{11}CH_3$.
Properties: Colorles liquid. Soluble in alcohol; insoluble in water. Sp. gr. 0.755 (20/4°C); b.p. 225.5°C; f.p. −5.45°C; refractive index 1.4250 (20/D); flash point 175°F. Combustible; low toxicity.
Grades: 95%; 99%; research.
Containers: Glass bottles; 1-, 5-gal drums.
Uses: Organic synthesis; distillation chaser.

n-tridecanoic acid (tridecylic acid; tridecoic acid) $CH_3(CH_2)_{11}COOH$. A saturated fatty acid usually prepared synthetically.
Properties: Colorless crystals; m.p. 44.5°C; sp. gr. 0.8458 (80/4°C); b.p. 312.4°C, 192.2°C (16 mm); refractive index 1.4328 (50°C). Slightly soluble in water; soluble in alcohol and ether. Combustible; low toxicity.
Grade: 99% pure.
Uses: Organic synthesis; medical research.

tridecanol. See tridecyl alcohol.

tridecoic acid. See n-tridecanoic acid.

tridecyl alcohol (tridecanol). A commercial mixture of isomers of the formula $C_{12}H_{25}CH_2OH$.
Properties: Low-melting white solid with pleasant odor; b.p. 274°C; m.p. 31°C; sp. gr. (20/20°C) 0.845; wt/gal 7.0 lb; flash point (TOC) 180°F. Combustible; low toxicity.
Derivation: Oxo process (q.v.) from C_{15} hydrocarbons.
Grade: Technical.
Containers: 55-gal drums; tank cars.
Uses: Esters for synthetic lubricants; detergents; antifoam agent; other tridecyl compounds; perfumery.

tridecylbenzene (1-phenyltridecane) $C_6H_5(CH_2)_{12}CH_3$.
Properties: Colorless liquid; sp. gr. 0.85–0.86 (60/60°F); refractive index 1.4815–1.4830. Combustible.
Use: Detergent intemediate.

tridecylic acid. See n-tridecanoic acid.

tri(decyl) orthoformate $CH(OC_{10}H_{21})_3$.
Properties: Liquid; b.p. 194°C; f.p. −15 to −20°C; refractive index 1.448; insoluble in water; soluble in benzene, naphtha, ether, and alcohol.
Use: To remove small quantities of water from ethers or other solvents where acid catalysts can be employed.

tri(decyl) phosphite $(C_{10}H_{21}O)_3P$.
Properties: Water-white liquid; decyl alcohol odor; sp. gr. 0.892 (25/15.5°C); m.p. less than 0°C; refractive index 1.4565 (25°C). Flash point 455°F. Combustible.
Containers: 55-gal drums.
Uses: Chemical intermediate; stabilizer for polyvinyl and polyolefin resins.

tridihexethyl chloride
$C_6H_{11}C(C_6H_5)(OH)CH_2CH_2N(C_2H_5)_2 \cdot C_2H_5Cl$. (3-Diethylamino-1-phenyl-1-cyclohexylpropanol etho-

form, and in alcohol. Practically insoluble in ether and in acetone. Melting range 198–202°C.
Grade: N.F.
Use: Medicine.

2,4,6-tri(dimethylaminomethyl)phenol
$[(CH_3)_2NCH_2]_3C_6H_2OH$.
Properties: Liquid; refractive index 1.5181. Combustible.
Hazard: May be toxic.
Uses: Antioxidants, acid neutralizers, stabilizers, and catalysts for epoxy and polyurethane resins.

tri(dimethylphenyl)phosphite (trixylenyl phosphate) $[(CH_3)_2C_6H_3O]_3PO$.
Properties: Liquid. Sp. gr. 1.155; refractive index 1.5535; b.p. (10 mm), 243–265°C; flash point 450°F; solubility in water (85°C), 0.002% by weight. Combustible.
Use: Plasticizer.

"Tridione."[3] Trademark for trimethadione, U.S.P.

tridodecyl amine. See trilauryl amine.

tridodecyl borate. See boric acid ester.

tridymite SiO_2. A vitreous, colorless or white, native form of pure silica. Found variously but not so commonly as quartz (q.v.). Quartz will change into tridymite with a 16.2% increase in volume at 870°C. Unlike quartz, it is soluble in boiling sodium carbonate solution. Sp. gr. 2.28–2.3; Mohs hardness 7.

trietazine. Generic name for 2-chloro-4-diethylamino-6-ethylamino-s-triazine $ClC_3N_3[N(C_2H_5)_2]NHC_2H_5$.
Properties: Solid; practically insoluble in water.
Uses: Herbicide; plant growth regulator.

"Tri-Ethane."[177] Trademark for 1,1,1-trichloroethane (q.v.).

triethanolamine (TEA; tri(2-hydroxyethyl)amine) $(HOCH_2CH_2)_3N$.
Properties: Colorless, viscous, hygroscopic liquid with slight ammoniacal odor; m.p. 21.2°C; b.p. 335°C (dec); vapor pressure < 0.01 mm (20°C); sp. gr. 1.126; flash point (open cup) 375°F; wt/gal 9.4 lb; miscible with water, alcohol; soluble in chloroform; slightly soluble in benzene and ether; slightly less alkaline than ammonia. Commercial product contains up to 25% diethanolamine and up to 5% monoethanolamine. Combustible; low toxicity.
Derivation: Reaction of ethylene oxide and ammonia.
Grades: Technical; regular; 98%; U.S.P.
Containers: Drums; tank cars.
Uses: Fatty acid soaps used in drycleaning, cosmetics, household detergents, and emulsions; wool scouring; textile antifume agent and water-repellent; dispersion agent; corrosion inhibitor; softening agent, humectant, and plasticizer; insecticide; chelating agent; rubber accelerator.

triethanolamine lauryl sulfate
$(HOC_2H_4)_3NOS(O)_2OC_{12}H_{25}$. A liquid or paste.
Containers: Drums, tank cars; tank trucks.
Uses: Detergent; wetting, foaming and dispersing agent for industrial, cosmetic and pharmaceutical applications, especially shampoos.

triethanolamine methanearsonate
$CH_3As(O)[ONH(C_2H_4OH)_3]_2$.
Hazard: Highly toxic by ingestion.
Use: Herbicide.
Shipping regulations: (Rail, Air) Arsenical compounds, n.o.s. Poison label.

triethanolamine oleate. See trihydroxyethylamine oleate.

triethanolamine stearate. See trihydroxyethylamine stearate.

triethanolamine titanate. See titanium chelate.

1,1,3-triethoxyhexane
$CH(OC_2H_5)_2CH_2CH(OC_2H_5)C_3H_7$.
Properties: Colorless liquid; sp. gr. 0.8746 (20/20°C); b.p. 133°C (50 mm); f.p. −100°C; wt/gal 7.3 lb; flash point 210°F. Insoluble in water. Combustible. Low toxicity.
Use: Synthesis of aldehydes, acids, esters, chloride, amines, etc.

triethoxymethane. See triethyl orthoformate.

1,1,3-triethoxy-3-methoxypropane (triethylmethyl malonaldehyde diacetal)
$(CH_3O)(C_2H_5O)CHCH_2CH(OC_2H_5)_2$.
Properties: Colorless liquid. Sp. gr. (25/4°C), 0.9300; b.p. (6 mm) 86°C. Combustible.
Grade: 99%.
Uses: Intermediate; crosslinking and insolubilizing agent.

triethylaconitate
$C_2H_5OOCCHC(COOC_2H_5)CH_2COOC_2H_5$.
Properties: Liquid. Sp. gr. (25°C) 1.096; refractive index (26°C) 1.4517; b.p. (5 mm) 154–156°C. Combustible.
Use: Plasticizer.

triethylaluminum (ATE; TEA; aluminum triethyl). $(C_2H_5)_3Al$.
Properties: Colorless liquid; sp. gr. 0.837; f.p. −52.5°C; b.p. 194°C; specific heat 0.527 (91.4°F). Miscible with saturated hydrocarbons. Flash point −63°F.
Derivation: By introduction of ethylene and hydrogen into an autoclave containing aluminum. The reaction proceeds under moderate temperature and varying pressures.
Grades: 88–94%.
Containers: Cylinders.
Hazard: Highly toxic; destructive to tissue. Flammable, dangerous fire risk; ignites spontaneously in air; reacts violently with water, acids, alcohols, halogens, and amines.
Uses: Catalyst intermediate for polymerization of olefins, especially ethylene; pyrophoric fuels; production of alpha-olefins and long chain alcohols; gas plating of aluminum.
Shipping regulations: (Rail) Red label. (Air) Not acceptable. (Rail) Legal label name; aluminum triethyl.

triethylamine $(C_2H_5)_3N$.
Properties: Colorless liquid; strong ammoniacal odor. B.p. 89.7°C; f.p. −115.3°C; sp. gr. (20/20°C) 0.7293; wt/gal (20°C) 6.1 lb; flash point (open cup) 20°F. Soluble in water and alcohol.
Derivation: From ethyl chloride and ammonia under heat and pressure.
Containers: 1-, 5-gal cans; 55-gal drums; tank cars.
Hazard: Flammable, dangerous fire risk. Explosive limits in air 1.2 to 8.0%. Tolerance, 25 ppm in air. Toxic by ingestion and inhalation; strong irritant to tissue.
Uses: Catalytic solvent in chemical synthesis; accelerator activators for rubber; wetting, penetrating and waterproofing agents of quaternary ammonium

P-AH TP-90B - SPGR, 0.97. High boiling, straw colored liquid; little or no odor; non-toxic in ordinary handling. Visc (27°C) 8 cps. Bp 660-760°F.

TABLE 15.3

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C. In Water	Water in	In Mineral Oil	Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr. 212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers											
1	Acetin	$C_6H_{10}O_4$	134	1.190 at 25° C.	1.445 at 25° C.	66.8 at 25° C.						
2	*o*- and *p*-Toluenesulfonamides (mixture)	$C_7H_9O_2NS$	171	1.353 solid		f.p. 105						
3	Diacetin	$C_7H_{12}O_5$	176	1.178	1.438 at 25° C.	35.7 at 25° C.						
4	*N*-Ethyl-*p*-toluenesulfonamide	$C_9H_{13}O_2NS$	199	1.171 at 65° C.	1.522 at 65° C.	f.p. 59.0						
5	*N*-Ethyl-*o*- and *p*-toluenesulfonamides (mixture)	$C_9H_{13}O_2NS$	199	1.190 at 25° C.	1.540 at 25° C.	426 at 25° C.					0.55	101
6	Triacetin	$C_9H_{14}O_6$	218	1.157 (av.)	1.429 at 25° C.	15.1 at 25° C.						
7	Dimethyl phthalate	$C_{10}H_{10}O_4$	194	1.191	1.513 at 25° C.	16.3			0.5	0.34	>4.0	>1000
8	*o*-Nitrobiphenyl	$C_{12}H_9O_2N$	199	1.203 at 25° C.	1.613 at 25° C.	38 at 25° C.						
9	Diethyl phthalate	$C_{12}H_{14}O_4$	222	1.118	1.501 at 20° C.	12.6	0.15	0.7	2.8	1.1	3.40	> 500
10	Triethyl citrate	$C_{12}H_{20}O_7$	276	1.136 at 25° C.	1.441 at 24.5° C.							
11	Dimethyl sebacate	$C_{12}H_{22}O_4$	230	0.986 at 30° C.	1.436 at 30° C.	3.5 at 38° C.						

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]: Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
	Simple Plasticizers													
1	Acetin												——	Kes
2	*o*- and *p*-Toluenesulfonamides (mixture)												——	Mon
3	Diacetin												——	Kes
4	*N*-Ethyl-*p*-toluenesulfonamide												——	Mon
5	*N*-Ethyl-*o*- and *p*-toluenesulfonamides (mixture)												——	Mon
6	Triacetin												——	Kes, TE
7	Dimethyl phthalate												——	Mon, TE
8	*o*-Nitrobiphenyl												——	Mon
9	Diethyl phthalate												——	Mon, TE, USI
10	Triethyl citrate												——	Pf
11	Dimethyl sebacate												——	Har

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
12	Di-*n*-butyl tartrate	$C_{12}H_{22}O_6$	262	1.094	1.444 at 25° C.	67.7 at 25° C.	0.5	0.7	0.3	2.4	1.50	143
13	Tri-*n*-butyl phosphate	$C_{12}H_{27}O_4P$	266	0.978	1.424 at 20° C.	3.4 at 25° C.	<0.07	6.0	*M*	*M*	>4	502
14	Monomethyl phthalate ethyl glycolate ester	$C_{13}H_{14}O_6$	266	1.227	1.504 at 25° C.	185	0.1	1.2	0.5	0.1	0.65	61
15	*N*-Cyclohexyl-*p*-toluenesulfonamide	$C_{13}H_{19}O_2NS$	253	1.125 solid		f.p. 87° C.					0.05	26
16	Monoethyl phthalate ethyl glycolate ester	$C_{14}H_{16}O_6$	280	1.186	1.498 at 25° C.	68.0 at 25° C.	<0.08	1.38	1.60	0.18	0.50	93
17	Di(methyl CELLOSOLVE) phthalate	$C_{14}H_{18}O_6$	282	1.169	1.501 at 25° C.	53	0.85	3.2	0.50	0.10	0.16	61
18	Triethyl acetylcitrate	$C_{14}H_{22}O_8$	318	1.13	1.439 at 23° C.							> 525
19	Diisobutyl adipate	$C_{14}H_{26}O_4$	258	0.957	1.428 at 25° C.	70 at 25° C.						
20	Tributyrin	$C_{15}H_{26}O_6$	302	1.036	1.433 at 25° C.	8.9 at 25° C.						
21	Methyl CELLOSOLVE laurate	$C_{15}H_{30}O_3$	258	0.894 at 25° C.	1.440 at 25° C.	7.5 at 25° C.						

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence [a]												Supplier [m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	% Loss, 4-mil Film: 24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	% Extraction, 10 days, 23° C., 4-mil Film: Oil	Spew, 2 days, 60° C., 100% Humidity [b]	
	Simple Plasticizers (Continued)													
12	Di-n-butyl tartrate												——	Kes
13	Tri-*n*-butyl phosphate												——	CS
14	Monomethyl phthalate ethyl glycolate ester	55.4 [c]							17.5		6.1	5.9	——	Mon
15	*N*-Cyclohexyl-*p*-toluenesulfonamide												——	Mon
16	Monoethyl phthalate ethyl glycolate ester												——	Mon
17	Di(methyl CELLOSOLVE) phthalate	46 [c]							6.6		4.6	3.7	None	OA, TE
18	Triethyl acetylcitrate												——	Pf
19	Diisobutyl adipate												——	Cab
20	Tributyrin												——	TE
21	Methyl CELLOSOLVE laurate												——	Kes

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C. In Water	Water in	In Mineral Oil	Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr. 212° F. (100° C.)	375° F. (191° C.)
						Simple Plasticizers (Continued)						
22	Di-*n*-butyl phthalate	$C_{16}H_{22}O_4$	278	1.048	1.493 at 20° C.	20.3	Insol.	0.46	34	30.0	0.98	148
23	Di(CELLOSOLVE) phthalate	$C_{16}H_{22}O_6$	310	1.120	1.491 at 25° C.	f.p. 31° C.	0.2	2.0	2	0.64	0.15	30
24	*n*-Butyl laurate	$C_{16}H_{32}O_2$	256	0.857 at 25° C.								
25	Methyl CELLOSOLVE myristate	$C_{17}H_{34}O_3$	286	0.895 at 25° C.								
26	Di(butyl CARBITOL) formal	$C_{17}H_{36}O_6$	336	0.97								
27	Triphenyl phosphate	$C_{18}H_{15}O_4P$	326	1.268 at 60° C.	1.552 at 60° C.	f.p. 49.9° C.					0.02	22
28	Bis(dimethylbenzyl) ether	$C_{18}H_{22}O$	286	1.008	1.553 at 25° C.	29.0						
29	*n*-Butyl cyclohexyl phthalate	$C_{18}H_{24}O_4$	304	1.078	1.508 at 20° C.	117.0						75
30	Mono-*n*-butyl phthalate *n*-butyl glycolate ester	$C_{18}H_{24}O_6$	336	1.103	1.490 at 25° C.	64.9	Insol.	0.37	4.65	2.70	0.08	31
31	Tri-*n*-butyl citrate	$C_{18}H_{32}O_7$	360	1.045	1.443 at 25° C.		Insol.	<0.2	10.0	14.5	0.16	44
32	Triethylene glycol di(2-ethylbutyrate)	$C_{18}H_{34}O_6$	346	0.995	1.440 at 20° C.	11.5	0.02	1.0	0.2	24.0	0.86	

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a] Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film 10 days, 60° C.	24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film Water	Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
						Simple Plasticizers (Continued)							
22	Di-*n*-butyl phthalate	41.4[c]							17.5		2.7	6.8	None	Bar, CS, Har, Mon, Nev, Pitt, TE, USI, DA
23	Di(CELLOSOLVE) phthalate												——	OA
24	*n*-Butyl laurate												——	AH
25	Methyl CELLOSOLVE myristate												——	AH
26	Di(butyl CARBITOL) formal	55.3[c]							10.1		15.6	14.5	None	Thi
27	Triphenyl phosphate												——	Dow, Mon, Pitt
28	Bis(dimethylbenzyl) ether												——	OA
29	*n*-Butyl cyclohexyl phthalate	58.8					+3	−20	6.5		0.6	8.8	None	Bar
30	Mono-*n*-butyl phthalate *n*-butyl glycolate ester	53.2[c]	3000	300					3.3		17	4.3	None	Mon
31	Tri-*n*-butyl citrate	55.1	2800	300			−4	−32	3.1		8.1	14.6	None	Pf
32	Triethylene glycol di(2-ethylbutyrate)												——	CCCC

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]

[m] For key to supplier abbreviations see page 903.

Table 15.3 (*Continued*)

Properties of Commercially Available Plasticizers Arranged in Order of Ascending Number of Carbon Atoms

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
33	Butyl CELLOSOLVE laurate	$C_{18}H_{36}O_3$	300	0.882 at 25° C. (av.)	1.439 at 25° C.	6.5 at 25° C.						
34	Di-*n*-hexyl adipate	$C_{18}H_{34}O_4$	314	0.933 at 25° C.	1.439 at 25° C.	7.8 at 25° C.						
35	Di(1,3-dimethylbutyl) adipate	$C_{18}H_{34}O_4$	314	0.926	1.433 at 25° C.	5.6 cs. at 38° C.						
36	Di-*n*-butyl sebacate	$C_{18}H_{34}O_4$	314	0.936	1.440 at 25° C.	9.8	Insol.	1.6	*M*	*M*		63
37	Di(butyl CELLOSOLVE) adipate	$C_{18}H_{34}O_6$	346	0.997	1.442 at 25° C.	12.5						58
38	*n*-Butyl myristate	$C_{18}H_{36}O_2$	284	0.861 at 25° C.								
39	Tri(butyl CELLOSOLVE) phosphate	$C_{18}H_{39}O_7P$	398	1.022	1.434 at 25° C.	12.2	0.08	6.8	Almost miscible			
40	Cresyl diphenyl phosphate	$C_{19}H_{17}O_4P$	340	1.208 at 25° C.	1.563 at 20° C.	39.8						
41	*n*-Butyl benzyl phthalate	$C_{19}H_{20}O_4$	312	1.116 at 25° C.	1.538 at 20° C.	39.3 at 25° C.						29
42	Bis(dimethylbenzyl) carbonate	$C_{19}H_{22}O_3$	298	1.083	1.547 at 20° C.	155						32

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Simple Plasticizers (Continued)													
33	Butyl CELLOSOLVE laurate												——	Kes
34	Di-*n*-hexyl adipate												——	Kes
35	Di(1,3-dimethylbutyl) adipate												——	Har
36	Di-*n*-butyl sebacate	37.8[c]							7.2		0.4	10.5	None	Har, Pitt, RH
37	Di(butyl CELLOSOLVE) adipate	41.4[c]										18.0	None	Kes, OA
38	*n*-Butyl myristate												——	AH
39	Tri(butyl CELLOSOLVE) phosphate	43.7[c]							1.1		14.2	13.5	None	OA
40	Cresyl diphenyl phosphate	72	3000	292	64	475	4	−15		6.1	0.9	14.8	None	Mon
41	*n*-Butyl benzyl phthalate	59	2930	281	66	730	6	−11		9.5	0.6	7.8	None	Mon
42	Bis(dimethylbenzyl) carbonate	71	3000	284	63	450	2	− 9		11.8	1.5	9.2	——	OA

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[20]
[m] For key to supplier abbreviations see page 903

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
43	Methyl pentachlorostearate	$C_{19}H_{33}O_2Cl_5$	471	1.204	1.497 at 20° C.	975.0						7
44	Methyl ricinoleate	$C_{19}H_{36}O_3$	312	0.925 at 25° C.	1.462 at 25° C.							
45	Methyl CELLOSOLVE palmitate	$C_{19}H_{38}O_3$	314	0.891 at 25° C.								
46	Methyl hydroxystearate	$C_{19}H_{38}O_3$	314			f.p. 48° C.						
47	Diphenyl phthalate	$C_{20}H_{14}O_4$	318	1.28 solid	1.572 at 74° C.	f.p. 69° C.					0.006	10
48	Dicyclohexyl phthalate	$C_{20}H_{26}O_4$	330	1.23		f.p. 63.5						
49	2-Ethylhexyl diphenyl phosphate	$C_{20}H_{27}O_4P$	362	1.092	1.511 at 20° C.	21.0						44
50	Di-*n*-hexyl phthalate	$C_{20}H_{30}O_4$	334	1.007	1.487 at 20° C.	29.5	Insol.	0.24				43
51	Di(2-ethylbutyl) phthalate	$C_{20}H_{30}O_4$	334	1.016	1.488 at 25° C.	56	Insol.	<0.05	*M*	*M*	0.20	65
52	Di(1,3-dimethylbutyl) phthalate	$C_{20}H_{30}O_4$	334	0.995	1.480 at 25° C.	28.8 cs. at 38° C.						> 150

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Simple Plasticizers (Continued)													
43	Methyl pentachlorostearate	69[d]	2900	338	64	600	− 6	−19	0.2		0.2	17.1	None	Hook
44	Methyl ricinoleate												——	Bak
45	Methyl CELLOSOLVE palmitate												——	AH
46	Methyl hydroxystearate												——	Bak
47	Diphenyl phthalate												——	Mon
48	Dicyclohexyl phthalate	64[e]	3000	290			+ 5	− 5	1.0		0	4.5	None	Bar, OA
49	2-Ethylhexyl diphenyl phosphate	60	2580	260	64	540	− 2	−28	1.6		0.2	14.8	None	Mon
50	Di-*n*-hexyl phthalate	57	2720	293	63	570	− 8	−31	3.8	11.6	0	18.5	None	CCCC, TE
51	Di(2-ethylbutyl) phthalate	45.3[c]							4.4		0.2	3.4	None	TE
52	Di(1,3-dimethylbutyl) phthalate												——	Har

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]
[d] Mixture of 1 part plasticizer to 2 parts FLEXOL plasticizer DOP.
[e] Mixture of 0.9 part plasticizer to 1 part FLEXOL plasticizer DOP.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C. In Water	Water in	In Mineral Oil	Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr. 212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
53	Di(butyl CELLOSOLVE) phthalate	$C_{20}H_{30}O_6$	360	1.063	1.483 at 25° C.	42.0	Insol.	0.63	2.80	6.50	0.06	24
54	Di(CARBITOL) phthalate	$C_{20}H_{30}O_8$	398	1.150	1.492 at 25° C.	82.0	Insol.	2.80	0.09	0.20	0.08	18
55	Tri-*n*-butyl acetylcitrate	$C_{20}H_{34}O_8$	402	1.046 at 25° C.	1.441 at 25° C.							61
56	*n*-Butyl palmitate	$C_{20}H_{40}O_2$	313	0.865 at 25° C.								
57	Tricresyl phosphate	$C_{21}H_{21}O_4P$	368	1.165	1.557 at 20° C.	120.0	Insol.	0.37	5.5	2.0	0.01	7
58	*n*-Butyl benzyl sebacate	$C_{21}H_{32}O_4$	348	1.004	1.479 at 25° C.	8.6 ca. at 38° C.						
59	Methyl acetylricinoleate	$C_{21}H_{38}O_4$	355	0.936	1.456 at 20° C.	23.1						
60	Methyl CELLOSOLVE oleate	$C_{21}H_{40}O_3$	341	0.902	1.453 at 25° C.	10.2					0.12	29
61	Di(2-ethylbutyl) azelate	$C_{21}H_{40}O_4$	357	0.930	1.442 at 25° C.	11.4						43
62	Propylene glycol monoricinoleate	$C_{21}H_{40}O_4$	357	0.950 at 25° C.								
63	Methyl CELLOSOLVE stearate	$C_{21}H_{42}O_3$	343	0.877 at 25° C.	1.443 at 25° C.	8.9 at 25° C.						30

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a] Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film 10 days, 60° C.	24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film Water	Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
	Simple Plasticizers (Continued)													
53	Di(butyl CELLOSOLVE) phthalate	47.8[c]							2.1		4.8	11.4	None	OA
54	Di(CARBITOL) phthalate	54.4[c]							2.0		10.1	9.9	None	OA
55	Tri-*n*-butyl acetylcitrate												——	Pf
56	*n*-Butyl palmitate												——	AH
57	Tricresyl phosphate	75	2880	274	58	580	+ 5	− 3	0.1		0.7	6.1	None	Cel, Mon, OA, Pitt
58	*n*-Butyl benzyl sebacate												——	Har
59	Methyl acetylricinoleate	47.8[c]							8.8		9.6	11.0	——	Bak
60	Methyl CELLOSOLVE oleate	50.5[c,f]							3.6		3.0	10.3	——	AH, Kes, OA
61	Di(2-ethylbutyl) azelate	44.5	2800	260				−40	5.2		1.5	18.0	None	Em
62	Propylene glycol monoricinoleate												——	Bak
63	Methyl CELLOSOLVE stearate												——	AH, Kes

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]
[f] Mixture of 0.63 part plasticizer to 1 part tricresyl phosphate.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
64	*n*-Butyl ricinoleate	$C_{22}H_{42}O_3$	355									
65	Di(1,3-dimethylbutyl) sebacate	$C_{22}H_{42}O_4$	371	0.911	1.439 at 25° C.	9.2 cs. at 38° C.						
66	Di(2-ethylhexyl) adipate	$C_{22}H_{42}O_4$	371	0.927	1.447 at 20° C.	13.7	Insol.	0.12				41
67	Diisoöctyl adipate	$C_{22}H_{42}O_4$	371	0.928	1.448 at 25° C.	17.7						38
68	Dicapryl adipate	$C_{22}H_{42}O_4$	371	0.915	1.440 at 25° C.	8.3 cs. at 38° C.						
69	Diethylene glycol dipelargonate	$C_{22}H_{42}O_5$	387	0.963	1.447 at 20° C.	19						
70	Di(butyl CELLOSOLVE) sebacate	$C_{22}H_{42}O_6$	403	0.970							0.04	
71	Triethylene glycol di(2-ethyl hexanoate)	$C_{22}H_{42}O_6$	403	0.968	1.444 at 20° C.	16.1	Insol.	0.4	*M*	*M*	0.18	50
72	Triethylene glycol dicaprylate	$C_{22}H_{42}O_6$	406 (av.)	0.973								
73	Di(butyl CARBITOL) adipate	$C_{22}H_{42}O_8$	435	1.02 at 16° C.		15 at 22° C.						
74	*n*-Butyl stearate	$C_{22}H_{44}O_2$	341	0.858	1.444 at 20° C.	7.9 at 25° C.						59

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Simple Plasticizers (Continued)													
64	*n*-Butyl ricinoleate												——	Dee
65	Di(1,3-dimethylbutyl) sebacate												——	Har
66	Di(2-ethylhexyl) adipate	51	2730	318	67	600	−15	−53	3.5	12.2	2.2	21.0	None	CCCC, Gdr, MWi, Kes, OA, Har
67	Diisoöctyl adipate												——	Kes, MWi, OA, Pitt, RCA, Har, Cab
68	Dicapryl adipate												——	Har
69	Diethylene glycol dipelargonate	51.3	2800	330			−15	−48	6.9		6.0	22.0	Yes	Em
70	Di(butyl CELLOSOLVE) sebacate												——	Dee
71	Triethylene glycol di(2-ethylhexanoate)	59	2680	300	69	800	−17	−50	4.7	12.4	2.0	22.8	None	CCCC
72	Triethylene glycol dicaprylate												——	RCA, Drew
73	Di(butyl CARBITOL) adipate												——	Thi
74	*n*-Butyl stearate												——	CS, AH, Har, Kes, OA

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
						Simple Plasticizers (Continued)						
75	*n*-Butyl oleate	$C_{22}H_{42}O_2$	339	0.864 at 25° C.	1.449 at 25° C.	7.7 at 25° C.						
76	Tetrahydrofurfuryl oleate	$C_{23}H_{42}O_3$	366	0.925	1.466 at 20° C.	17.8						
77	Methyl CELLOSOLVE acetylricinoleate	$C_{23}H_{42}O_5$	399	0.955	1.456 at 20° C.	42.1	Insol.	0.6	*M*	*M*		12
78	*o*-Xenyl diphenyl phosphate	$C_{24}H_{19}O_4P$	402	1.233	ca. 1.586 at 60° C.	30–55 at 60° C.	Insol.	0.35	2.22	0.3	0.005	20
79	Dibenzyl sebacate	$C_{24}H_{30}O_4$	382	1.055 at 30° C.	1.520 at 30° C.	13.0 ca. at 38° C.						
80	Di(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	390	0.986	1.486 at 20° C.	81.0	Insol.	0.20	*M*	*M*	0.02	24
81	Diisoöctyl phthalate	$C_{24}H_{38}O_4$	390	0.987	1.486 at 20° C.	83.0						19
82	Dicapryl phthalate	$C_{24}H_{38}O_4$	390	0.966	1.479 at 20° C.	66.7						22
83	Di(2-ethylhexyl) tetrahydrophthalate	$C_{24}H_{42}O_4$	395	0.969	1.466 at 20° C.	42.0	Insol.	0.26				30
84	Tetra-*n*-butyl thiodisuccinate	$C_{24}H_{42}O_8S$	491	1.054	1.462 at 20° C.	63.6	Insol.	0.22				6
85	Di(2-ethylhexyl) hexahydrophthalate	$C_{24}H_{44}O_4$	397	0.956	1.461 at 20° C.	35.9						37
86	*n*-Butyl acetylricinoleate	$C_{24}H_{44}O_4$	397	0.929	1.456 at 25° C.	35.3						30

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence [a]												Supplier [m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity [b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
						Simple Plasticizers (Continued)								
75	*n*-Butyl oleate												——	AH, Kes
76	Tetrahydrofurfuryl oleate	59 [d]	2590	297	67	650	− 8	−34	0.8		0.3	17.2	None	AH, Em, Pitt
77	Methyl CELLOSOLVE acetylricinoleate	50.8 [c]							2.4		1.3	14.5	None	Bak, Dee
78	*o*-Xenyl diphenyl phosphate												——	Dow
79	Dibenzyl sebacate	45.3 [c]							0.7		0.3	11.8	None	Har
80	Di(2-ethylhexyl) phthalate	61	2360	253	67	700	− 3	−31	0.7	5.1	0	15.5	None	Bar, CCCC, Har, Mon, MWi, OA, Pitt, TE, DA, Gdr
81	Diisoöctyl phthalate	56	2700	300			− 1	−27					None	Bar, Cab, Har, MWi, OA, Pitt, RCA
82	Dicapryl phthalate	64	2500	270			− 5	−35	0.6		0	33.8	None	RH, Har
83	Di(2-ethylhexyl) tetrahydrophthalate	66	2590	320	68	560	−13	−37	4.1	11.5	0.3	21.8	None	CCCC
84	Tetra-*n*-butyl thiodisuccinate	64	3200	318	62	760	− 2	−22	0	2.5	0.8	15.2	None	CCCC
85	Di(2-ethylhexyl) hexahydrophthalate	64	2580	300	68	750	−10	−34		9.7	0	25.4	None	CCCC
86	*n*-Butyl acetylricinoleate	55.4 [c]											Yes	Bak

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]
[d] Mixture of 1 part plasticizer to 2 parts FLEXOL plasticizer DOP.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.: In Water	Solubility, % at 20° C.: Water in	Solubility, % at 20° C.: In Mineral Oil	Solubility, % at 20° C.: Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr.: 212° F. (100° C.)	Volatility of Free Plasticizer in Air, mg./sq. cm./hr.: 375° F. (191° C.)
	Simple Plasticizers (Continued)											
87	Butyl CELLOSOLVE oleate	$C_{24}H_{46}O_3$	383	0.885 at 25° C.	1.454 at 25° C.	5.5 at 25° C.						
88	Dinonyl adipate	$C_{24}H_{46}O_4$	398	0.914 at 25° C.	1.445 at 25° C.	18.5 at 25° C.						
89	*n*-Octyl *n*-decyl adipate (mixture)	$C_{24}H_{46}O_4$ (est.)	398 (av.)	0.920	1.450 at 20° C.	15.4						
90	Polyethylene glycol di(2-ethylhexanoate)	$C_{24}H_{46}O_7$	447	0.989	1.447 at 20° C.	25.1	Insol.	1.4				44
91	Butyl CELLOSOLVE stearate	$C_{24}H_{46}O_3$	385	0.882	1.446 at 25° C.	13.3						26
92	Tri(2-ethylhexyl) phosphate	$C_{24}H_{51}O_4P$	435	0.926	1.443 at 20° C.	14.1	Insol.	1.4	*M*	*M*		39
93	Di(2-ethylhexyl) azelate	$C_{25}H_{48}O_4$	413	0.918	1.450 at 20° C.	20						20
94	*n*-Octyl *n*-decyl phthalate (mixture)	$C_{26}H_{42}O_4$ (est.)	418 (av.)	0.975	1.484 at 20° C.	72						8
95	Isoöctyl *n*-octyl *n*-decyl phthalate (mixture)	$C_{26}H_{42}O_4$ (est.)	418 (av.)	0.978	1.485 at 20° C.	42.9						
96	Di(2-ethylhexyl) sebacate	$C_{26}H_{50}O_4$	427	0.912	1.451 at 20° C.	19.9						12
97	Diisoöctyl sebacate	$C_{26}H_{50}O_4$	427	0.917	1.447 at 25° C.	20.4 at 25° C.						
98	Dicapryl sebacate	$C_{26}H_{50}O_4$	427	0.907	1.444 at 25° C.	13.0 ca. at 38° C.						

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]: Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	% Loss, 4-mil Film: 24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	% Extraction, 10 days, 23° C., 4-mil Film: Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
	Simple Plasticizers (Continued)													
87	Butyl CELLOSOLVE oleate												——	Kes
88	Dinonyl adipate												——	Pitt
89	*n*-Octyl *n*-decyl adipate (mixture)	53	2550	295	78	1050	− 7	−54		5.5	0.3	23.5	None	Herc, OA
90	Polyethylene glycol di(2-ethylhexanoate)	62	2690	308	70	750	−12	−44	2.8	8.8	3.0	19.4	None	CCCC
91	Butyl CELLOSOLVE stearate												——	AH, Kes, OA
92	Tri(2-ethylhexyl) phosphate	59	2640	300	66	980	−16	−57	3.2	6.8	0.6	24.8	None	CCCC
93	Di(2-ethylhexyl) azelate	57	2590	334	66	750	−17	−56	0.5		0.4	22.5	None	Ein
94	*n*-Octyl *n*-decyl phthalate (mixture)	62	2640	318	64	640	− 8	−38	0.2		0.3	21.8	None	Harc
95	Isoöctyl *n*-octyl *n*-decyl phthalate (mixture)	67	2720	334	66	470	−12	−39		3.9	0	22.4	None	Herc
96	Di(2-ethylhexyl) sebacate	60	2420	293	67	1700	−19	−56	0.08	4.8	0.3	30.2	None	Dee, Har, MWi, RH
97	Diisoöctyl sebacate												——	Har, Pitt, MWi
98	Dicapryl sebacate												——	Har

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
99	2-Ethylhexanoic acid diester of *N,N*-bis(2-hydroxyethyl)-2-ethylhexanamide	$C_{28}H_{53}O_5N$	484	0.956	1.458 at 20° C.	139.2	Insol.	0.5				12
100	Tri(*p-tert*-butylphenyl) phosphate	$C_{30}H_{39}O_4P$	495			f.p. 95–99.5 °C.						0.9
101	Glyceryl triricinoleate	$C_{57}H_{104}O_9$	933	0.959 at 25° C.	1.477 at 25° C.							
102	Glyceryl tri(acetylricinoleate)	$C_{63}H_{110}O_{12}$	1060	0.964	1.469 at 25° C.	271						0.7
	Resinous Plasticizers											
103	AROCLOR 1242, chlorinated biphenyl			1.378–1.388 at 25° C.	1.627–1.629 at 20° C.		Insol.	<0.1	*M*	*M*	2.50	146
104	FLEXOL plasticizer R-2H, polyester			1.055	1.469 at 20° C.	ca. 20,000	Insol.	1.0				0.5
105	G.E. 2557, polyester			1.028	1.459 at 20° C.	306						3
106	G.E. 2559, polyester			1.060	1.492 at 20° C.	4278						1
107	PARACRIL C, nitrile rubber			0.984								
108	PARAPLEX G-25, polyester		ca. 8000	1.06	1.470 at 20° C.	300,000						0.2

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
									% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film			
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	10 days, 60° C.	24 hours, 70° C.	Water	Oil	Spew, 2 days, 60° C., 100% Humidity[b]	
	Simple Plasticizers (Continued)													
99	2-Ethylhexanoic acid diester of *N,N*-bis(2-hydroxyethyl)-2-ethylhexanamide	64	2730	327	63	650	− 8	−23	0.4	1.7	1.1	11.0	None	CCCC
100	Tri(*p-tert*-butylphenyl) phosphate												——	Dow
101	Glyceryl triricinoleate												——	Bak
102	Glyceryl tri(acetylricinoleate)	68.0[c, g]							1.4		2.5	9.5	None	Bak
	Resinous Plasticizers													
103	AROCLOR 1242, chlorinated biphenyl	56.2[h]							4.5		0.6	0.6	None	Mon
104	FLEXOL plasticizer R-2H, polyester	90	3080	360	57	440	+2	−10	0	0	0	2.4	None	CCCC
105	G.E. 2557, polyester	72	2730	310	63	580	− 2	−18	0.9	3.5	3.1	17.0	Very slight	GE
106	G.E. 2559, polyester	90[i]	2110	215	72	740	6	− 6	0.6	2.3	2.7	7.1	Very slight	GE
107	PARACRIL C, nitrile rubber	106	2500	410			+ 7	−54	0.5		0.2	0.6	None	Nau
108	PARAPLEX G-25, polyester	82	2600	310	60	480	− 1	−25	0.2		1.0	0.6	None	RH

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[25]

[g] Mixture of 0.9 part plasticizer to 1 part tricresyl phosphate.

[h] Only composition tested, does not yield standard elongation.

[i] Highest plasticizer content tested. Elongation at 1000 p.s.i. = 64%.

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C. In Water	Water in	In Mineral Oil	Mineral Oil in	Volatility of Free Plasticiser in Air, mg./sq. cm./hr. 212° F. (100° C.)	375° F. (191° C.)
	Resinous Plasticizers (Continued)											
109	Paraplex G-40, polyester		ca. 6000	1.15	1.472 at 20° C.	290,000						0.6
110	Paraplex G-50, polyester		ca. 2200	1.084	1.470 at 20° C.	3000						1
111	Plastolein 9720, polyester		ca. 850	1.043	1.462 at 20° C.	431						2
	Hydrocarbon-Type Plasticizers											
112	Dow 276-V2, polymolecular product derived from α-methylstyrene			1.021	1.582 at 20° C.							
113	HB 40, partially hydrogenated mixture of isomeric terphenyls			1.007	1.570 at 25° C.	112.8						115
114	Kenflex L, hydrocarbon resin made by reaction of formaldehyde + dimethylnaphthalenes			1.01 at 15.6° C.		f.p. −1° C.						
115	Nevillac 10° (PHO), a hydrindyl phenol derivative		240 (av.)	1.075 to 1.10 at 15.6° C.	1.597 at 25° C.	23,500 at 25° C.						
116	Nevinol			1.03 to 1.08 at 15.6° C.	1.596 (av.) at 25° C.	65 to 110 at 25° C.						
117	Panaflex BN-1, alkylated aromatic hydrocarbon mixture			0.955	1.561 at 20° C.	151.6						
118	Sovaloid C, alkylated aromatic hydrocarbon mixture			1.038		105						

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]: Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
	Resinous Plasticizers (Continued)													
109	Paraplex G-40, polyester	67[j]	2780	310	69	760	1	−15	0.3		1.0	5.2	Slight	RH
110	Paraplex G-50, polyester	75	2630	320	62	680	0	−16	0.2		1.3	6.5	None	RH
111	Plastolein 9720, polyester	69	2850	312	66	900	−7	−23	0.3	1.8	1.9	14	None	Em
	Hydrocarbon-Type Plasticizers													
112	Dow 276-V2, polymolecular product derived from α-methylstyrene	74[k]	2420	315	62	650	−5	−24	1.4		0.6	22.6	None	Dow
113	HB 40, partially hydrogenated mixture of isomeric terphenyls	62[d]	2890	298	66	940	−1	−23	8.4		0.5	15.5	None	Mon
114	Kenflex L, hydrocarbon resin made by reaction of formaldehyde + dimethylnaphthalenes												——	Ken
115	Nevillac 10° (PHO), a hydrindyl phenol derivative	56.3[c, h]							13.3		0.1	0.1	None	Nev
116	Nevinol												None	Nev
117	Panaflex BN-1, alkylated aromatic hydrocarbon mixture	63[d]	2800	310	66	920	2	−21	6.1		1.3	16.8	None	Pan
118	Sovaloid C, alkylated aromatic hydrocarbon mixture	61.4[l]	3100	280			+ 4	−16	11.5		1.7	9.0	None	SV

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]

[d] Mixture of 1 part plasticizer to 2 parts Flexol plasticizer DOP.

[h] Only composition tested, does not yield standard elongation.

[j] Mixture of 1 part plasticizer to 1 part Flexol plasticizer DOP.

[k] Mixture of 1 part plasticizer to 3 parts Flexol plasticizer DOP.

[l] Mixture of 0.85 part plasticizer to 1 part Flexol plasticizer DOP.

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

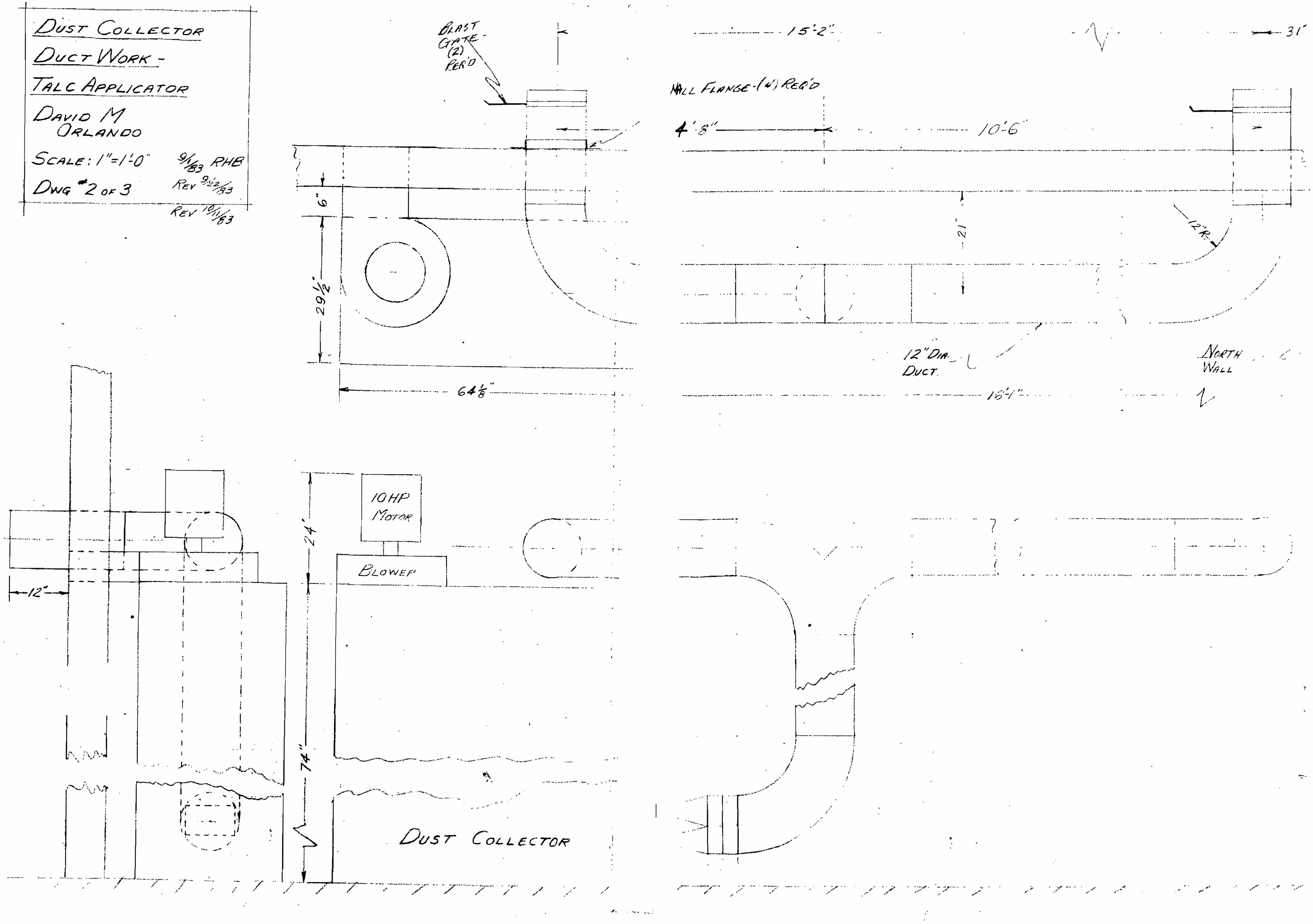
No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C. In Water	Water in	In Mineral Oil	Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr. 212° F. (100° C.)	375° F. (191° C.)
	Miscellaneous Plasticizers											
119	Arneel TOD, mixture of oleic, linoleic, and cyclic nitriles		ca. 278	0.910		30.2						
120	*n*-Butyl acetyl polyricinoleate, PG16		362 (av.)	0.913 at 25° C.	1.460 at 25° C.							
121	Chlorinated paraffin 40			1.164	1.505 at 23° C.	3100 at 25° C.						
122	Flexol plasticizer B-400, polypropylene glycol mono-*n*-butyl ether			0.995	1.449 at 20° C.	152	0.1	3.3				ca. 60
123	Glyceryl polyricinoleate, No. 15 oil			1.031 at 25° C.	1.483 at 25° C.							
124	Harflex 500, monomeric ester type			0.932	1.488 at 20° C.	17.0						
125	Hercoflex 600, a pentaerythritol ester		538 (av.)	1.006	1.453 at 20° C.	48.3						
126	Ohopex Q-10, octyl fatty-phthalic acid esters			0.952	1.475 at 25° C.	41						
127	Paraplex G-60, high-molecular-weight ester		ca. 1000	0.994	1.474 at 20° C.	240 to 300						0.9
128	Plasticizer DP-520, chlorinated aliphatic product			1.126 at 15.6° C.	1.478 at 25° C.	66.4 ca. at 54° C.						
129	Polyethylene glycol dilaurate			0.97 at 25° C.								
130	Santicizer 180			1.071	1.506 at 20° C.	234						
131	Staflex KA, monomeric ester type											

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]: Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
	Miscellaneous Plasticizers													
119	Arneel TOD, mixture of oleic, linoleic, and cyclic nitriles	52.8	2000	290				−44	11.7		0.7	14.8	None	Arm
120	*n*-Butyl acetyl polyricinoleate, PG16	Incompatible at 55.3 p.h.r.											——	Bak
121	Chlorinated paraffin 40	68[e]	2820	335	67	900	− 5	−28	1.0		0	20	None	Halo, Dia, Herc, Hook
122	Flexol plasticizer B-400, polypropylene glycol mono-*n*-butyl ether												——	CCCC
123	Glyceryl polyricinoleate, No. 15 oil												——	Bak
124	Harflex 500, monomeric ester type	63	2400	319	67	980	−10	−61	1.1		0.4	23.0	None	Har
125	Hercoflex 600, a pentaerythritol ester	58	2910	327	66	900	− 2	−28	0	1.1		12.8	None	Herc
126	Ohopex Q-10, octyl fatty-phthalic acid esters												——	OA
127	Paraplex G-60, high-molecular-weight ester	69	2800	317	67	880	− 2	−21	0.2		0.4	11.1	None	RH
128	Plasticizer DP-520, chlorinated aliphatic product												——	Drew
129	Polyethylene glycol dilaurate												——	Gly
130	Santicizer 180	73	2670	308	67	430	− 2	−17		2.7	1.3	12.2	None	Mon
131	Staflex KA, monomeric ester type												——	Des

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[e] Mixture of 0.9 part plasticizer to 1 part Flexol plasticizer DOP.
[m] For key to supplier abbreviations see page 903.

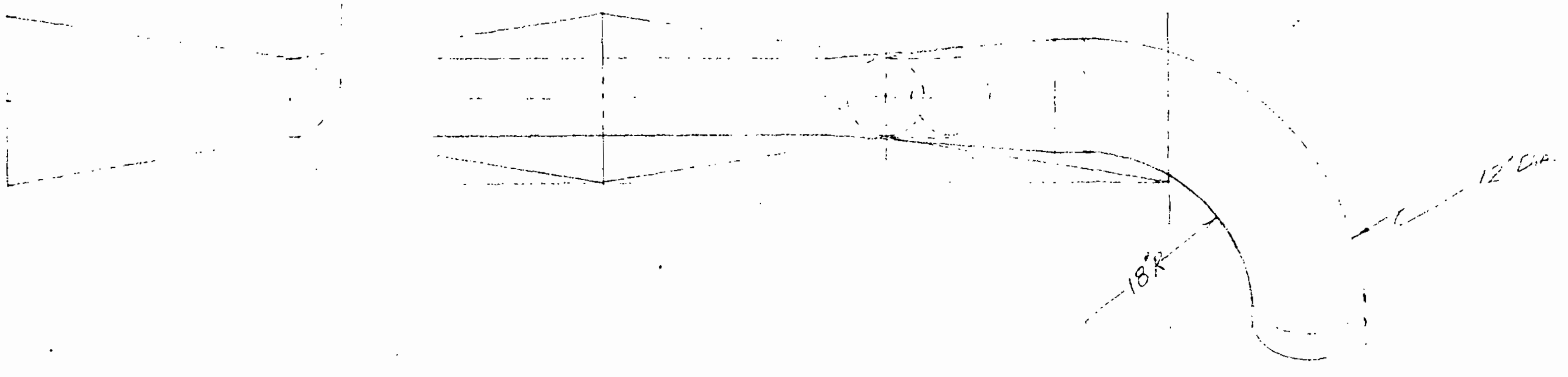
BEST AVAILABLE COPY

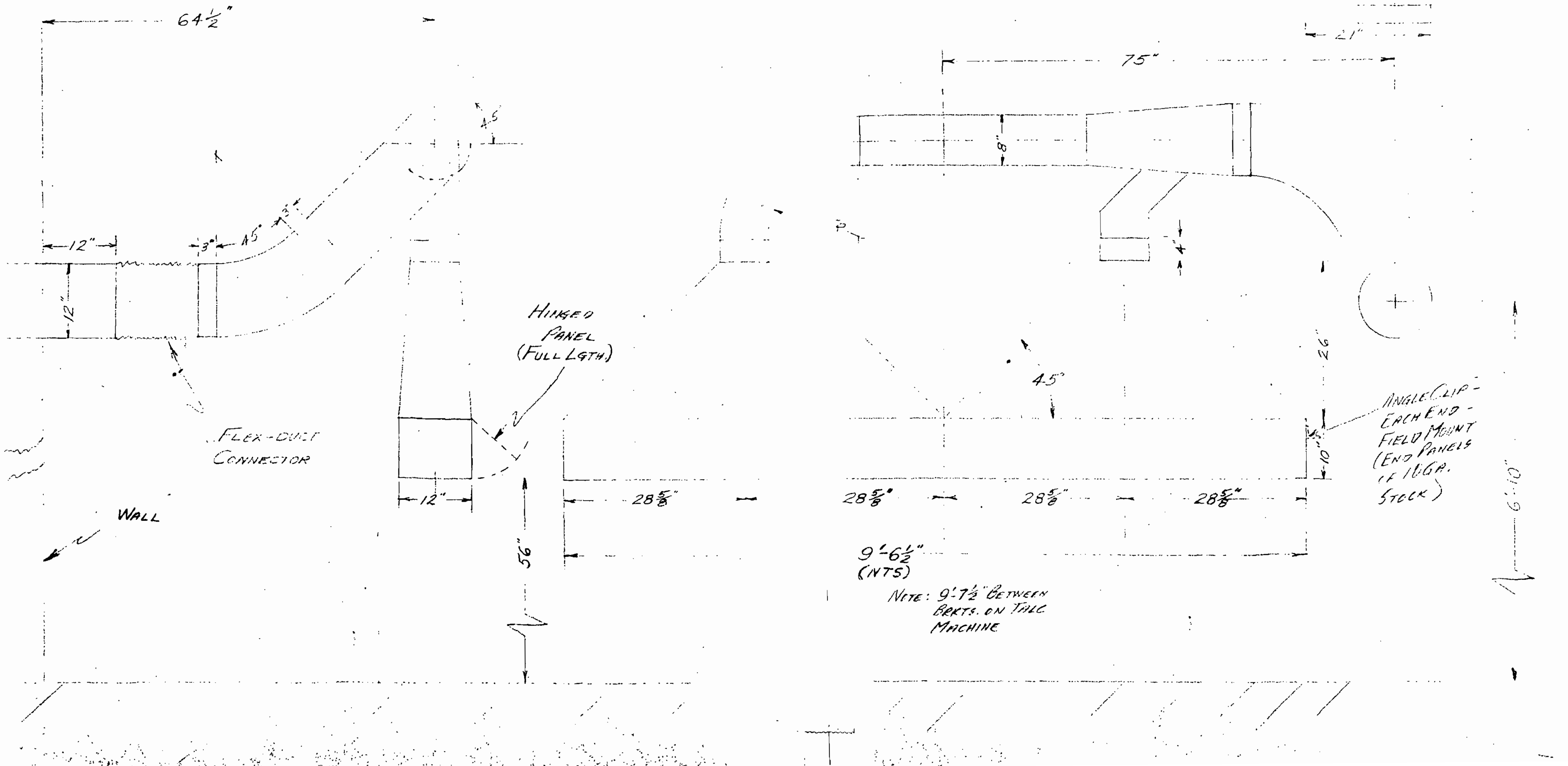


BEST AVAILABLE COPY

DUST COLLECTOR
HOOD & DUCT –
TALC APPLICATOR –
DAVID M
ORLANDO

SCALE: 1"=1'-0" 9/1/83 RHB
DWG. #1 OF 3 REV. 3/22/83
REV. 10/1/83





11. c) Will product scrap be recycled to the mills? If so, will VOC be emitted by the scrap?

No, and as such no VOC will be emitted by the scrap.

12. Are the flow rates listed in the application from points 4 and 5 correct?

Yes, each emission point has two (2) fans and the duct velocity in each is 800 fpm. Given the area of each duct (1.76 ft.^{2}), the flow would equate to 1415 ACFM. In the original application the velocities in the ducts were incorrectly shown in feet per second. Those numbers were actually in feet per minute. Please excuse the typographical error.

13. What will be the percent of the lower explosive limit (LEL) at peak solvent evaporation rates for each exhaust stream?

The new ventilation system will be designed around peak solvent evaporation rates of 40% of the lower explosive limit and will incorporate the use of a lower explosive limit detection and control system designed to enhance safe operation.

14. What will be the percent of the threshold limit values (TLV) near the discharge points ~ 20 feet outside the plant during peak solvent evaporation rates?

The control device, which will provide at least a 90% removal efficiency can be expected to reduce emission levels 20 feet from the exhaust discharge points to well below the current (OSHA) TLV's for Toluene 200 ppm and MEK 200 ppm, however, without extensive modeling an estimated percent of the TLV at the property line cannot be established. Please advise of the necessity of performing said modeling in view of the proposed control program.

15. a) How many employees will work at this plant?

61 full-time employees.

b) What impact will the emissions from the plant have on the ambient air quality, vegetation and visibility near the plant?

With the incorporation of a control device capable to continuous operation at or above 90% removal efficiency, adverse effects on air quality, visibility and vegetation are not anticipated since the control program reflects state of the art air pollution control technology.

16. If the solvents were recovered, could they be used or sold to a reclamation plant?

    Yes, either avenue is a possibility.

17. What is the current delivered cost of the solvents used at the plant?

Toluene	$1.30/gallon
MEK	$ .36/pound

18. Has the company made any studies on recovering and reusing the solvents at the plant and, if so, what conclusions were reached?

    Yes, preliminary studies suggest that recovery and on-site re-use are well within the realm of feasibility, however, the necessary equipment requires a very substantial capital investment.

19. Please explain price estimate.

    Enclosed you will find a copy of a budget quotation for a 25,000 SCFM solvent recovery plant (Appendix VI) which includes equipment and installation. Our original $700,000.00 figure also included ventilation rework estimates and process control system installation. At this time it is not possible to guarantee that a solvent recovery or thermal incineration device will be of this size or cost since efforts are now underway to reduce the size of the system, however, if a system of such size is necessary due to the nature of the process (non-continuous peak evaporation type), the original $700,000.00 figure is a very real number.

20. How many gallons of VOC per year will be shipped to Emille for disposal?

    Approximately 220 (55 gallon drums) which would contain some 5,000 gallons of VOC. (By estimate.)

DISCUSSION:

In accordance with our recent conversation and the historical data provided in item one, David 'M' Company may be considered a major source of air pollution in an uncontrolled state. As such a B.A.C.T. type standard would be applicable and will likely approximate the 2.9 lbs. VOC/gallon of coating applied or 90% removal of VOC from the exhaust stream. David 'M' Company cannot meet the afore-mentioned low solvent technology standard and will be obligated to propose the control device intended for use in meeting the 90% removal standard referenced above. While I cannot guaranty at this time the exact type of control device which David 'M' Company will install, I can state that both recovery and thermal destruction techniques capable of delivering 90% removal of VOC's from exhaust streams are being evaluated.

The attached schedule estimates the time periods associated with specifying the type of control device and ultimately installing same. Would you please advise me of the proposed schedule's acceptability. We believe this schedule to be a fair appraisal of the time necessary to complete the installation of a project of this magnitude. Should you require further information and/or assistance, please do not hesitate to contact me directly.

Sincerely,

Michael A. Ware

Michael A. Ware
Graphics Div. Env. Coord.
Chemicals & Coatings Group
Wheelabrator-Frye, Inc.

MAW:bjw
Attach.

Mike Ware

October 19, 1983

ESTIMATED
OVERALL COMPLIANCE SCHEDULE
DAVID M COMPANY VOC CONTROL PROJECT

PHASE	
Data Accumulation	January 1, 1984
Spreader Enclosure - (1) For Temperature Evaluation	January 15, 1984
Process Modifications and Development	April 1, 1984
Methods Comparison/Analysis - Thermal Incineration Vs. Recovery	May 15, 1984
Final Specification Development	July 1, 1984
Final Specification/Quotations and Analysis	September 1, 1984
Appropriations Request Development and Approval	December 1, 1984
Oven Enclosure and Exhaust System Installation	March 1, 1985
Solvent Recovery Delivery and Installation	August 1, 1985
Operational Shakedown, Debugging and Compliance Testing	December 1, 1985

APPENDIX VI

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908020~~ 240189

COPY

YOUR REF:

OUR REF: E 0379
S 7212

DATE: 2 August 1983

PROPOSAL

FOR

SOLVENT RECOVERY SYSTEM

TO BE LOCATED AT:

DAVID M. COMPANY

201 VALENTINE WAY
LONGWOOD, FLORIDA

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~968020~~ 240189

YOUR REF: OUR REF: S 7212 DATE: 2 August 1983

David M. Company
201 Valentine Way
Longwood, Florida

SOLVENT RECOVERY PLANT

ACTIVATED CARBON ADSORPTION UNIT

AIRFLOW	25,000 scfm.
AIR TEMPERATURE	140° F.
SOLVENT CAPACITY	50 gph (360 lb/hr)
SOLVENT	Toluene

AUTOMATICALLY CONTROLLED

BY

GAS ANALYSER

PRELIMINARY PROPOSAL

PLANT DESCRIPTION

The solvent laden air would be filtered to remove dust, cooled to approximately 95° F by the air cooler and then delivered by the fan to the three adsorbers.

Two of the three adsorbers would normally be handling the solvent laden air whilst the other would be regenerating with steam to extract the solvent from the carbon or would be held on "stand-by" following "steaming" and a short dry/cool period.

The adsorbers would cycle consecutively and automatically with override of the cycle time and steam input by gas analyser control. The proposed adsorbers are of annular bed design, the solvent air after filtering and cooling passes through an automatic inlet valve into the outer annulus of the adsorber, through the carbon bed and then exhausts to atmosphere through the inner annulus and the automatic exhaust valve.

At the end of an adsorbing period the air inlet and outlet valves close and an automatic steam valve allows steam to enter the inner annulus of the adsorber and pass through the carbon bed to the outer annulus from which point the steam together with solvent vapour extracted from the carbon passes to the condenser. During steaming some condensation occurs on the outer shell of the adsorber and is drained through filters to join the main condensate flow from the condenser to the decanter.

At the end of the steaming period the adsorber automatic steam valve shuts and the air inlet and outlet valves open to allow solvent laden air to again pass through the adsorber for a short period to dry and cool the bed (during this dry/cool period the solvent laden air is shut off from the other adsorber). The inlet valve of the dried/cooled adsorber would then close and the adsorber would be held on "stand-by" until the gas analyser, sampling the exhaust of the other adsorber, or the override timer, gives the signal for that adsorber to change to the steaming cycle, the stand-by adsorber being first brought back into service, so that there is no interruption to the adsorber cycle.

Any incondensibles from the condenser return through the condenser vent pipe to the inlet duct for recycling through the adsorbers. The condenser vent is fitted with high temperature alarm to indicate overloading from excessive steam flow or shortage or failure of the cooling water supply.

Safety features include adsorber pressure and vacuum relief valves and liquid seals.

We would supply the following:

1. AIR FILTER - 25,000 scfm capacity

   a) Pre-Filter Section

   With removable and disposable fiberglass panels to protect and extend the life of the main filter.

   b) Main Filter Section

   With disposable filter elements of the HEPA type of fiberglass material, with an efficiency of better than 99% for particles down to 0.3 microns per standard tests.

   The whole of the above would be incorporated in a galvanized steel case with access doors to facilitate servicing.

   A differential resistance gauge would be fitted.

2. AIR COOLER - 25,000 scfm capacity.

   Would be of finned tube design with copper tubes and aluminum fins to cool the inlet airstream from 140° F to approximately 95° F when supplied with cooling water at a temperature of maximum 86° F.

   The air cooler coils would be housed in a galvanized steel case and would be drainable.

3. FAN AND MOTOR

   The fan would be of the high efficiency type with airfoil impeller capable of handling 25,000 scfm of solvent laden air, when at an actual temperature of approximately 95° F, at a total pressure of approximately 18" w.g., allowing for 2" w.g. suction before the air filters.

   The casing would be of substantial carbon steel construction and the unit would have spark-proof features to AMCA standards.

   The impeller would be driven through a flexible coupling by a 125 HP explosion proof motor to Class 1, Group D, Division 1, 460 volt, 3 phase, 60 cycles.

   A manually operated radial leaf damper would be fitted at the fan inlet for regulation of the airflow.

4. **THREE ADSORBERS** - 6'8" diameter x approximately 10'0" high shell.

Each capable of handling 12,500 scfm of solvent laden air calculated at 70° F, when at an actual temperature of approximately 95° F.

The adsorbers would be of the annular carbon bed type with the carbon contained between stainless steel panels formed up into cyclinders and reinforced by carbon steel stiffening bands. The activated carbon bed and screens would be supported upon a carbon steel tray to which would be connected the solvent laden air inlet valve, vapour piping to condenser and liquor drains. The air exhaust valve and the steam valve would be connected to the outlet branch of the adsorber.

The carbon bed and screens would be contained within a removable carbon steel shell, fitted with access and inspection holes with bolted cover plates. Flanged connections would be fitted to the tray so that the carbon could be easily and quickly run off into drums.

Vacuum and pressure relief valves would be provided for each adsorber.

Handrails would be fitted round the tops of the adsorbers, with a walkway over and between the adsorbers, and with an access ladder from ground level, in accordance with the requirements of OSHA.

5. **ACTIVATED CARBON**

We would provide the initial charge of approximately 6400 lbs of high quality carbon for each of the three adsorbers. The carbon would be manufactured by Sutcliffe Speakman and would be of the grade most suited to the required duty.

6. **INLET AND OUTLET AIR VALVES** - 26" diameter

We would provide an inlet and outlet valve for each adsorber 26" diameter of the mushroom type of substantial construction arranged for pneumatic operation through the automatic control mechanism.

Renewable seats would be fitted in the valve bodies and access holes with bolted cover plates provided. An indicator would be fitted to each valve so that the attitude of the valve could be easily ascertained.

7. CONDENSER

To condense the steam and solvent vapours leaving an adsorber during the steaming period.

The unit would be of the tubular surface type with the shell in 304 stainless steel and the tubes in 316 stainless steel The water boxes and tubeplates would be in carbon steel.

The condenser vent pipe (fitted with thermometer with high temperature alarm contacts) would be connected to the inlet duct so that any incondensibles displaced from the adsorbers would recycle.

8. ONE DECANTER - 3'0" diameter x 4'6" high

It would be of the self-adjusting decanting type to separate automatically the condenser water and solvent. The tank would be of carbon steel welded construction fitted with a bolted cover plate and all the necessary connections. A sight glass would be fitted in the solvent outlet.

9. TRUNKING

We would provide the interconnecting trunking between the air filter, air cooler, fan and adsorbers, but do not allow for any trunking prior to the inlet manifold of the air filter. The trunking would be of carbon steel of welded construction flanged at suitable intervals and be adequately supported.

10. THREE EXHAUSTS

An exhaust stack would be provided for each adsorber, of carbon steel welded construction, galvanized and would terminate about 6' above the adsorber platform.

11. PIPING AND VALVES

We would provide pipework to interconnect the above and manifold the service pipes to terminal flanges at the battery limits.

Vapour and liquor piping would be in 304 stainless steel, utility piping in carbon steel.

We include for all isolating valves, steam traps, pipe supports, etc.

12. PLANT CONTROL UNIT

Would consist of the following:

a) Gas Analyser (Infra-Red Type)

To measure the solvent content in the exhaust airstream of the adsorber next due for desorbing and to delay steaming until the set point was achieved. However, an adjustable override timer would be incorporated into the program to limit the period of such a delay.

A strip recorder for the exhaust gas concentration would be included and the unit would have a "high level" alarm.

b) Programmable Logic Controller

Of the solid state type which on receipt of the appropriate signals would cause the adsorber valves to sequence as appropriate. The program logic would be such that the next step would not be commenced until the previous one had been proven completed.

In the unlikely event of failure of the P.L.C. the solvent recovery plant could be operated manually by the use of pilot air solenoid valves inbuilt into the panel.

c) Annunciation Section

Of the 'Panalarm' type or similar to alarm:

"high level" - gas analyser output

"high temperature" - condenser vent

d) Control Panel

The above items would be mounted in a free-standing enclosure, suitable for indoor location in a non-hazardous area, assumed within 50' of the adsorbers.

The panel would be pre-wired and tubed to terminal points on the frame. We exclude the impulse tubing from the panel to the plant items.

13. INSTRUMENTS

We would provide the following indicating type instruments which would be locally mounted on the plant:

4 Dial type thermometers
1 Steam pressure gauge
1 Differential pressure gauge (resistance through air filter)
1 4-Point pressure gauge (air pressure and suctions within the plant)

14. STRUCTURES

We would provide structures to support items of the plant.

15. PAINTING

Where applicable, plant items would be primer coated before shipment.

16. COMPRESSED AIR

You to supply compressed air, clean, dry and oil free at a pressure of approximately 80 psig.

17. DRAWINGS AND INSTRUCTIONS

We would provide three (3) copies of each of the following:

Foundation drawing
Flowsheet
Plant arrangement drawing
Major assemblies

Plus two (2) copies of:

Erection drawings and instructions
Operating and Maintenance Manual

A list of recommended spares would also be provided.

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908020~~ 240189

YOUR REF: OUR REF: DATE: 2 August 1983

David M. Company
201 Valentine Way
Longwood, Florida

TERMS, PRICE AND CONDITIONS

PRICE OF PROPOSAL **PROPOSAL NO. S 7212**

For the supply of the whole of the items as specified in this proposal, delivered only to your works in Longwood, Florida (offloading from the transport and installation by others) would be the sum of approximately..$ 370,000.00

(THREE HUNDRED SEVENTY THOUSAND DOLLARS)

Any Federal, State or local taxes that may be applicable are excluded.

TERMS OF PAYMENT

25% of quoted price with order.

45% of quoted price in three (3) equal payments pursuant to invoices on the following basis:

a) upon submission of preliminary drawings comprising plant arrangement and foundation drawings and flowsheet.

b) upon submission of confirmation that the manufacture is at least 40% complete.

c) upon submission of confirmation that the manufacture is at least 70% complete.

25% of quoted price upon despatch or when ready for despatch if despatch date is delayed by you.

5% of quoted price on start-up and successful operation, at latest three (3) months after despatch, or when ready for despatch, whichever is sooner.

Continued.........

TERMS, PRICE AND CONDITIONS...continued

DESPATCH

Approximately six (6) months from receipt of order assuming that there are no delays due to changes in specifications or approval of drawings.

EXCLUSIONS

We do not include for any motor controls, electrical wiring, or any special cold weather protection or insulation, or any parts, materials, work for services of any kind whatsoever except those specifically mentioned in the body of the proposal.

STANDARD OF MANUFACTURE

The goods described in this proposal would be manufactured to normal commercial standards and be suitable for the duty specified. Should you desire manufacture to any specific standards, codes or inspection schedules other than those allowed for then we will be pleased to comply with your requests, but any extra charges so incurred would be in addition to the prices quoted.

VALIDITY OF PROPOSAL

This proposal is open for acceptance for a period of thirty (30) days from the date of this quotation and after this period confirmation must be obtained that the terms and conditions contained herein are still valid.

SUTCLIFFE SPEAKMAN INCORPORATED

Moses

William C. Moses
Vice President

E. & O. E.

WCM/pmd

UTILITY REQUIREMENTS

The following are the approximate utility requirements of the plant when operating at design load conditions. The figures are subject to confirmation by our final design study.

STEAM	1190 lb/hr, dry saturated quality at 40 psig.
COOLING WATER	170 gpm, inlet 86°, maximum, return 115°.
POWER	100 KwH.
COMPRESSED AIR	20 scfh.

SPACE

The equipment, we estimate, would require a floor area of approximately 45' x 20'.

The height of the equipment would be approximately 18', but if it is to be located inside, then provision should be made for lifting of the adsorber shells.

APPENDIX 'A'

OUR PRELIMINARY PROPOSAL FOR THE TURNKEY INSTALLATION OF THE PLANT QUOTED IN MAIN PROPOSAL NO. S 7212

1. FOUNDATIONS

We would provide concrete foundations for the appropriate items of our equipment.

Our price is conditional on the understanding that the ground is of suitable load bearing capacity, that no rock blasting or piling would be required and that all work would be above the water table.

2. MOTOR CONTROL CENTER

We include the starters for the fan motor, the water cooling tower fan and the recirculating water pumps, and which would be suitable for location in a non-hazardous area which we assume will be by the control panel.

3. WATER COOLING TOWER

Corrosion Inhibitors ?. Chromates

We would supply and install a water cooling tower designed to cool the required amount of water from 115° F to approximately 86° F. The tower would be of induced draft type and complete with fan and motor. The system would include two pumps with motors (one normally operating, one stand-by) and the water circulating piping and valves between the water cooling tower and the air cooler and condenser of the recovery plant, the water cooling tower to be at ground level and located adjacent to the recovery plant.

4. INSTALLATION

We include for the necessary labour, tools, moving and lifting gear including cranes, for the installation of the items of equipment specified in this proposal onto the foundation.

4. INSTALLATION...Continued

It is understood that the work would be undertaken during our normal working hours and that we and our sub-contractors or agents would be allowed free and unrestricted access to the site.

Any overtime worked at your request would be chargeable extra at the rate in force at the time.

You would be responsible for offloading from the transport any items delivered prior to the start of the installation work and provide suitable storage and protection for all parts close to the battery limits.

All temporary site support facilities including but not limited to water, electricity, steam, drain, office and telephone would be provided by you at your expense, adjacent to the site.

Note that the quoted price assumes we will have continuity of work on site.

5. SUPERVISION

We include for the services of our own suitably qualified supervisor to supervise and give instructions to the labour provided by our sub-contractors, to secure the installation of the equipment in a competent manner.

6. IMPULSE TUBING

The pneumatic tubing from the appropriate plant items to the control panel would be supplied and installed in a workmanlike manner. It is assumed that the tubing run is a maximum of fifty feet.

7. ELECTRICAL WIRING

We would supply and install all necessary electrical wiring, cable trays, etc. to interconnect the various items of plant to the motor control center and the control panel, assuming a maximum cable run of fifty feet from the adsorbers. Where appropriate, the wiring would be to explosion proof, classification.

8. **INSULATION/WINTERIZATION**

Insulation and heat tracing of appropriate equipment within our battery limits effected, assuming a minimum ambient temperature of 25° F.

9. **START-UP**

We include for the services of a skilled engineer for a period of two (2) consecutive weeks on site to start-up the plant and provide instructions to your personnel on its operation.

Any extra time required by you or non-continuity in attendance would be at additional cost.

10. **INSURANCE**

We would provide and maintain the following insurances and would require any and all sub-contractors employed by us at your site to procure and maintain the same type and amount of insurance.

a) Workman's Compensation and employer's Liability
   - $100,000.00 each accident and aggregate disease.

b) Comprehensive General Liability
   - Bodily injury and Property damage of up to $1,000,000 combined single limit.

c) Comprehensive Automobile Liability
   - To cover owned, non-owned, leased and hired cars, combined single limit $1,000,000.

Certificates of the above shall be provided to you prior to the start of our on site work.

In addition to the above and in order to insure the equipment from its delivery to your site, through installation to your acceptance of the plant, we would take out "all risks" insurance plus "builders risk" and "installation floaters" at the appropriate time and at your expense.

BUDGETARY PRICE

Our approximate additional price to that quoted in Main Proposal No. S 7212 for the turnkey installation of the plant as detailed in this Appendix 'A' would be the sum of ....$ 160,000.00.

(ONE HUNDRED SIXTY THOUSAND DOLLARS)

COMPLETION

We would expect to supply and install the specified plant in approximately nine (9) months from receipt of order.

TERMS AND CONDITIONS

Otherwise as Main Proposal No. S 7212.

SOLVENT RECOVERY WITH ACTIVE CARBON

SUTCLIFFE SPEAKMAN, INC.

Sutcliffe Speakman have specialised for over 50 years in the design and manufacture of Solvent Recovery plant. Their unique position in the industry stems from a background of almost 80 years experience in the manufacture of active carbon for general adsorption and catalytic applications.

SOLVENT RECOVERY WITH ACTIVE CARBON

Our recovery plants are in world-wide use in a great variety of solvent-using industries, ranging from coating, impregnation and printing of materials to the manufacture of man made fibres.

Our active carbon plants for the recovery of industrial solvents, from air or gas mixtures, can give a recovery efficiency of at least 99% by volume depending on the conditions. In addition to vapour phase recovery, active carbon plants can efficiently extract and recover solvents and organic compounds from water and other liquid mixtures.

MONEY SAVING

Recovery plants save industry millions a year and the dramatic savings on solvent costs ensure more economic production.

CLEAN AIR

The adsorption efficiency of Sutcliffe Speakman plant is extremely high, effecting an important contribution to clean air.

LIQUID EFFLUENTS

Can also be purified with an active carbon plant.

WORKING CONDITIONS

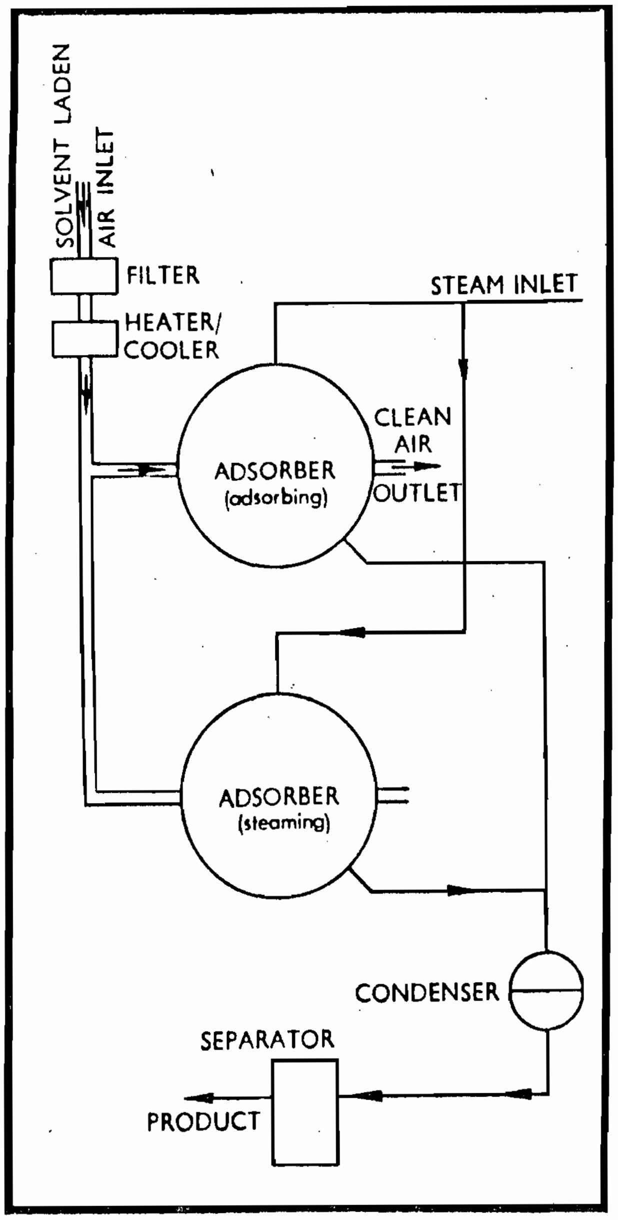
A general improvement in working and safety conditions often results from the effective collection system required to achieve high overall efficiency.

WHEN IS IT WORTHWHILE?

If you are using more than 200 gallons a week of alcohols, esters, ethers, ketones, hydrocarbons, chlorinated compounds and other organic solvents, it is certainly worth giving preliminary consideration to the economic potential of installing recovery plant. The actual economics depend upon the cost of new solvent, the concentration of solvent in air entering the plant, the number of hours per week which the process will operate and the possible ancillary equipment which may be necessary to prepare the recovered solvent for re-use. This may be required if the solvent is water miscible or where a mixture of different solvents may be recovered together and necessitate separation.

Sometimes solvent quantities as low as 1 gallon per hour can be economically recovered. WRITE TO US, WE WILL ADVISE WHETHER A DETAILED STUDY IS JUSTIFIED.

BASIC FLOW DIAGRAM



HOW IT WORKS

The Sutcliffe Speakman system draws air laden with solvent vapour through a ducting into the plant when, if necessary, it is first filtered to remove dust or other contaminants and then heated or cooled to a suitable temperature before passing into an adsorber which contains a bed of active carbon. The solvent vapour is adsorbed on the carbon and the clean air is discharged to atmosphere. When the carbon bed has adsorbed the designed charge of solvent, the vapour/air stream is switched to a second adsorber and steam at low pressure is introduced to the charged adsorber which causes the carbon to release, in vapour form, the solvent which it adsorbed. The steam/solvent vapour mixture is then condensed and the solvent recovered.

If the solvent is insoluble in water, a separator is provided to divide the condensate into a solvent layer and water layer which automatically leave the separator by gravity flow. If the solvent is water soluble, the condensate is taken to a distillation unit or liquid phase adsorption system for final separation.

CARBONS

The wide range of Sutcliffe Speakman carbons developed specially for solvent recovery give a high degree of adsorption efficiency at relatively high velocities. These carbons also have low retention characteristics, so that steam usage for the regeneration of beds is minimised. The most suitable carbon is selected to meet the particular conditions under which the plant will operate.

PLANT

Sutcliffe Speakman design their adsorbers to give maximum surface area of carbon, thereby ensuring the minimum resistance to air-flow, and a relatively lower power consumption. Adsorbers are designed with static or rotary beds.

Automatic operation of the adsorber valves with variable time cycle, is effected by instrumentation or by the robust Sutcliffe Speakman standard control unit.

In normal applications the adsorbers are not subjected to pressures of more than 0.5 lbs/square inch. Where necessary, plants can be designed for operating at higher pressures.

If required, plant can be designed for further extension to suit clients needs.

The rotary bed plants and a range of static units can be supplied as fully "packaged" plants. Wherever practicable, all plants are pre-assembled in our works before despatch. Full erection and maintenance services are available including contract visits by Technical Service Engineers.

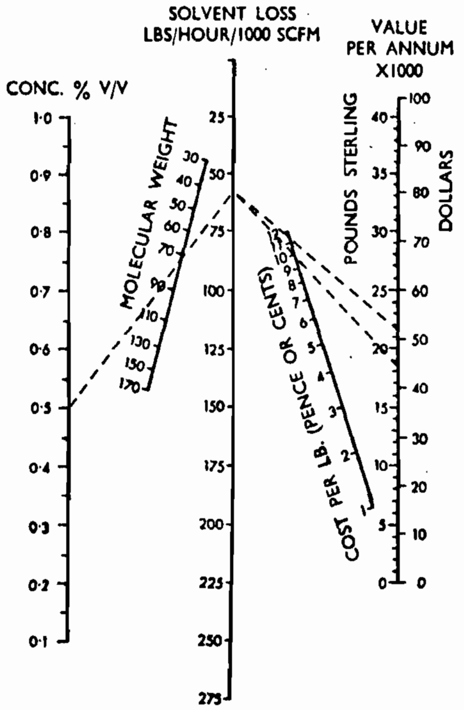
SOLVENT CONCENTRATION IN AIR

The adjacent diagram shows the quantities of solvent in relation to air flow at given volume/volume concentrations, corrected to the normal temperature and pressure conditions at the inlet to the recovery plant, with indication of solvent value per annum.

It is important that the concentration of solvent in the air stream from a process is, where applicable, well below the lower explosive limit of that particular solvent vapour in air, to ensure a satisfactory operational safety margin. It is normally considered that the quantity of air flow from a process should be sufficient to ensure that the concentration of solvent vapour in air is no more than a maximum of 50% of the lower explosive limit.

Conversely it is usually necessary to ensure that the concentration is not too low, or the size of plant required to handle air flow may be larger than can be justified economically in relation to the quantity of solvent to be recovered. The ideal concentration range is usually between 20%-40% of the lower explosive limit.

Sutcliffe Speakman technical staff are available to advise on the collection of solvent from your process to ensure that maximum overall recovery efficiency is achieved, and that the desirable air flow from an economic point of view is sufficient to collect the solvent vapours effectively.



EXAMPLE:

0·5% CON. METHYL ETHYL KETONE—M.W. 72·1

LOSS 56·5 LBS/HOUR/1000 SCFM OF AIR

VALUE PER ANNUM (OF 8000 HOURS) AT 10 PENCE/LB IS £18,800

VALUE PER ANNUM (OF 8000 HOURS) AT 11·5 CENTS/LB IS $52,000

TABLE OF MOLECULAR WEIGHTS AND LOWER EXPLOSIVE LIMITS FOR SOME TYPICAL INDUSTRIAL SOLVENTS

	A	B		A	B
Acetone	58.08	2.15	*Methyl Acetate*	74.08	4.1
Benzene	78.11	1.4	Methyl Alcohol	32.04	6.72
Butyl Acetate (Normal)	116.16	1.7	Methyl Ethyl Ketone	72.10	1.81
Butyl Acetate (Iso)	116.16	2.4	Methylene Chloride	84.93	Non-flam.
Butyl Alcohol (Normal)	74.12	1.45	Nonane	128.25	0.74
Butyl Alcohol (Iso)	74.12	1.68	Octane	114.23	0.95
Carbon Disulphide	76.13	1.0	Pentane (Normal)	72.15	1.3
Carbon Tetrachloride	153.84	Non-flam.	Pentane (Iso)	72.09	1.3
Chloroform	119.39	Non-flam.	Perchlorethylene	165.85	Non-flam.
Cyclohexane	84.16	1.35	Propyl Acetate (Normal)	102.3	2.0
Decane (Normal)	142.28	0.7	Propyl Acetate (Iso)	102.3	2.0
Dichloroethylene	97	9.7	Propyl Alcohol (Normal)	60.09	2.15
Ether (Diethyl)	74.12	1.85	Propyl Alcohol (Iso)	60.09	2.02
Ethyl Acetata	88.10	2.25	Tetrachlorethane	167.86	Non-flam.
Ethyl Alcohol	46.07	3.3	*Tetrahydrofuran*	72.10	1.84
Ethylene Dichloride	98.97	6.2	Toluene	92.13	1.3
Furfural	98.08	2.1	Trichlorethylena	131.4	Non-flam.
Heptane (Normal)	100.2	1.0	Xylene	106.16	1.0
Hexane (Normal)	86.17	1.25			

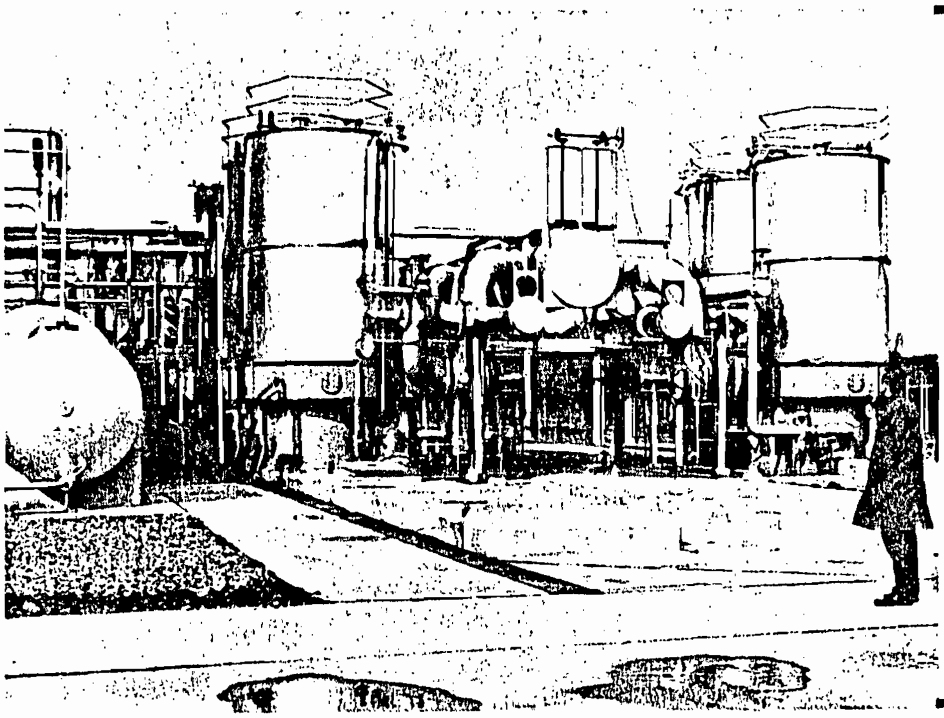
A Mol. Wt.

B Lower Explosive Limit in Air % V/V at 20°C and approx. atmospheric Pressure

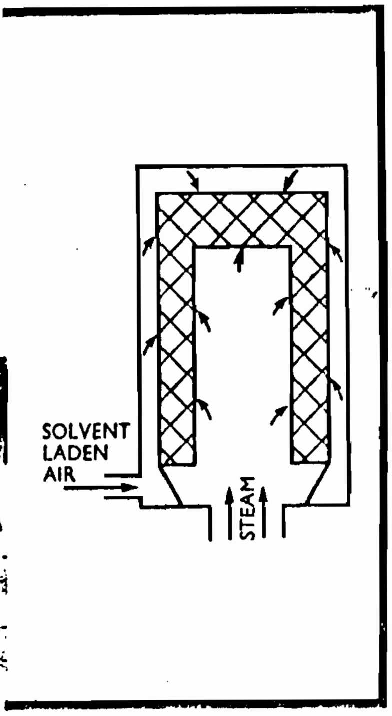
Sutcliffe Speakman manufacture two principal types of Gaseous Phase Recovery Plant—
Both types employ active carbon.

STATIC BED PLANT

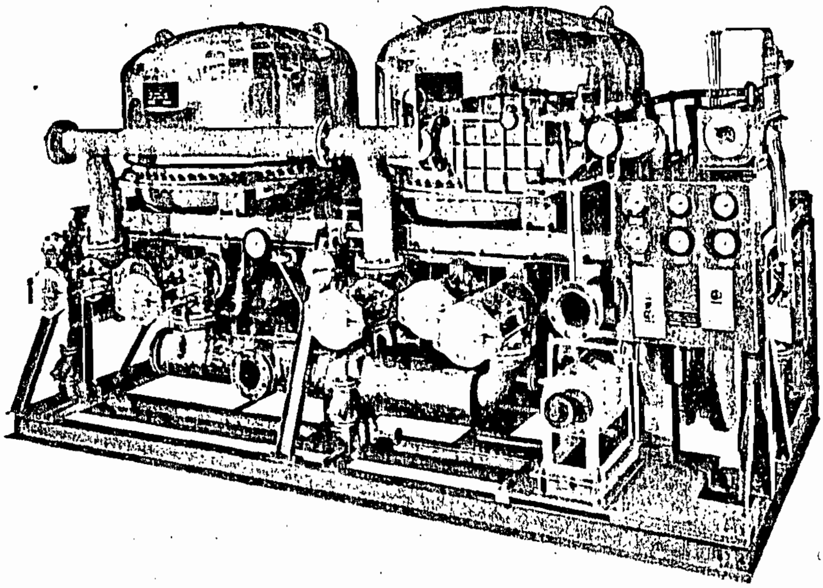
A static plant usually consists of two or more adsorbers each containing a vertical annular or flat bed of active carbon. One or more of the adsorbers receives the solvent laden air whilst one or more are being steamed out to recover the solvent. The adsorbers are suitably valved and cycle automatically so that the process is continuous. The smaller plants can be of packaged design, skid mounted. Plants are individually designed to meet customers specifications.



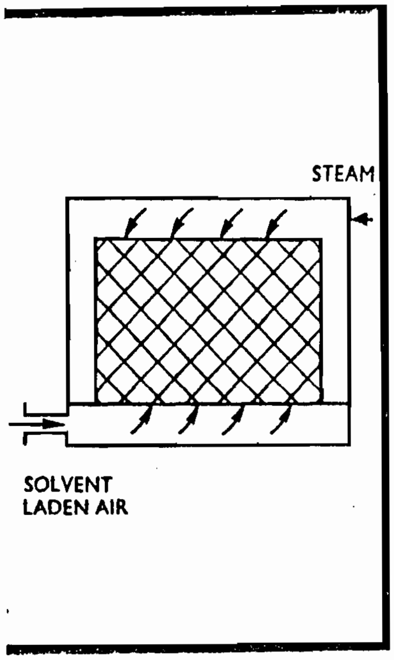
Adsorption section of a large recovery complex at an Acetate Fibre Factory in Belgium. The plant is arranged for future extension.



ANNULAR BED



Packaged type fully automatic plant of cylindrical flat bed design.



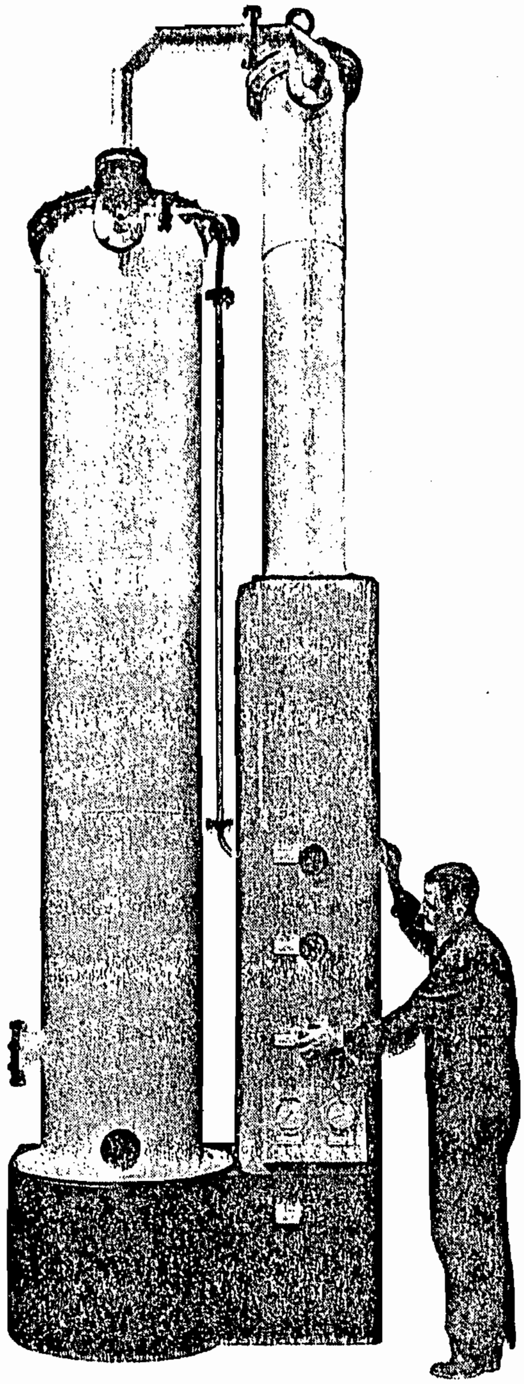
FLAT BED

LIQUID PHASE ADSORPTION

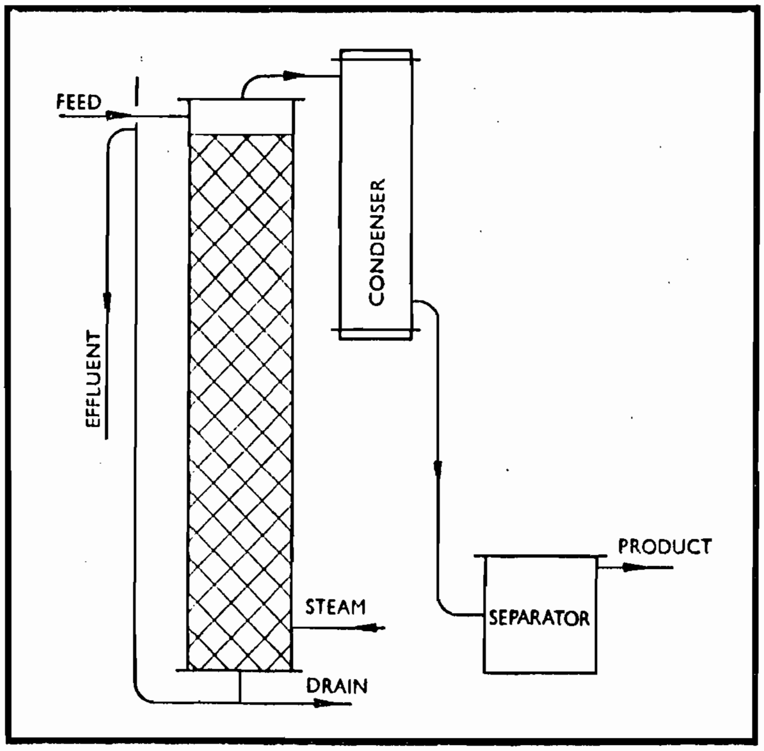
This system uses active carbon for the adsorption of small amounts of certain water-miscible solvents from solutions with water. The weak solvent/water liquor is passed through an active carbon bed and, when the carbon has adsorbed the designed charge of solvent, the solvent is distilled off by our patented system. This process effects substantial increase in concentration of a weak solvent/water solution, the water in the inlet feed passing through the bed and to effluent drain. During steaming of the carbon a small amount of water is introduced and the products of steaming taken to a separating tank from which the water layer recycles through the system.

In certain cases the carbon can be used to adsorb selectively a particular solvent component from a mixture of solvents with water.

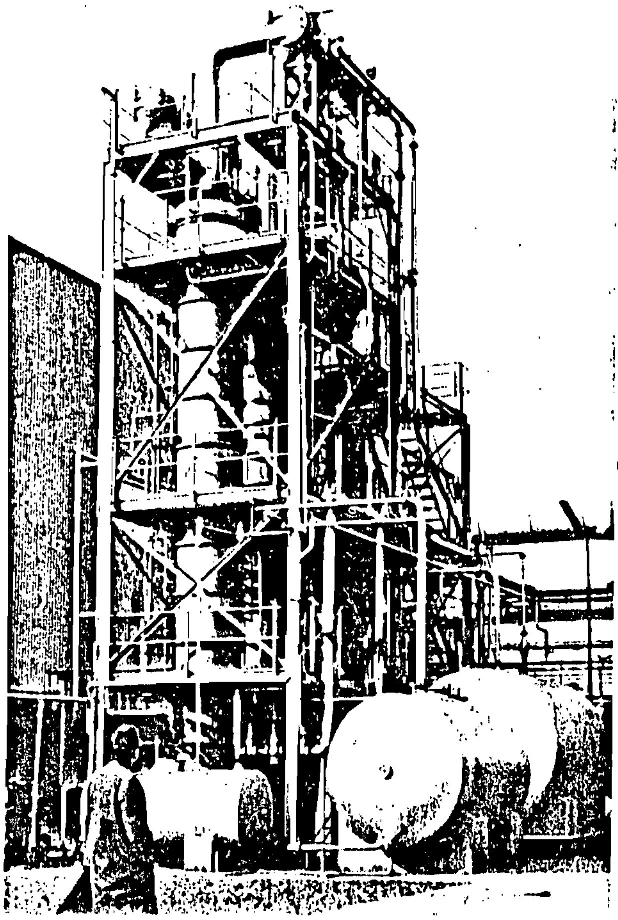
A particular feature of this system is the extreme simplicity of operation and control which can be manual or automatic.



Liquid phase adsorption unit.



DISTILLATION



Section of a large distillation complex.

Sutcliffe Speakman supply a complete range of distillation equipment, which may be required in the separation of water-miscible solvents from the products of recovery of the main adsorption plant, or for other purposes.

The range of distillation equipment includes both perforated plate and bubble cap designs, and the operations can be automatically controlled in relation to steam input and reflux ratio.

Stills can be supplied either for continuous or batch operation.

There is also a range of small units for the recovery of solvents from contaminated mixtures, i.e. by extraction of residues from waste lacquers or in cases where solvents are used for washing down printing and paint machines, etc., the solvent can be cleaned for further use.

ENQUIRIES

In submitting enquiries for evaluation, it is helpful if the following preliminary details can be submitted.

Gas or liquid flow rate

Operating pressures

Temperature and relative humidity of air or gas stream

Quantity, nature and value of compounds to be extracted

Other substances in air, gas or liquid stream of a contaminant or corrosive nature

Normal operating time of process

Details of steam, cooling water, power and compressed air services available.

TYPICAL SOLVENT RECOVERY APPLICATIONS

Acetate Fibre · Insulated Cables · Balata Belting · Leather Cloth · Hydrocarbon Extraction (Natural Gas) · Metallic Foil Printing and Lacquering · Compressed Asbestos Fibre Products Oil Extraction · Degreasing · Paper Impregnating and Lacquering · De-sulphurising of Gas Paper Printing · Dry Cleaning · Pressure-Sensitive Tapes · Explosives · Rotogravure Printing Film Casting · Rubber-Dipped Goods · Rubber-Spread Goods · Surgical Bandages Shoes, etc. · Solvent Manufacture · Tail Gas from Petroleum Wells · Viscose Fibre Viscose and Acetate Film · Weatherproof Sheeting · Process Off-Gas

SUTCLIFFE SPEAKMAN INC

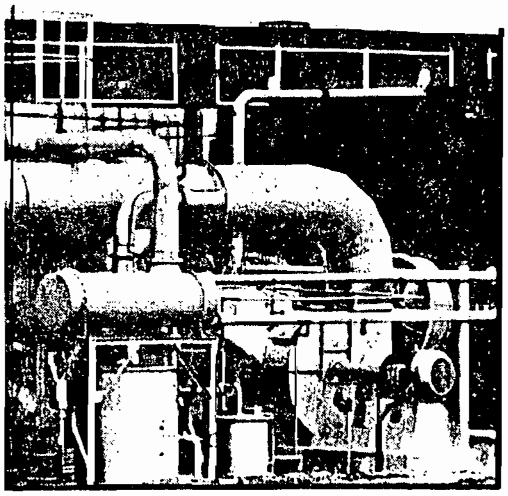
SUITE 200, HEAVER PLAZA,
1301 YORK RD. LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: 908020

The many facets of activated carbon

Reprinted from
Chemical Age 26 June 1981

activated carbon

and business advantages of solvent recovery



toluene and SBP2.

annular bed is the most efficient when it comes to steaming the solvent off the carbon bed (desorption). This is because the steam enters the inner annulus of the adsorber working its way outwards in contrast to other designs where the adsorber vessels have to be efficiently lagged to prevent waste of heat energy. With the annular bed design by the time the steam has worked its way through the carbon bed to the outer annulus it has performed its useful work, and the cooler outer shell of the adsorber vessel serves as an air condenser and relieves the load on the main condenser with regard to the amount of cooling water required.

The basic components of a typical solvent recovery plant are:

- Air filter (to remove any airborne particulate matter in the solvent-laden air stream).
- Air cooler/heater (to temperature adjust air stream for safe and good adsorption on the carbon bed).
- Main fan(s) (to provide correct rate of airflow through the adsorbers).
- Activated carbon adsorbers (where the solvent(s) are adsorbed/desorbed).
- Condenser (to condense solvent vapour and steam from the desorption cycle).
- Separator (decanter) — (where non-miscible solvent/water mixture separates).
- Product tank (for collection of solvent from the separator).

In operation the solvent-laden air is passed to two of the adsorbers while the solvent is desorbed (by steaming) in the third adsorber.

The process operates automatically and continuously, usually with infra-red gas analyser control to ensure optimum efficiency, and each adsorber consecutively undergoes an adsorption and desorption cycle.

The simplest type of solvent recovery is where there is a single solvent which is non-miscible with water, eg, xylene. This solvent will collect as the upper layer in the decanter and, being virtually insoluble in water, can simply be decanted for re-use whilst the lower (water) layer is passed to drain.

If, however, a mixture of solvents is being recovered and some of these are miscible with water then additional plant is necessary to separate the solvents. This usually takes the form of distillation and dehydration equipment depending on the solvents involved and the final specification required by the customer for the recovered solvents.

Each solvent recovery system has its own particular technique for recovery, but the basic adsorption/desorption on activated carbon is common to all. When designing a solvent recovery plant for a particular set of conditions one must have detailed information on such parameters as airflow, air temperature, humidity, solvent concentrations, maximum/minimum process conditions, and details of any impurities in the solvent-laden air stream. The last factor can be particularly important since it can have an important bearing on materials of construction and expected carbon life.

There are several aspects which require careful attention to ensure that the best efficiency of solvent recovery is achieved and that at the same time minimum energy is consumed in the running of the plant. The first practical step which can be taken to maximise recovery efficiency is to present as high a solvent concentration as is safely possible with minimum airflow.

This will be largely governed by the type of process upstream of the

Table 1: Some typical results of solvent adsorption by carbons

Solvent	*Concentration (%V/V)*	**Initial adsorption (%W/W)*	*§Cyclic adsorption (%W/W)*	***Steam ratio*	*Boiling point range (°C)*
Methylene chloride	1.0	28.3	17.3	1.4	40.5
Arklone P	0.5	44.9	20.8	1.4	47.6
Acetone	1.0	20.3	12.5	2.3	56
Tetrahydrofuran	0.5	22.0	9.0	2.0	66
Hexane	0.48	21.3	8.2	3.5	68.7
Ethyl acetate	0.5	27.6	13.6	2.1	77.2
Trichlorethylene	0.5	44.6	19.9	1.8	86.7
n-Heptane	0.12	22.4	5.9	4.3	98
Toluene	0.4	23.3	9.6	3.5	110
Methyl isobutyl ketone	0.2	22.0	9.0	3.5	115.9
Mixed rubber solvent	0.3	25.7	10.3	3.8	120-160
Shellsol E	0.3	35.6	11.9	3.7	153-193
3, 3, 5-trimethyl cyclohexyl acetate	0.1	36.4	7.9	4.5	206

**Initial adsorption refers to the solvent adsorbed by new carbon to 'breakpoint', i.e. when solvent can be detected in the effluent air stream. The 'slip' level at this point is normally of the order of 20 ppm.*

§Cyclic adsorption refers to the solvent which can be adsorbed and desorbed consistently at an economical steam consumption.

***Steam ratio refers to the total steam used to desorb the solvent from the adsorbent and is an overall figure inclusive of condensate and moisture condensed on the carbon bed.*

SUTCLIFFE SPEAKMAN INC

SENSOR CONTROLS

for SOLVENT RECOVERY

WITH PARTICULAR REFERENCE
TO THE USE OF INFRA-RED GAS ANALYSERS

Extract from paper prepared by
Dr. Robert D. Hill
Previously of Chemical Plant Division
Sutcliffe Speakman & Co. Ltd.

and

Presented at the 30th Annual Meeting of the
Gravure Technical Association
Chicago, April, 1979

There are many different types of sensors one can use on a solvent recovery plant but all function either to report information and/or to act on that information to control the solvent recovery plant's operation in some way. For example, proximity sensors can be used to sense whether a valve is open or shut, and flow metering and LEL meters can be used in conjunction with each other to measure the total solvent presented to an adsorber. My remarks will concentrate on using sensor control to optimize the conservation of energy, and maximize the efficiency of solvent recovery, and the role of the infra-red gas analyser in helping to achieve these aims.

The first practical step we can take in maximizing solvent recovery plant efficiency is to ensure that we are presenting, safely, as high a solvent load as possible in the minimum airflow passed to the solvent recovery plant. To a large extent this will be governed by the type of process upstream of the solvent recovery plant. Wherever possible, and economically achievable, recirculation of a portion of the solvent laden air should be considered. This will significantly increase the efficiency of solvent recovery across the carbon bed. The examples given below illustrate the typical improvement in efficiency of recovery of solvent which can be achieved:

(a) Inlet concentration 1000 ppm
Outlet concentration 35 ppm

$$\eta = \frac{1000-35}{1000} \times 100\% = 96.5\%$$

(b) Inlet concentration 2000 ppm
Outlet concentration 35 ppm

$$\eta = \frac{2000-35}{2000} \times 100\% = 98.25\%$$

The side benefits from ensuring maximum concentration of solvent vapor that is presented to the solvent recovery plant are that it will reduce the size of the solvent recovery plant required and with it the capital outlay, space needed, and services required to run it. The sensors applicable to this area of plant operation are typically LEL meters coupled to variable damper controls which will vary proportion of solvent laden air from the process which is recirculated and diluted with fresh air.

Let us now consider in some detail the adsorption/desorption cycles which are at the heart of the solvent recovery plant's operation.

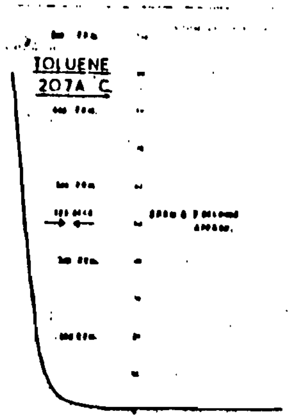


Figure 1

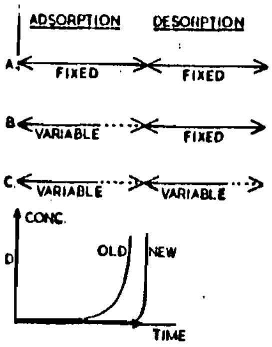


Figure 2

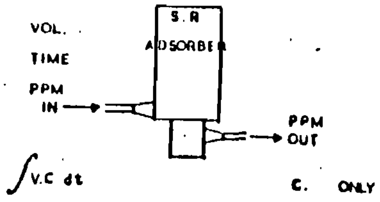


Figure 3

In Figure 1 we see the typical rise in solvent concentration as solvent (in this example - Toluene) starts to "slip" through the bed of activated carbon as an adsorption cycle nears its end. It can be seen that there is a rapid rise in solvent concentration - about 100 ppm in around 135 sec. With the particular sensor favored by **Sutcliffe Speakman** a rise of 5 ppm can readily be detected, and when a pre-selected concentration is reached (usually around 50 - 75 ppm) the sensor produces a signal which is used to initiate an automatic cycle controller which changes over the particular adsorber vessel being monitored from "Adsorb" to "Desorb" mode by opening/closing appropriate valves.

Let us now examine this process more closely. In Figure 2, on Line A, we have an "ideal" situation where a constant concentration of solvent in a constant airflow is presented to the solvent recovery plant. Provided constant conditions are maintained and the activated carbon's adsorptive properties also remain constant, then it is merely a matter of timing the length of the adsorption and steaming cycles to achieve optimum operating efficiency. This ideal situation is rare. What is frequently encountered in practice is that a variable concentration of solvent is presented to the solvent recovery plant. Now, if the adsorption cycle has been time controlled for the full designed load of solvent, and if, for example, half that load has been adsorbed on to the carbon bed in the preset time, not only will the carbon not be utilized fully, but an excessive amount of steam also will be consumed in the desorption cycle. As much as one third of the steam used for desorption could, for example, be wasted.

In Line B of Figure 2 we have the situation where we must be able to sense when the active carbon has adsorbed the optimum amount of solvent, and solvent "slip" is starting to occur through the carbon bed. In this case the length of the adsorbing cycle will be a variable and this is represented by the dotted part of the line in the figure.

However, what will be the situation if, in addition to the solvent concentration varying, we have a process in which there are airborne contaminants with the solvent which cause an unavoidable and progressive deterioration with time of the activated carbon (irrespective of the design or manufacture of the plant or source of carbon)? In some large, multi-adsorber plants associated with such processes it is often the practice to overhaul one adsorber at a time and to replace the poisoned carbon with a charge of new carbon. In this situation one can have an adsorber containing new carbon working in conjunction with one containing old carbon.

On Line D of Figure 2 we see a graphical representation of how the "slip" curves for old and new carbon compare.

In Figure 3 we see the two basic approaches used to measure when an adsorption cycle should be terminated. On the left side as solvent laden air enters the adsorber we can measure solvent concentration and flow rate, and compute, by integration with respect to time, the total quantity of solvent passed to the adsorber. When a predetermined amount of solvent has been passed a signal is generated which is used to change over the adsorber from Adsorb to Desorb mode. This approach, as used by some companies, seems to be a fundamentally less reliable approach in that it assumes a given carbon performance at all times. Furthermore, it can never give any useful information about what is happening inside the adsorber.

For example, an unusually high "slip" of solvent could indicate that valve seatings require renewal. It is considered that the fundamentally correct approach is to sense what is happening on the exhaust side of the adsorber and use this information for control purposes. It should be noted that this entails measuring only one parameter (solvent concentration in the air stream) against time. Now, whereas the inlet concentration is typically in the 1000 - 3000 ppm range we are now looking at a 0 - 100 ppm range on the outlet of the adsorber. For optimum efficiency we need a sensor which will be capable of measuring very low ppm's, have a fast response, be stable, be accurate, have high reproducibility, not be affected by water vapor and by other extraneous factors which are frequently encountered in the industrial situation. This tends to exclude the use of LEL meters (too insensitive), gas chromatography (slow response and not continuous), and flame ionization detectors, and brings us to the infra-red gas analyser.

Many gases absorb energy in the infra-red region because of the resonant molecular vibrations within the molecules of gas or solvent vapor. These resonances are highly specific and give rise to I-R spectra which are characteristic of the substances in question. The I-R spectrum of a molecule has been likened to the human finger print by means of which one specific wavelength depends on the concentration of absorbing molecules placed between the Infra-red source and the detector, and this fact is utilized to determine the concentration of a selected component in a gas or vapor mixture.

Because of the complexity of typical gaseous infra-red spectra, some overlapping of absorption bands frequently occurs, and it is usually necessary to select a very narrow wavelength band to avoid cross sensitivity. Figure 4 shows the 1-8 microns region of the I-R spectrum of toluene and shows several characteristic absorption bands for this solvent.

There are several types of I-R gas analysers potentially available for use, and broadly they can be divided into single wavelength/single beam; single wavelength/double beam; and double wavelength/single beam instruments. In my experience all two-beam energy absorbing systems suffer from the inherent defect of

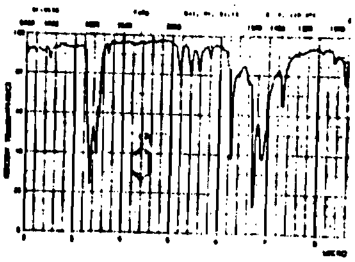


Figure 4

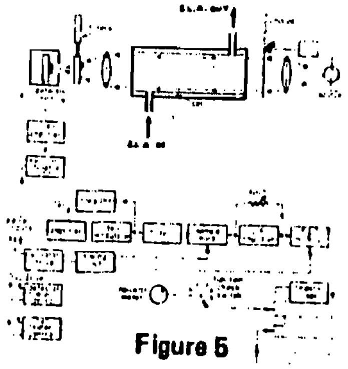


Figure 5

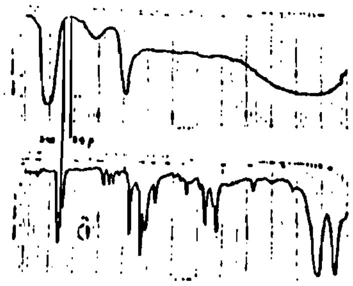


Figure 6

being sensitive to background absorptions caused by fouling of the sample cell windows, broad band absorptions in the sample gas (such as that caused by water vapor), and temperature differences between sample and reference beams. However, most of the disadvantages of the two beam system can be eliminated without losing the advantage of a continuous reference measurement by examining, alternately in time, the I-R energy transmission at the peak absorption wavelength of the measured component and that at a nearby wavelength which represents the "background" energy, but which is itself unaffected by the measured component. This can be achieved with a two wavelength/single beam instrument.

Such a system is shown in Figure 5. By having the source and detector units in optical alignment with each other, and arranging for a pair of very narrow band pass interference filters to be switched alternately in time into the beam (actually at 6 Hz) it is possible to produce a sensitive, accurate, reliable, I-R gas analyser which is immune from many of the extraneous factors which can plague other types of I-R gas analysers.

Let us now turn to the critical area of deciding what wavelengths to select for the solvent(s) in question. This is an area to which, I believe, too little consideration is often given - probably because it calls for expert knowledge in the field of infra-red spectroscopy.

If the solvent is toluene there are, as we can see from the I-R spectrum for this solvent (lower spectrum in Figure 6) several bands to choose from. Or are there? If we look at the spectrum of water (upper spectrum in Figure 6) we can see that there are several regions where water is absorbing energy strongly and has the potential ability to interfere. We must remember also that we are wanting to detect a 50 ppm level (say) which is only a 0.005% v/v concentration whereas if there is a 40% R.H. situation with respect to water vapor that corresponds to a 2.9% v/v concentration of water vapor - i.e. 580 times greater! The possibility of interference from water is obvious. However, if we select wavelengths 3.45 microns for toluene and 3.9 microns for the reference, then we can see that we shall meet the best criteria for having the solvent and reference wavelengths near to each other, but with the latter at a point of least interference from water. In this way we can ensure that even 100% RH will not affect this sensor's performance in controlling the solvent recovery plant.

Figure 7

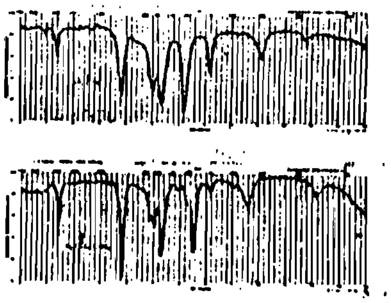


Figure 8

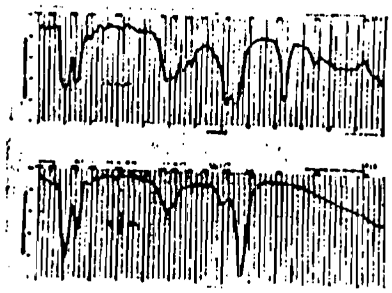


Figure 9

To illustrate just how complex the I-R spectrum of water vapor really is and how the effect of raised temperature can cause the molecules to become more agitated and resonate more strongly, Figure 7 shows the I-R spectrum for water vapor at 100° C, using an expanded scale between 5 and 8 microns. It will readily be appreciated that it is most important that the designer of a solvent recovery plant must have access to such specialized knowledge if the best sensor control design is to be achieved.

Let us now consider some other commonly used solvents: Figure 8 shows the I-R spectra for acetone and methyl ethyl ketone. Here the CH stretching absorbtion band at around 3.5 microns is relatively weak and it is usual to select the C=O (carbonyl) band at about 5.8 microns instead.

Figure 9 shows the I-R spectra for methyl alcohol and ethyl alcohol. Here one can use the CH band at around 3.5 microns as both alcohols have strong enough absorbtion bands.

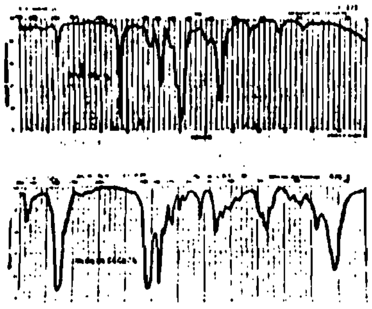


Figure 10

Figure 10 shows the I-R spectra for ethyl acetate and hexane. Here we have a good illustration of the relative weakness of the CH band at 3.5 microns for ethyl acetate and the corresponding strength of the CH band for hexane at the same point in the spectrum.

In conclusion, in order to get the best out of a solvent recovery plant the following objectives should be achieved:

(1) Maximize the solvent concentration and minimize the airflow within safe/economic limits.

(2) Use I-R Gas Analyser control of the adsorption cycle to nullify the effects of varying solvent load and possibly also varying air flow in order to achieve the fullest use of the charge of active carbon in any particular adsorber.

(3) Select a 2 wavelength/single beam instrument which can guarantee:
(a) immunity from water vapor
(b) Virtual immunity from all normal extraneous factors such as voltage variation, temperature change, etc.
(c) fast and accurate response
(d) is fully automatic and requires virtually no attention.

(4) If the carbon is likely to have its activity modified by the process gas/vapor stream, then control the steaming cycle also by sensing a falling concentration of solvent in the steam/solvent mixture coming from an individual adsorber.

As manufacturers of their own activated carbon for the past 75 years plus solvent recovery plant which embraces the sensor technology, I have described, I believe, that Sutcliffe Speakman have one of the best systems for optimizing efficiency and minimizing the use of energy.

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908029~~ 240189

YOUR REF: OUR REF: DATE: 4 August 1983

DESIGN FOR EXPANDABILITY!

Mr. Michael A. Ware
Environmental Coordinator
Wheelabrator-Frye Incorporated
Graphic Supplies Division
Chemicals and Coatings group
2010 Indiana Street
Racine, Wisconsin 53405

Dear Mr. Ware:

We have pleasure in referring to the discussions with your colleagues and yourself during the visit to David M. Company, Longwood, last Friday, and we appreciated the opportunity to discuss the project for the recovery of toluene from the three rubber spreading machines.

For your preliminary information we have pleasure in enclosing our Preliminary Proposal No. S 7212, in triplicate, for a plant to recover up to 50 gallons per hour of toluene from 25,000 scfm airflow, as you requested, for your initial studies. We understand that consideration is being given to the possibility of making changes to the process operations to reduce the peak evaporation rates of solvent so that the capacity of the recovery plant might be reduced.

The proposed plant is quoted on the basis of supply only, with the addition of a preliminary proposal, Appendix 'A', for the turnkey installation of the plant which we would be pleased to firm up after further study of site conditions.

The proposed plant is very similar to a considerable number of installations that we have supplied for operation with rubber spreading machines in which particular industry we have over 40 years experience.

We will be pleased to quote also for the supply of suitable hoods for the spreading machines and a collection system when you so require.

We trust that the enclosed information is sufficient for your immediate requirements but we will be very pleased to discuss any aspects further with you at your convenience.

Yours sincerely,

William C. Moses
Vice President

WCM/pmd

david M COMPANY™

Wheelabrator-Frye Inc. Chemicals & Coatings Group

201 VALENTINE WAY • LONGWOOD, FLORIDA 32750 • (305) 321-0945

10/13 Bill Willard

October 10, 1983

DER
OCT 13 1983
BAQM

Mr. C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality Management
Twin Towers Office Building
9000 Blair Stone Road
Tallahassee, FL 32301-3241

Dear Mr. Fancy:

David 'M' Company is in receipt of your correspondence requesting additional information concerning its recent application to construct a lithographic printing blanket manufacturing facility. We will move as expeditiously as possible to gather the necessary information and will consult Mr. Willard Hanks of your staff concerning any questions we may have during the course of compiling the information you have requested.

Sincerely,

Michael A. Ware

Michael A. Ware
Graphics Div. Env. Coord.
Chemicals & Coatings Group
Wheelabrator-Frye, Inc.

MAW:bjw

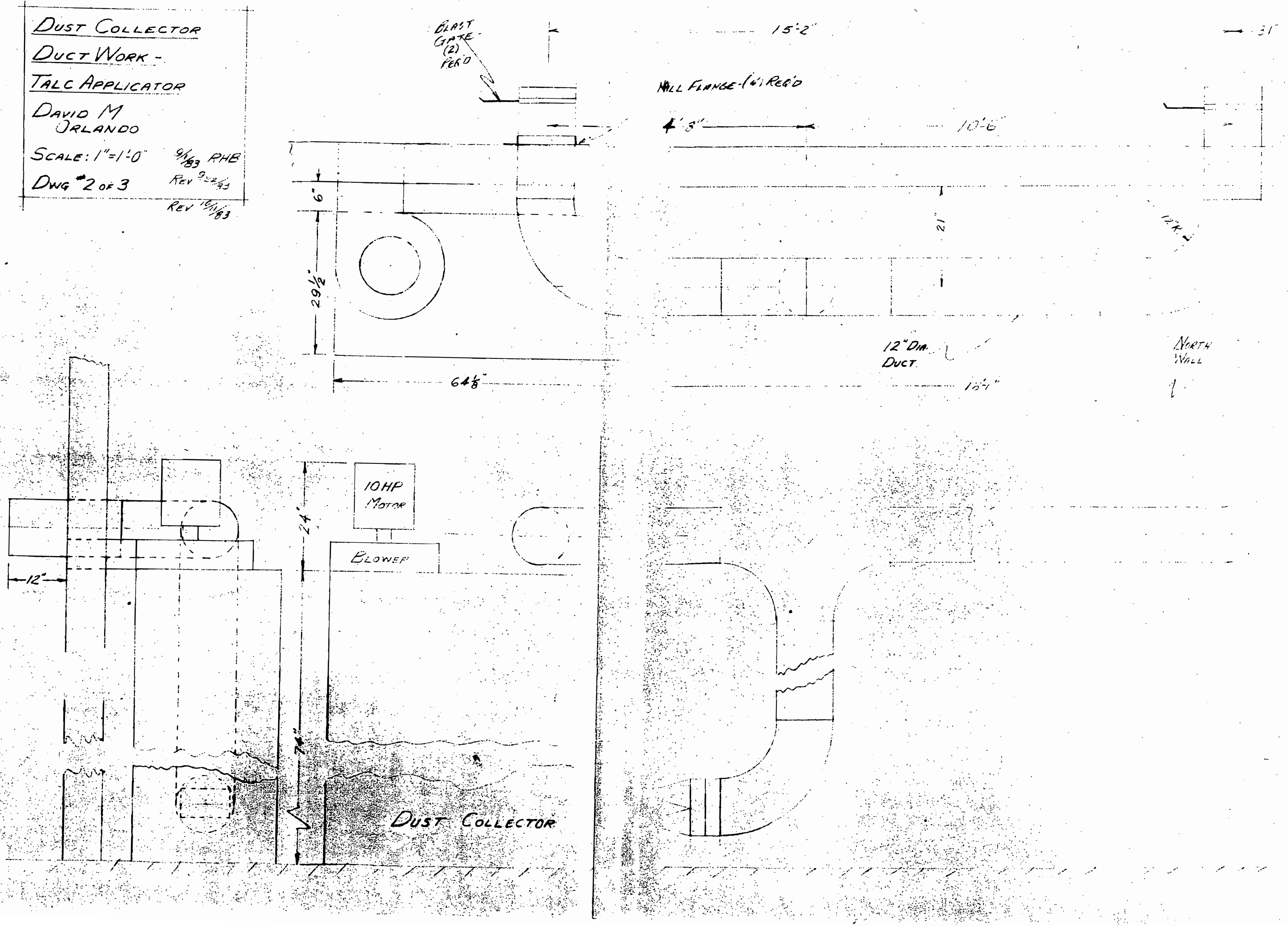
cc: Wayne Brady
R. H. Baddeley
J. Spangler
H. Mycroft
T. Lucas
J. Seabury
C. Collins

davidM® COMPANY
201 VALENTINE WAY
LONGWOOD, FLORIDA 32750

RACINE WIS. OCT 10'83
U.S. POSTAGE 0.20
P.B. METER 1278190

Mr. C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality Management
Twin Towers Office Building
9000 Blair Stone Road
Tallahassee, FL 32301-3241

BEST AVAILABLE COPY

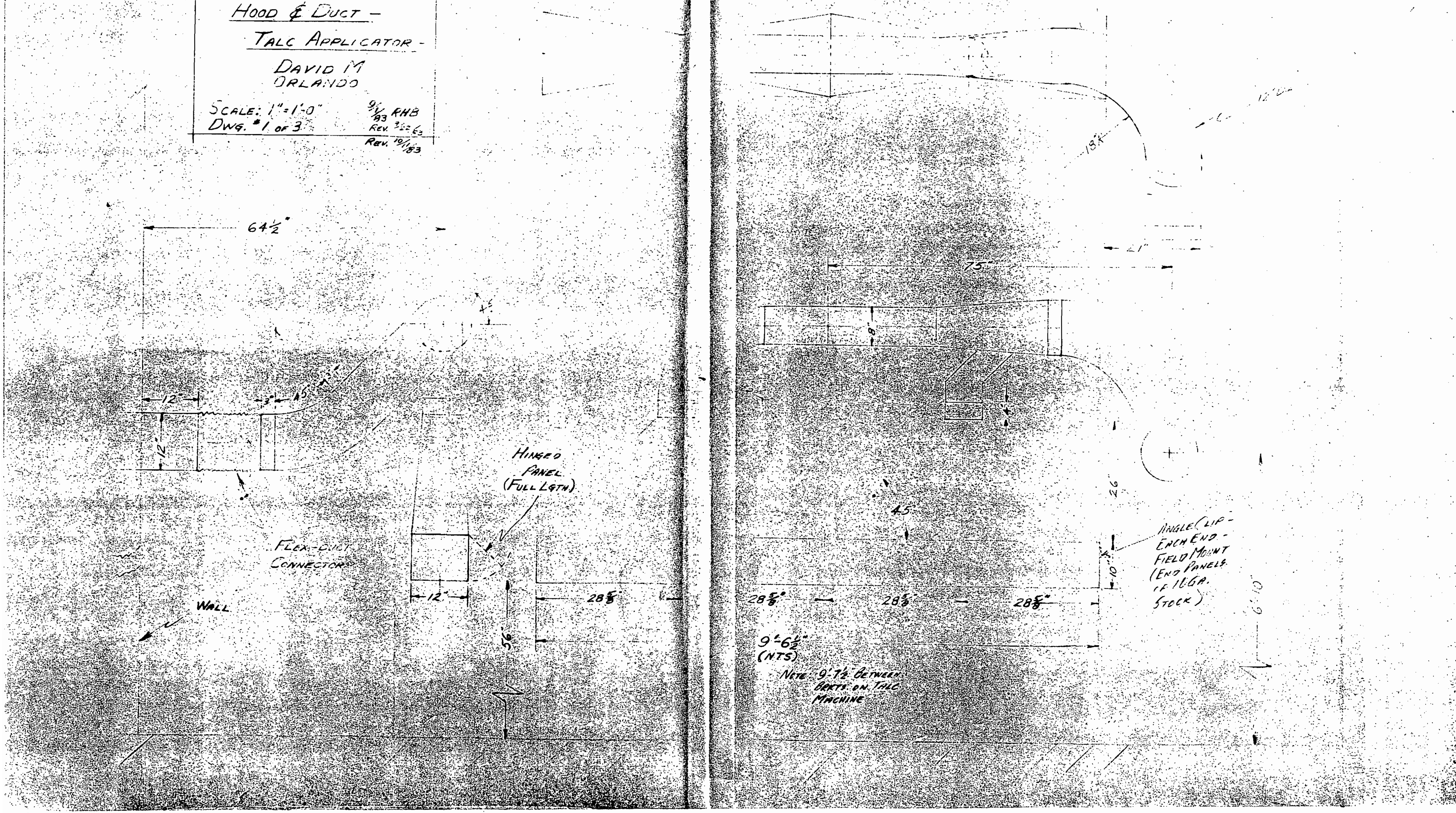


DUST COLLECTOR
DUCT WORK -
TALC APPLICATOR
DAVID M ORLANDO
SCALE: 1"=1'-0" 9/1/83 RHB
DWG #2 OF 3 REV 9/22/83
REV 10/11/83

BEST AVAILABLE COPY

DUST COLLECTOR
HOOD & DUCT -
TALC APPLICATOR -
DAVID M
ORLANDO

SCALE: 1"=1'-0"
DWG. #1 OF 3
9/1/83 RHB
REV. 3/22/83
REV. 10/1/83



david M™ COMPANY

Wheelabrator-Frye Inc. Chemicals & Coatings Group

201 VALENTINE WAY • LONGWOOD, FLORIDA 32750 • (305) 321-0945

October 10, 1983

DER
OCT 12 1983
BAQM

Mr. L. T. Kozlov, P.E.
District Enforcement Chief
State of Florida
Department of Environmental Regulation
St. Johns River District
3319 Maguire Blvd.
Suite 232
Orlando, FL 32803

SUBJECT: Your Memorandum of August 12, 1982 Concerning VOC Permits, Boiler Permits and Settlement Fees

Dear Mr. Kozlov:

Following our original meeting with Mr. Chuck Collins of your department in late February of 1983, the David 'M' Company undertook a project to quantify the VOC content of its many rubber cements used in the blanket making process. The purpose of the study was to assess our ability to comply with existing low solvent technology guidelines for the fabric coating industry which were referred to by Mr. Collins during the course of our February meeting. The results of our study which encompassed ten of our rubber cements representing high, median and low VOC formulations, yielded solvent contents in coatings ranging from a low of 3.6 lbs. solvent/gallon of coating applied to 6.1 lbs. solvent/gallon of coating applied. The afore-mentioned results were obtained in early May and indicated that David 'M' Company could not meet the 2.9 lb. VOC/gallon of coating applied limitation established by Florida Administrative Code Rule 17-2.650(1)(f)(4) with our existing process parameters.

We subsequently initiated a project to assess the feasibility of lowering our existing VOC leadings in order to achieve compliance with the previously referenced emission limitation. In July of 1983, our study was completed and we concluded that although a few of our compounds could be reformulated to meet the existing guidelines, the vast majority of them could not be formulated into compliance without inducing density and viscosity problems which would preclude their use on our coating lines.

While conducting the previous survey, we concurrently evaluated the possibility of utilizing waterborne or 100% solids coatings. The results of this survey indicated that both of these approaches would require extensive research and development over a long period of time and promised no guaranty that compliance would be achieved while maintaining the ability to produce a viable and marketable product.

Having exhausted the alternatives previously discussed, David 'M' Company began evaluating the cost and feasibility of installing three types of end of pipe control devices designed to yield compliance with F.A.C. Rule 17-2.650(1)(f)(4) by removing 90% of the VOC delivered to the control device. The technologies preliminarily investigated were thermal oxidation, catalytic oxidation and carbon adsorption.

At the time of this writing, we have received representative quotations from suppliers of the above technologies for the purpose of cost comparison. Our engineering, environmental and process personnel are currently engaged in the establishment of the specifications and operational parameters required for the installation of such control devices.

We have also completed and forwarded to your office, permit and applications covering the existing VOC operations at the suggestion of both yourself and Mr. Chuck Collins of your staff during the course of our July 29, 1983 meeting concerning this subject.

I sincerely hope that I have described to your satisfaction our efforts to comply with regulations of your department. In the event that you should require further information and/or explanation of our efforts, either past or present, please don't hesitate to contact me directly.

Sincerely,

Michael A. Ware
Graphics Div. Env. Coord.
Chemicals & Coatings Group
Wheelabrator-Frye, Inc.

MAW:bjw

cc: Wayne Brady
Charles Collins
Willard Hanks
Herb Mycroft
Jerry Spangler

PDI®
PRINTING DEVELOPMENTS, INC.
2010 INDIANA STREET
RACINE, WIS. 53405

RACINE
OCT 10'83
WIS.
P.B. METER
1270190
U.S. POSTAGE
0.20

Mr. Willard Hanks
State of Florida
Department of Environmental Regulation
Twin Towers Office Building
9600 Blair Stone Road
Tallahassee, FL 32301

P 408 530 302

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED—
NOT FOR INTERNATIONAL MAIL

(See Reverse)

Sent to Wayne Brady	
Street and No. 201 Valentine Way	
P.O., State and ZIP Code Longwood, Fl 32750	
Postage	$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt Showing to whom and Date Delivered	
Return Receipt Showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	$
Postmark or Date	

PS Form 3800, Feb. 1982

PS Form 3811, Jan. 1979

RETURN RECEIPT, REGISTERED, INSURED AND CERTIFIED MAIL

SENDER: Complete items 1, 2, and 3.
Add your address in the "RETURN TO" space on reverse.

1. The following service is requested (check one.)
   - ☑ Show to whom and date delivered. .... ___¢
   - ☐ Show to whom, date and address of delivery. ... ___¢
   - ☐ RESTRICTED DELIVERY Show to whom and date delivered. .... ___¢
   - ☐ RESTRICTED DELIVERY. Show to whom, date, and address of delivery. $___

(CONSULT POSTMASTER FOR FEES)

2. ARTICLE ADDRESSED TO:

Wayne Brady
201 Valentine Way
Longwood, FL 32750

3. ARTICLE DESCRIPTION:

REGISTERED NO.	CERTIFIED NO.	INSURED NO.
	P408530302	

(Always obtain signature of addressee or agent)

I have received the article described above.

SIGNATURE ☐ Addressee ☐ Authorized agent

4. DATE OF DELIVERY 9-6-83

POSTMARK

5. ADDRESS (Complete only if requested)

6. UNABLE TO DELIVER BECAUSE:

CLERK'S INITIALS

☆GPO : 1979-300-459

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR
VICTORIA J. TSCHINKEL
SECRETARY

September 2, 1983

Mr. Wayne L. Brady, General Manager
David "M" Company
201 Valentine Way
Longwood, Florida 32750

Dear Mr. Brady:

The Department has made a preliminary review of your application for a permit to construct a lithographic printing blanket manufacturing facility. The additional information listed below is required before we can process your application.

1. What will be the maximum production (weight/time) and operation time (hr/d) of the plant? This information is required to establish the maximum allowable production of the plant and will be a condition in any permit to construct that is issued for the plant.

2. What percent of the maximum production was the emission and raw material data in the application based on?

3. Will solvents other than MEK and toluene be used at this plant?

4. How many gallons per year of each solvent will be consumed at the maximum production of the plant?

5. How will the solvents be shipped to the plant? Submit a drawing showing the storage area and piping to the mixing area.

6. How many storage tanks will be built at this plant? What air pollution control equipment will be used to minimize VOC emission from the tanks? What will the emission from the tanks be? Please submit a copy of the emission calculations.

7. What will be the mixing ratio of solvent to rubber (lb/lb)?

8. How many pounds of volatile organic compounds (VOC) will be in a gallon of applied coating?

9. How will talc be received, stored, and conveyed to the process? What air pollution control equipment or operation practices will be used to minimize talc emissions? How much talc will be emitted to the atmosphere?

10. Will the solvent laden air discharged from the plant contain any particulate matter or oil mist?

11. What will be the emissions (particulate matter and VOC) from air emission point No. 2 (mills)? What control equipment will be used to limit particulate emission from the mills? Will product scrap be recycled to the mills? If so, how much VOC will be emitted by the scrap?

12. Are the flow rates listed in the application from air emissions points 4 and 5 correct? A flow of 1415 ACFM through two 1.33 ft x 1.33 ft ducts would have a velocity of 400 FPM.

13. What will be the percent of the lower explosive limit (LEL) at peak solvent evaporation rates for each exhaust stream?

14. What will be the percent of the threshold limit values (TLV) near the discharge points (approx. 20') outside the plant during peak solvent evaporation rates?

15. How many employees will work at this plant and what impact will the emissions from the plant have on the ambient air quality, vegetation and visibility near the plant?

16. If the solvents evaporated from the process were recovered, could they be reused by the plant or sold to a reclamation plant?

17. What is the current delivered cost of the solvents used at the plant?

18. Has the Company made any studies on recovering and reusing the solvents at the plant and, if so, what conclusions were reached?

19. On page 10 of 12 of the application, the capital cost of carbon absorbers is shown as $600,000 - $700,000.

Reference sources available to us estimate the cost of a carbon absorber is $300,000. This cost includes process and equipment design, foundations, erection, electrical wiring, controls and thermal insulation. Please explain what is included in your estimate.

20. How many gallons of VOC per year will be sent to Emille, Alabama for disposal?

If the information requested confirms the proposed plant is a new major source of VOC, (annual emissions greater 250 TPY), you will also need a federal permit to construct the plant. To apply for a federal permit, you need only to request the Department to process the application for both federal and state permits.

Emission standards for major VOC sources in attainment areas are established by the best available control technology (BACT) procedures described in Florida Administrative Code Rule 17-2.500. Although I cannot predict what standard will be allowed for your process, regulations require the emission standard to be no more than 2.9 lb VOC/gal of coating applied or 90 percent removal of VOC from the exhaust stream (Fla. Admin. Code Rule 17-2.650(1)(f)4). If the plant cannot meet this standard with low solvent content coating technology, then it will be necessary for you to propose the control equipment that the plant will use to meet the standard.

Please furnish the information requested by November 1, 1983, so that we can resume processing your application. If you have any questions on the data requested, Willard Hanks (904/488-1344) will discuss them with you.

Sincerely,

C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality
Management

CHF/WH/s

cc: Charles Collins
John Seabury

```
           DER PERMIT APPLICATION TRACKING SYSTEM MASTER RECORD
FILE#000000073966 COE#          DER PROCESSOR:CLAIR FANCY        DER OFFICE:TLH
FILE NAME:DAVID "M" COMPANY       DATE FIRST REC: 08/12/83  APPLICATION TYPE:AC
APPL NAME:DAVID M/SPREADERS #1,2,3  APPL PHONE:(305)321-0945   PROJECT COUNTY:59
ADDR:201 VALENTINE WAY                       CITY:LONGWOOD          ST:FLZIP:
AGNT NAME:SEABURY-BOTTORF ASSOC     AGNT PHONE:(305)298-0846
ADDR:3702 SILVER STAR ROAD                   CITY:ORLANDO           ST:FLZIP:32808

ADDITIONAL INFO REQ:  /  /       /  /       /  /   REC:  /  /       /  /      /  /
APPL COMPLETE DATE:    /  /   COMMENTS NEC:Y DATE REQ:  /  /    DATE REC:  /  /
LETTER OF INTENT NEC:Y   DATE WHEN INTENT ISSUED:  /  /     WAIVER DATE:  /  /

HEARING REQUEST DATES:                          /  /           /  /           /  /
HEARING WITHDRAWN/DENIED/ORDER -- DATES:        /  /           /  /           /  /
HEARING ORDER OR FINAL ACTION DUE DATE:         /  /        MANUAL TRACKING DESIRED:N
       *** RECORD HAS BEEN SUCCESSFULLY UPDATED ***    08/22/83    14:29:50
FEE PD DATE#1:08/12/83 $1000  RECEIPT#00074416 REFUND DATE:  /  /  REFUND $
FEE PD DATE#2:  /  /   $      RECEIPT#         REFUND DATE:  /  /  REFUND $
APPL:ACTIVE/INACTIVE/DENIED/WITHDRAWN/TRANSFERRED/EXEMPT/ISSUED:TR DATE:08/12/83
REMARKS:ORL.  CHECK ALREADY SENT TO PURCHASING OFFICE.
```

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~008020~~ 240189

COPY

YOUR REF:

OUR REF: E 0379
S 7212

DATE: 2 August 1983

PROPOSAL

FOR

SOLVENT RECOVERY SYSTEM

TO BE LOCATED AT:

DAVID M. COMPANY

201 VALENTINE WAY
LONGWOOD, FLORIDA

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908920~~ 240189

YOUR REF:
OUR REF: S 7212
DATE: 2 August 1983

David M. Company
201 Valentine Way
Longwood, Florida

SOLVENT RECOVERY PLANT

ACTIVATED CARBON ADSORPTION UNIT

AIRFLOW..............................25,000 scfm.
AIR TEMPERATURE......................140° F.
SOLVENT CAPACITY.....................50 gph (360 lb/hr)
SOLVENT..............................Toluene

AUTOMATICALLY CONTROLLED
BY
GAS ANALYSER

PRELIMINARY PROPOSAL

$598\,\frac{\text{tons}}{\text{yr}}\;\frac{2000\#}{T}\;\frac{\text{yr}}{16\times250\text{h}} = 299\ \#/\text{h}$

300 #/h

(30#/hr emission)

PLANT DESCRIPTION

The solvent laden air would be filtered to remove dust, cooled to approximately 95° F by the air cooler and then delivered by the fan to the three adsorbers.

Two of the three adsorbers would normally be handling the solvent laden air whilst the other would be regenerating with steam to extract the solvent from the carbon or would be held on "stand-by" following "steaming" and a short dry/cool period.

The adsorbers would cycle consecutively and automatically with override of the cycle time and steam input by gas analyser control. The proposed adsorbers are of annular bed design, the solvent air after filtering and cooling passes through an automatic inlet valve into the outer annulus of the adsorber, through the carbon bed and then exhausts to atmosphere through the inner annulus and the automatic exhaust valve.

At the end of an adsorbing period the air inlet and outlet valves close and an automatic steam valve allows steam to enter the inner annulus of the adsorber and pass through the carbon bed to the outer annulus from which point the steam together with solvent vapour extracted from the carbon passes to the condenser. During steaming some condensation occurs on the outer shell of the adsorber and is drained through filters to join the main condensate flow from the condenser to the decanter.

At the end of the steaming period the adsorber automatic steam valve shuts and the air inlet and outlet valves open to allow solvent laden air to again pass through the adsorber for a short period to dry and cool the bed (during this dry/cool period the solvent laden air is shut off from the other adsorber). The inlet valve of the dried/cooled adsorber would then close and the adsorber would be held on "stand-by" until the gas analyser, sampling the exhaust of the other adsorber, or the override timer, gives the signal for that adsorber to change to the steaming cycle, the stand-by adsorber being first brought back into service, so that there is no interruption to the adsorber cycle.

Any incondensibles from the condenser return through the condenser vent pipe to the inlet duct for recycling through the adsorbers. The condenser vent is fitted with high temperature alarm to indicate overloading from excessive steam flow or shortage or failure of the cooling water supply.

Safety features include adsorber pressure and vacuum relief valves and liquid seals.

We would supply the following:

1. AIR FILTER - 25,000 scfm capacity

   a) Pre-Filter Section

   With removable and disposable fiberglass panels to protect and extend the life of the main filter.

   b) Main Filter Section

   With disposable filter elements of the HEPA type of fiberglass material, with an efficiency of better than 99% for particles down to 0.3 microns per standard tests.

   The whole of the above would be incorporated in a galvanized steel case with access doors to facilitate servicing.

   A differential resistance gauge would be fitted.

2. AIR COOLER - 25,000 scfm capacity.

   Would be of finned tube design with copper tubes and aluminum fins to cool the inlet airstream from 140° F to approximately 95° F when supplied with cooling water at a temperature of maximum 86° F.

   The air cooler coils would be housed in a galvanized steel case and would be drainable.

3. FAN AND MOTOR

   The fan would be of the high efficiency type with airfoil impeller capable of handling 25,000 scfm of solvent laden air, when at an actual temperature of approximately 95° F, at a total pressure of approximately 18" w.g., allowing for 2" w.g. suction before the air filters.

   The casing would be of substantial carbon steel construction and the unit would have spark-proof features to AMCA standards.

   The impeller would be driven through a flexible coupling by a 125 HP explosion proof motor to Class 1, Group D, Division 1, 460 volt, 3 phase, 60 cycles.

   A manually operated radial leaf damper would be fitted at the fan inlet for regulation of the airflow.

4. THREE ADSORBERS - 6'8" diameter x approximately 10'3" high shell.

Each capable of handling 12,500 scfm of solvent laden air calculated at 70° F, when at an actual temperature of approximately 95° F.

The adsorbers would be of the annular carbon bed type with the carbon contained between stainless steel panels formed up into cyclinders and reinforced by carbon steel stiffening bands. The activated carbon bed and screens would be supported upon a carbon steel tray to which would be connected the solvent laden air inlet valve, vapour piping to condenser and liquor drains. The air exhaust valve and the steam valve would be connected to the outlet branch of the adsorber.

The carbon bed and screens would be contained within a removable carbon steel shell, fitted with access and inspection holes with bolted cover plates. Flanged connections would be fitted to the tray so that the carbon could be easily and quickly run off into drums.

Vacuum and pressure relief valves would be provided for each adsorber.

Handrails would be fitted round the tops of the adsorbers, with a walkway over and between the adsorbers, and with an access ladder from ground level, in accordance with the requirements of OSHA.

5. ACTIVATED CARBON

We would provide the initial charge of approximately 6400 lbs of high quality carbon for each of the three adsorbers. The carbon would be manufactured by Sutcliffe Speakman and would be of the grade most suited to the required duty.

6. INLET AND OUTLET AIR VALVES - 26" diameter

We would provide an inlet and outlet valve for each adsorber 26" diameter of the mushroom type of substantial construction arranged for pneumatic operation through the automatic control mechanism.

Renewable seats would be fitted in the valve bodies and access holes with bolted cover plates provided. An indicator would be fitted to each valve so that the attitude of the valve could be easily ascertained.

7. CONDENSER

To condense the steam and solvent vapours leaving an adsorber during the steaming period.

The unit would be of the tubular surface type with the shell in 304 stainless steel and the tubes in 316 stainless steel The water boxes and tubeplates would be in carbon steel.

The condenser vent pipe (fitted with thermometer with high temperature alarm contacts) would be connected to the inlet duct so that any incondensibles displaced from the adsorbers would recycle.

8. ONE DECANTER - 3'0" diameter x 4'6" high

It would be of the self-adjusting decanting type to separate automatically the condenser water and solvent. The tank would be of carbon steel welded construction fitted with a bolted cover plate and all the necessary connections. A sight glass would be fitted in the solvent outlet.

9. TRUNKING

We would provide the interconnecting trunking between the air filter, air cooler, fan and adsorbers, but do not allow for any trunking prior to the inlet manifold of the air filter. The trunking would be of carbon steel of welded construction flanged at suitable intervals and be adequately supported.

10. THREE EXHAUSTS

An exhaust stack would be provided for each adsorber, of carbon steel welded construction, galvanized and would terminate about 6' above the adsorber platform.

11. PIPING AND VALVES

We would provide pipework to interconnect the above and manifold the service pipes to terminal flanges at the battery limits.

Vapour and liquor piping would be in 304 stainless steel, utility piping in carbon steel.

We include for all isolating valves, steam traps, pipe supports, etc.

12. PLANT CONTROL UNIT

Would consist of the following:

a) Gas Analyser (Infra-Red Type)

To measure the solvent content in the exhaust airstream of the adsorber next due for desorbing and to delay steaming until the set point was achieved. However, an adjustable override timer would be incorporated into the program to limit the period of such a delay.

A strip recorder for the exhaust gas concentration would be included and the unit would have a "high level" alarm.

b) Programmable Logic Controller

Of the solid state type which on receipt of the appropriate signals would cause the adsorber valves to sequence as appropriate. The program logic would be such that the next step would not be commenced until the previous one had been proven completed.

In the unlikely event of failure of the P.L.C. the solvent recovery plant could be operated manually by the use of pilot air solenoid valves inbuilt into the panel.

c) Annunciation Section

Of the 'Panalarm' type or similar to alarm:
"high level" - gas analyser output
"high temperature" - condenser vent

d) Control Panel

The above items would be mounted in a free-standing enclosure, suitable for indoor location in a non-hazardous area, assumed within 50' of the adsorbers.

The panel would be pre-wired and tubed to terminal points on the frame. We exclude the impulse tubing from the panel to the plant items.

13. INSTRUMENTS

We would provide the following indicating type instruments which would be locally mounted on the plant:

4 Dial type thermometers
1 Steam pressure gauge
1 Differential pressure gauge (resistance through air filter)
1 4-Point pressure gauge (air pressure and suctions within the plant)

14. STRUCTURES

We would provide structures to support items of the plant.

15. PAINTING

Where applicable, plant items would be primer coated before shipment.

16. COMPRESSED AIR

You to supply compressed air, clean, dry and oil free at a pressure of approximately 80 psig.

17. DRAWINGS AND INSTRUCTIONS

We would provide three (3) copies of each of the following:

Foundation drawing
Flowsheet
Plant arrangement drawing
Major assemblies

Plus two (2) copies of:

Erection drawings and instructions
Operating and Maintenance Manual

A list of recommended spares would also be provided.

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908020~~ 240189

YOUR REF: OUR REF: DATE: 2 August 1983

David M. Company
201 Valentine Way
Longwood, Florida

TERMS, PRICE AND CONDITIONS

PRICE OF PROPOSAL

PROPOSAL NO. S 7212

For the supply of the whole of the items as specified in this proposal, delivered only to your works in Longwood, Florida (offloading from the transport and installation by others) would be the sum of approximately..$ 370,000.00

(THREE HUNDRED SEVENTY THOUSAND DOLLARS)

Any Federal, State or local taxes that may be applicable are excluded.

TERMS OF PAYMENT

25% of quoted price with order.

45% of quoted price in three (3) equal payments pursuant to invoices on the following basis:

a) upon submission of preliminary drawings comprising plant arrangement and foundation drawings and flowsheet.

b) upon submission of confirmation that the manufacture is at least 40% complete.

c) upon submission of confirmation that the manufacture is at least 70% complete.

25% of quoted price upon despatch or when ready for despatch if despatch date is delayed by you.

5% of quoted price on start-up and successful operation, at latest three (3) months after despatch, or when ready for despatch, whichever is sooner.

Continued.........

TERMS, PRICE AND CONDITIONS...continued

DESPATCH

Approximately six (6) months from receipt of order assuming that there are no delays due to changes in specifications or approval of drawings.

EXCLUSIONS

We do not include for any motor controls, electrical wiring, or any special cold weather protection or insulation, or any parts, materials, work for services of any kind whatsoever except those specifically mentioned in the body of the proposal.

STANDARD OF MANUFACTURE

The goods described in this proposal would be manufactured to normal commercial standards and be suitable for the duty specified. Should you desire manufacture to any specific standards, codes or inspection schedules other than those allowed for then we will be pleased to comply with your requests, but any extra charges so incurred would be in addition to the prices quoted.

VALIDITY OF PROPOSAL

This proposal is open for acceptance for a period of thirty (30) days from the date of this quotation and after this period confirmation must be obtained that the terms and conditions contained herein are still valid.

SUTCLIFFE SPEAKMAN INCORPORATED

William C. Moses
Vice President

E. & O. E.

WCM/pmd

UTILITY REQUIREMENTS

The following are the approximate utility requirements of the plant when operating at design load conditions. The figures are subject to confirmation by our final design study.

STEAM........................	1190 lb/hr, dry saturated quality at 40 psig.
COOLING WATER..............	170 gpm, inlet 86°, maximum, return 115°.
POWER........................	100 KwH.
COMPRESSED AIR.............	20 scfh.

SPACE

The equipment, we estimate, would require a floor area of approximately 45' x 20'.

The height of the equipment would be approximately 18', but if it is to be located inside, then provision should be made for lifting of the adsorber shells.

APPENDIX 'A'

OUR PRELIMINARY PROPOSAL FOR THE TURNKEY INSTALLATION OF THE PLANT QUOTED IN MAIN PROPOSAL NO. S 7212

1. FOUNDATIONS

We would provide concrete foundations for the appropriate items of our equipment.

Our price is conditional on the understanding that the ground is of suitable load bearing capacity, that no rock blasting or piling would be required and that all work would be above the water table.

2. MOTOR CONTROL CENTER

We include the starters for the fan motor, the water cooling tower fan and the recirculating water pumps, and which would be suitable for location in a non-hazardous area which we assume will be by the control panel.

3. WATER COOLING TOWER

Corrosion Inhibitors → ? Chromates

We would supply and install a water cooling tower designed to cool the required amount of water from 115° F to approximately 86° F. The tower would be of Induced draft type and complete with fan and motor. The system would include two pumps with motors (one normally operating, one stand-by) and the water circulating piping and valves between the water cooling tower and the air cooler and condenser of the recovery plant, the water cooling tower to be at ground level and located adjacent to the recovery plant.

4. INSTALLATION

We include for the necessary labour, tools, moving and lifting gear including cranes, for the installation of the items of equipment specified in this proposal onto the foundation.

4. INSTALLATION...Continued

It is understood that the work would be undertaken during our normal working hours and that we and our sub-contractors or agents would be allowed free and unrestricted access to the site.

Any overtime worked at your request would be chargeable extra at the rate in force at the time.

You would be responsible for offloading from the transport any items delivered prior to the start of the installation work and provide suitable storage and protection for all parts close to the battery limits.

All temporary site support facilities including but not limited to water, electricity, steam, drain, office and telephone would be provided by you at your expense, adjacent to the site.

Note that the quoted price assumes we will have continuity of work on site.

5. SUPERVISION

We include for the services of our own suitably qualified supervisor to supervise and give instructions to the labour provided by our sub-contractors, to secure the installation of the equipment in a competent manner.

6. IMPULSE TUBING

The pneumatic tubing from the appropriate plant items to the control panel would be supplied and installed in a workmanlike manner. It is assumed that the tubing run is a maximum of fifty feet.

7. ELECTRICAL WIRING

We would supply and install all necessary electrical wiring, cable trays, etc. to interconnect the various items of plant to the motor control center and the control panel, assuming a maximum cable run of fifty feet from the adsorbers. Where appropriate, the wiring would be to explosion proof, classification.

8. INSULATION/WINTERIZATION

Insulation and heat tracing of appropriate equipment within our battery limits effected, assuming a minimum ambient temperature of 25° F.

9. START-UP

We include for the services of a skilled engineer for a period of two (2) consecutive weeks on site to start-up the plant and provide instructions to your personnel on its operation.

Any extra time required by you or non-continuity in attendance would be at additional cost.

10. INSURANCE

We would provide and maintain the following insurances and would require any and all sub-contractors employed by us at your site to procure and maintain the same type and amount of insurance.

a) Workman's Compensation and employer's Liability
- $100,000.00 each accident and aggregate disease.

b) Comprehensive General Liability
- Bodily injury and Property damage of up to $1,000,000 combined single limit.

c) Comprehensive Automobile Liability
- To cover owned, non-owned, leased and hired cars, combined single limit $1,000,000.

Certificates of the above shall be provided to you prior to the start of our on site work.

In addition to the above and in order to insure the equipment from its delivery to your site, through installation to your acceptance of the plant, we would take out "all risks" insurance plus "builders risk" and "installation floaters" at the appropriate time and at your expense.

BUDGETARY PRICE

Our approximate additional price to that quoted in Main Proposal No. S 7212 for the turnkey installation of the plant as detailed in this Appendix 'A' would be the sum of ....$ 160,000.00.

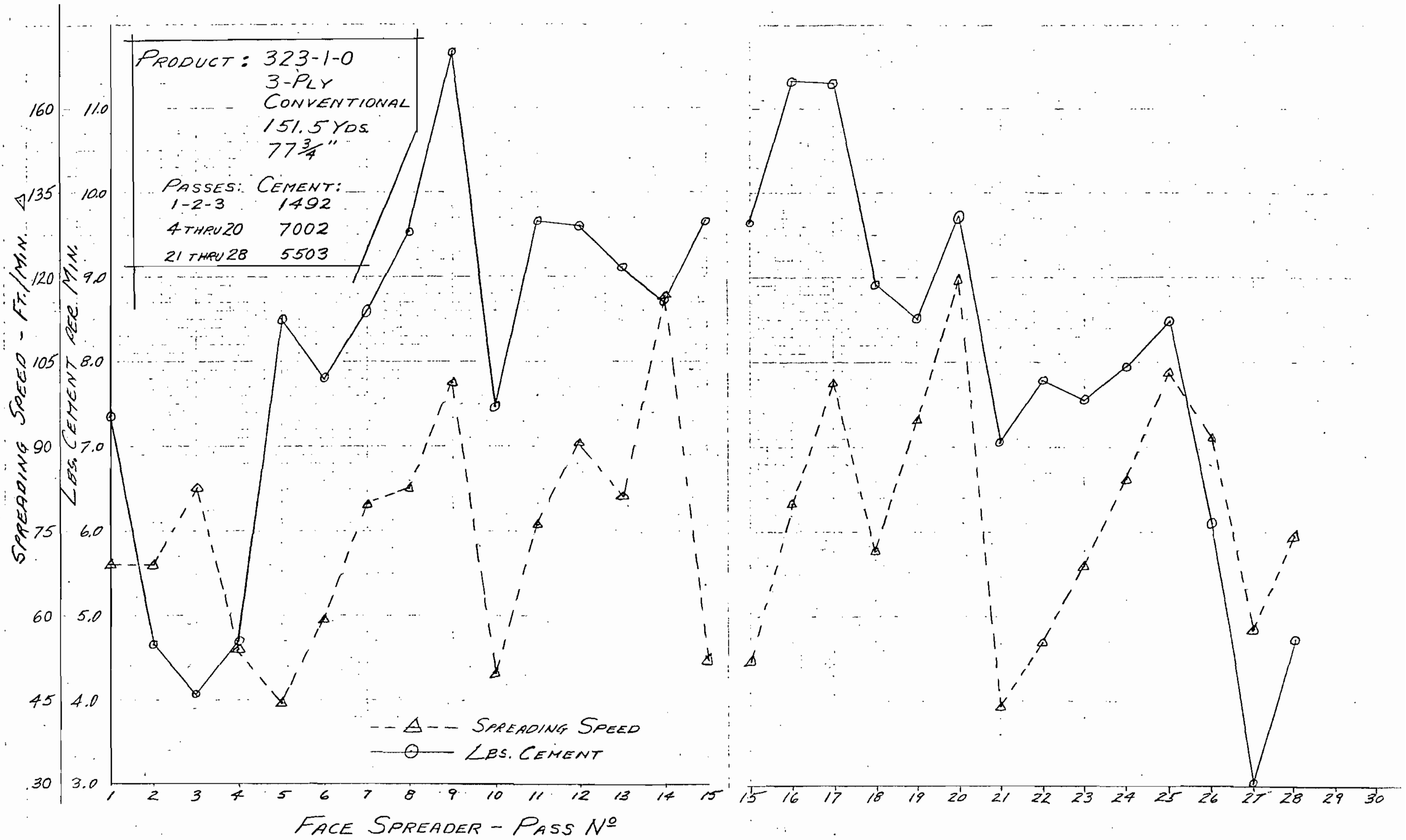
(ONE HUNDRED SIXTY THOUSAND DOLLARS)

COMPLETION

We would expect to supply and install the specified plant in approximately nine (9) months from receipt of order.

TERMS AND CONDITIONS

Otherwise as Main Proposal No. S 7212.



Charted ~~6/1/83~~ 9/1/83 RHB

AC59-073966
$1,000 fee paid

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

ST. JOHNS RIVER DISTRICT
3319 MAGUIRE BOULEVARD
SUITE 232
ORLANDO, FLORIDA 32803

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

ALEX SENKEVICH
DISTRICT MANAGER

PAID
1000
AUG 12 1983
SAINT JOHNS RIVER DISTRICT

RECEIVED
AUG 1983
Saint Johns River District

DER
AUG 24 1983
BAQM

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Blanket Spreading Operation [x] New[1] [ ] Existing[1]

APPLICATION TYPE: [x] Construction [ ] Operation [ ] Modification

COMPANY NAME: DAVID "M" COMPANY COUNTY: SEMINOLE

Identify the specific emission point source(s) addressed in this application (i.e. Lime Kiln No. 4 with Venturi Scrubber; Peaking Unit No. 2, Gas Fired) Spreaders #1,#2,#3 Festooning and Mixing are

SOURCE LOCATION: Street 201 Valentine Way City Longwood

UTM: East 17-470106 North 3177160

Latitude 28 ° 43 ' 26 "N Longitude 81 ° 18 ' 18 "W

APPLICANT NAME AND TITLE: Wayne L. Brady, General Manager

APPLICANT ADDRESS: 201 Valentine Way, Longwood, Florida 32750

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of David "M" Company

I certify that the statements made in this application for a construction permit are true, correct and complete to the best of my knowledge and belief. Further I agree to maintain and operate the pollution control source and pollution contro facilities in such a manner as to comply with the provision of Chapter 403, Florid Statutes, and all the rules and regulations of the department and revisions thereof. I also understand that a permit, if granted by the department, will be non-transferabl and I will promptly notify the department upon sale or legal transfer of the permitte establishment.

*Attach letter of authorization

Signed:

Vice President &
Wayne L. Brady, General Manager
Name and Title (Please Type)

Date: 8/ /83 Telephone No. 305/321-0945

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA (where required by Chapter 471, F.S.)

This is to certify that the engineering features of this pollution control project hav been designed/examined by me and found to be in conformity with modern engineerin principles applicable to the treatment and disposal of pollutants characterized in th permit application. There is reasonable assurance, in my professional judgment, that

---

[1] See Florida Administrative Code Rule 17-2.100(57) and (104)

the pollution control facilities, when properly maintained and operated, will discharge an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signed John W. Seabury

John W. Seabury
Name (Please Type)

Seabury-Bottorf Associates, Inc.
Company Name (Please Type)

3702 Silver Star Rd., Orlando, Florida 32808
Mailing Address (Please Type)

Florida Registration No. 8719 Date: August 11,1983 Telephone No. 305/298-0846

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

The project will involve the installation of a lithographic printing blanket manufacturing facility and will include the following sources which are part of a common exhuast system. Spreaders #1,#2,#3, Festooning area, and Mixing area. Please refer to emission points 1-5 on the following process layout diagrams to ascertain particular emission points and exhaust ventilation configurations.

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction upon arrival Completion of Construction 1 month post approval

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

Not applicable

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

None known

E. Requested permitted equipment operating time: hrs/day 16 ; days/wk 5 ; wks/yr 50 ; if power plant, hrs/yr N.A. ; if seasonal, describe:

F. If this is a new source or major modification, answer the following questions. (Yes or No)

1. Is this source in a non-attainment area for a particular pollutant? No
   - a. If yes, has "offset" been applied? No
   - b. If yes, has "Lowest Achievable Emission Rate" been applied? No
   - c. If yes, list non-attainment pollutants. No
2. Does best available control technology (BACT) apply to this source? If yes, see Section VI. Yes
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. No
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? No
5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

H. Do "Reasonably Available Control Technology" (RACT) requirements apply to this source? No

- a. If yes, for what pollutants? N.A.
- b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable.

F. 2. (Yes) Florida Air Pollution Regulation 17-2.500(5)(c) Application of best available control technology to pollutants subject to NSR requirements as set forth in 17.2.5(2)(f).

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Rubber	None Known	-	Variable	Used to formulate cements 2
Rubber Cement	V.O.C.	30-70%	Variable	Mixing (2), Spreading (3,4,5), Festooning (6)
	MEK Toluene			(At step #6 99%+ of V.O.C. has been flashed off)

*The process utilizes rubber cements which are mixtures of various rubber compounds i.e. (nitrile, e and hydrocarbon diluents such as toluene or MEK. VOC content of cement may vary from 30 to 70% of coating weight depending upon type.

B. Process Rate, if applicable: (See Section V, Item 1)

1. **Total Process Input Rate (lbs/hr):** Variable

2. **Product Weight (lbs/hr):** Variable

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

permitted values

Name of Contaminant	Emission[1] 8 hr d		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission 16 hr day		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
VOC - MEK/ Toluene	103	84	BACT	To be determined	420,000	210	1
"	5	4	BACT	To be determined	20,000	10	3
"	94.5	75.6	BACT	To be determined	378,000	189	4
"	94.5	75.6	BACT	To be determined	378,000	189	5
	297.0				major source	598	

2 ? MISSING

* Potential emissions are based upon a two shift (16 hour) operation, five days per week and 250 days per year. Actual emissions are based upon a one shift (8 hour) operation, five days per week, and 250 days per year.

[1] See Section V, Item 2.

[2] Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3] Calculated from operating rate and applicable standard.

[4] Emission, if source operated without control (See Section V, Item 3).

these must be 2 est
11/1/83 letter listed
300 TPY max potential
VOC emissions
(uncontrolled)

D. Control Devices: (See Section V, Item 4)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: N.A. Percent Ash: N.A.

Density: N.A. lbs/gal Typical Percent Nitrogen: N.A.

Heat Capacity: N.A. BTU/lb N.A. BTU/gal

Other Fuel Contaminants (which may cause air pollution): N.A.

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N.A. Maximum N.A.

G. Indicate liquid or solid wastes generated and method of disposal.

Rubber cement waste is generated by the process and consists of rubber and varying amounts of rubber mixed with VOC. The waste is packaged in 55 gallon open head drums and disposed of in a secure hazardous waste land disposal site in Emille, Alabama.

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack): (See following page)

Stack Height: ________ ft. **Stack Diameter:** ________ ft.

Gas Flow Rate: ________ ACFM ________ DSCFM **Gas Exit Temperature:** ________ °F.

Water Vapor Content: ________ % **Velocity:** ________ FPS

SECTION IV: INCINERATOR INFORMATION

Not Applicable

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Patholog-ical)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Inciner-ated							
Uncon-trolled (lbs/hr)							

Description of Waste ________

Total Weight Incinerated (lbs/hr) ________ Design Capacity (lbs/hr) ________

Approximate Number of Hours of Operation per day ________ day/wk ________ wks/yr. ________

Manufacturer ________

Date Constructed ________ **Model No.** ________

	Volume $(ft)^3$	Heat Release (BTU/hr)	Fuel		Temperature (°F)
			Type	BTU/hr	
Primary Chamber					
Secondary Chamber					

Stack Height: ________ ft. Stack Diamter: ________ Stack Temp. ________

Gas Flow Rate: ________ ACFM ________ DSCFM* Velocity: ________ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ________

H. Emission stack geometry and flow characteristics: From estimates

20.25 FT²

Emission Point ⟨1⟩ (SEE process floor diagram):

Stack Height: 18 ft. Stack Dimensions: 4.5 x 4.5 square (ft.)
Gas Flow Rate: 12,600 ACFM 9960 DSCFM Gas Exit Temp.: ~~150~~ 150 (°F)
Water Vapor Content Ambient (variable)% Velocity: ~~600~~ FPS 622.2 FPM

Emission Point ⟨3⟩ (See process flow diagram):

Stack Height: 12 ft. Stack Dimensions: 1.5 x 1.5 square (ft.)
Gas Flow Rate: 1575 ACFM 1410 DSCFM Gas Exit Temp.: 95 (°F)
Water Vapor Content Ambient (variable)% Velocity: 700 ~~FPS~~ 700 FPM

Emission Point ⟨4⟩ (See process flow diagram):

? Stack Height: 12.5 ft. Stack Dimensions: 2(1.33 x 1.33 outlets)(ft.)
Gas Flow Rate: 1415 ACFM 1120 DSCFM Gas Exit Temp.: 150 (°F)
Water Vapor Content: Ambient (variable)% Velocity: 800 ~~FPS~~ ? 400 FPS

Emission Point ⟨5⟩ (See process flow diagram):

Stack Height: 12.5 ft. Stack Dimensions: 2(1.33 x 1.33 outlets)(ft.)
Gas Flow Rate: 1415 ACFM 1120 DSCFM Gas Exit Temp.: 150 (°F)
Water Vapor Content: Ambient (variable)% Velocity: 800 ~~FPS~~ ?

⟨1⟩ Velocity = $\frac{12{,}600 \text{ FT}^3}{\text{MIN}} \Big| \frac{}{20.25 \text{ FT}^2} = 622.2$ FPM

Discharge point ⟨2⟩ (Mills) missing

Brief description of operating characteristics of control devices: Not Appliable

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

Not Applicable

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

1. **Total process input rate and product weight** -- show derivation **[Rule 17-2.100(127)]**

NOT APPLICABLE

2. **To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.**

SEE APPENDIX 1 ATTACHED

3. **Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).**

SEE APPENDIX 1 ATTACHED

4. **With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)**

NO Control Device

NOT APPLICABLE

5. **With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).**

NOT APPLICABLE

6. **An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.**

SEE APPENDIX 2

7. **An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).**

SEE APPENDIX 4

8. **An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.**

SEE APPENDIX 3

9. The appropriate application fee in accordance with Rule 17-4.05. The check should be made payable to the Department of Environmental Regulation. ATTACHED

10. With an application for operation permit, attach a Certificate of Completion of Construction indicating that the source was constructed as shown in the construction permit. NOT APPLICABLE

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?

[ ] Yes [ ] No

Contaminant	Rate or Concentration
N.A.	N.A.

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy)

[ ] Yes [x] No

Contaminant	Rate or Concentration
BACT has not been declared for this class of sources.	

C. What emission levels do you propose as best available control technology?

Contaminant	Rate or Concentration
VOLATILE ORGANIC COMPOUNDS	AVERAGE COATING VOC CONTENT OF 5.4 lbs./gal. VOC/gal. OF COATING DELIVERED TO COATING APPLICATOR.

D. Describe the existing control and treatment technology (if any).

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:

*Explain method of determining

5. **Useful Life:**

6. **Operating Costs:**

7. **Energy:**

8. **Maintenance Cost:**

9. **Emissions:**

Contaminant	Rate or Concentration

10. **Stack Parameters**

a. **Height:** ft.

b. **Diameter:** ft.

c. **Flow Rate:** ACFM

d. **Temperature:** °F.

e. **Velocity:** FPS

E. **Describe the control and treatment technology available (As many types as applicable, use additional pages if necessary).**

1. LOW SOLVENT TECHNOLOGY

a. **Control Device:** FORMULATE COATING TO GIVEN SPECIFICATION

b. **Operating Principles:** CONTROL VOC EMISSION BY FORMULATION

c. **Efficiency:**[1] NOT APPLICABLE

d. **Capital Cost:** ESTIMATE, $10,000.00

e. **Useful Life:** CONTINUING

f. **Operating Cost:** $20,000.00

g. **Energy:**[2] NOT APPLICABLE

h. **Maintenance Cost:** NOT AVAILABLE

i. **Availability of construction materials and process chemicals:** AVAILABLE

j. **Applicability to manufacturing processes:** APPLICABLE

k. **Ability to construct with control device, install in available space, and operate within proposed levels:** ABLE TO INITIATE

2. CATALYTIC INCINERATION

a. **Control Device:** CATALYTIC INCINERATOR

b. **Operating Principles:** CATALYZED INCINCERATI

c. **Efficiency:**[1] 90% +

d. **Capital Cost:** $500,000.00

e. **Useful Life:** 10-15 YEARS

f. **Operating Cost:** NOT AVAILABLE AT THIS WRITI

g. **Energy:**[2] NOT AVAILABLE FROM BUDGET QUOTATION

h. **Maintenance Cost:** NOT AVAILABLE

i. **Availability of construction materials and process chemicals:** AVAILABLE

---

[1] Explain method of determining efficiency.

[2] Energy to be reported in units of electrical power - KWH design rate.

j. **Applicability to manufacturing processes:** APPLICABLE WITH SOME PROCESS MODIFICATIONS

k. **Ability to construct with control device, install in available space, and operate within proposed levels:** NO FORSEEABLE DIFFICULTIES

3. SOLVENT RECOVERY

a. **Control Device:** CARBON ADSORBER

b. **Operating Principles:** PHYSICAL ADSORPTION

c. **Efficiency:**[1] 85-90%

d. **Capital Cost:** $600,000.00-$700,000.00

e. **Useful Life:** 10-15 YEARS

f. **Operating Cost:** NOT AVAILABLE AT THIS WRITING

g. **Energy:**[2] NOT AVAILABLE FROM BUDGET QUOTATION

h. **Maintenance Cost:** NOT AVAILABLE

i. **Availability of construction materials and process chemicals:** AVAILABLE

j. **Applicability to manufacturing processes:** APPLICABLE WITH PROCESS MODIFICATIONS

k. **Ability to construct with control device, install in available space, and operate within proposed levels:** NO FORSEEABLE MAJOR OBSTACLES TO INSTALLATION

4.

a. **Control Device:**

b. **Operating Principles:**

c. **Efficiency:**[1]

d. **Capital Costs:**

e. **Useful Life:**

f. **Operating Cost:**

g. **Energy:**[2]

h. **Maintenance Cost:**

i. **Availability of construction materials and process chemicals:**

j. **Applicability to manufacturing processes:**

k. **Ability to construct with control device, install in available space, and operate within proposed levels:**

F. **Describe the control technology selected:** LOW SOLVENT TECHNOLOGY

1. **Control Device:** FORMULATE TO GIVEN SPECIFICATION

2. **Efficiency:**[1] NOT APPLICABLE

3. **Capital Cost:** $10,000.00

4. **Useful Life:** CONTINUING

5. **Operating Cost:** $20,000.00

6. **Energy:**[2] NOT APPLICABLE

7. **Maintenance Cost:** NOT APPLICABLE

8. **Manufacturer:** NOT APPLICABLE

9. **Other locations where employed on similar processes:** NONE KNOWN

a. (1) **Company:** NOT APPLICABLE

(2) **Mailing Address:**

(3) **City:**

(4) **State:**

---

[1] Explain method of determining efficiency.
[2] Energy to be reported in units of electrical power - KWH design rate.

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

b. (1) Company:

(2) Mailing Address:

(3) City: (4) State:

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

10. Reason for selection and description of systems:

[1] Applicant must provide this information when available. Should this information not be available, applicant must state the reason(s) why.

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

NOT APPLICABLE

A. Company Monitored Data

1. ____________ no. sites ____________ TSP ____________ ( ) SO^2* ____________ Wind spd/dir

Period of Monitoring ______/______/______ to ______/______/______
month day year month day year

Other data recorded ____

Attach all data or statistical summaries to this application.

*Specify bubbler (B) or continuous (C).

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? ☐ Yes ☐ No

b. Was instrumentation calibrated in accordance with Department procedures?

☐ Yes ☐ No ☐ Unknown

B. Meteorological Data Used for Air Quality Modeling

1. ______ Year(s) of data from ____/____/____ to ____/____/____
month day year month day year

2. Surface data obtained from (location)______________________________

3. Upper air (mixing height) data obtained from (location)______________________________

4. Stability wind rose (STAR) data obtained from (location)______________________________

C. Computer Models Used

1. ______________________________ Modified? If yes, attach description.

2. ______________________________ Modified? If yes, attach description.

3. ______________________________ Modified? If yes, attach description.

4. ______________________________ Modified? If yes, attach description.

Attach copies of all final model runs showing input data, receptor locations, and principle output tables.

D. Applicants Maximum Allowable Emission Data

Pollutant	Emission Rate	
TSP	______________________________	grams/sec
SO^2	______________________________	grams/sec

E. Emission Data Used in Modeling

Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review.

G. Discuss the social and economic impact of the selected technology versus other applicable technologies (i.e., jobs, payroll, production, taxes, energy, etc.). Include assessment of the environmental impact of the sources.

H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

VOLATILE ORGANIC COMPOUND EMISSION CALCULATIONS

APPENDIX I

Maximum Potential Emissions

Spreader #1

Maximum VOC loading in lbs./min. during spreading: 4.3 lbs./min. = 258 lbs./hr

Actual spreading time: 15% of operating time (from time study)

Potential operating parameters:
16 hours/day
250 days/year
5 days/week

Use Calculation:

16 hrs./day x .15 = 2.4 hrs./day in spread mode

2.4 hrs./day x $\frac{60\text{ min.}}{1\text{ hr.}}$ x 4.3 lbs./min. during spreading = 619.20 lbs./day emission (maximum potential)

619.20 lbs./day x 250 days/yr. = 154,800 lbs./yr. = $\boxed{\text{77.4 tons/yr.}}$

Spreaders #2 and #3

Maximum VOC loading in lbs./min. during spreading: 14 lbs./min. = 840 lbs./hr

Actual spreading time: 15% of operating time (from time study)

Potential operating parameters:
16 hours/day per spreader
250 days/year per spreader
5 days/week per spreader

Use Calculation:

16 hrs./day x .15 = 2.4 hrs./day in spread mode

2.4 hrs./day x $\frac{60\text{ min.}}{1\text{ hr.}}$ x 14 lbs./min. = 2016 lbs./day emission-maximum potential

2016 lbs./day x 250 days/yr. = 504,000 lbs./yr. = $\boxed{\text{252 tons/yr.}}$ per spreader

2 spreaders x 252 tons/year = $\boxed{\text{504 tons/yr.}}$ for spreaders #2 and #3 - Maximum potential

Festooning Area

The festooning area routinely flashes off one pass worth of solvent per day/blanket. Four blankets would be placed into festooning each day on a two shift operation. Process records indicate that a maximum of 10 lbs. of solvent per blanket enters the festooning area. The blankets leave nearly solvent free. Therefore maximum potential solvent emissions would approximate.

4 blankets/day x 250 days/yr. x 10 lbs. solvent/blanket = 10,000 lbs./yr. = $\boxed{\text{5 tons/yr.}}$

Mixing Area

Emissions from the mixing area can be expected to approximate 12 tons/yr. maximum potential by estimate. This would include both local and general room exhausts. 10 T/yr. can be associated with local mixing tank exhaust and 2 T/yr. can be associated with general room exhaust.

Emission Point Allocation

Emission Point <1> :

Emission point <1> captures 25% of the VOC exhaust from spreaders #2 and #3, 100% of the VOC exhaust emissions from spreader #1, 100% of the festooning area VOC exhaust and 100% of general room exhaust from the mixing area.

Emission Point 1 Total = (spreader (# 1 : 77.4 T/yr.) + (spreaders (2 and 3) 504 T/yr. x .25) + (festooning 5 tons/yr.) + (mixing general 2.0 T/yr.) = 210 T/yr.

Emission Point <3> :

Emission Point <3> captures 100% of the VOC exhaust from the mixing room tanks. This emission can be expected to approximate a maximum potential emission of 10 tons/yr.

Emission Point <4> :

Emission point <4> captures 75% of spreader #2's exhaust. Therefore maximum potential emission from emission point <4> would be

252 T/yr. x .75 = 189 tons/yr.

Emission Point <5> :

Emission point <5> captures 75% of spreader #3's exhaust. Therefore maximum potential emission from emission point <5> would be

252 T/yr. x .75 = 189 tons/yr.

Maximum Lbs./Hr. Calculation

Emission Point <1> :

a) Spreader #1 maximum spreading time/hr. = 9.0 min./hr.
Spreader #1 maximum solvent use/min. = 4.3 lbs./min.
Spreader #1 emission point collection % = 100%
9.0 min./hr. x 4.3 lbs./min x 1.0 = 38.7 lbs./hr.

b) Spreader #2 maximum spreading time/hrs. = 9.0 min./hr.
Spreader #2 maximum solvent use/min. = 14.0 lbs./min.
Spreader #2 emission point collection % = 25%
9.0 min./hr. x 14.0 x .25 = 31.5 lbs./hr.

c) Spreader #3 maximum spreading time/hr. = 9.0 min./hr.
Spreader #3 maximum solvent use/min. = 14.0 lbs./min.
Spreader #3 emission point collection % = 25%
9.0 min./hr. x 14.0 x .25 = 31.5 lbs./hr.

d) Mixing general exhaust 2 T/yr. = 4000 lbs./hr. ÷ 250 days/yr. = 16
16 lbs./day ÷ 16 hrs./day = $\boxed{\text{1 lb./hr.}}$

TOTAL MAXIMUM LBS./HR. = a + b + c + d
= $\boxed{\text{103 lbs./hr}}$.

Emission Point ◇3 :

Total annual emission = 10 T/yr. = 20,000 lbs./yr.

20,000 lbs./yr. ÷ 250 days/yr. = 80 lbs./day ÷ 16 hrs./day = $\boxed{\text{5.0 lbs./hr.}}$

Emission Point ◇4 :

Spreader #2
Maximum spreading time/hr. = 9.0 min./hr.
Spreader #3
Maximum solvent use/min. = 14.0 lbs./min.
Spreader #2
Emission point collection % = 75%

9.0 min./hr. x 14.0 lbs./min. x .75 = $\boxed{\text{94.5 lbs./hr.}}$

Emission Point ◇5 :

Spreader #3 maximum spreading time/hr. = 9.0 min./hr.
Spreader #3 solvent use/min. = 14.0 lbs./min.
Spreader #3 emission point collection % = 75%

9.0 min./hr. x 14.0 lbs./min. x .75 = $\boxed{\text{94.5 lbs./hr.}}$

Actual Tons/Yr.

The facility currently operates at approximately 40% of its emitting potential. Therefore, potential T/yr. are multiplied by .40 to obtain actual emissions.

Emission Point	Potential Emissions	x	Actual Emissions .40
◇1	210 T/yr.		84 T/yr.
◇3	10 T/yr.		4 T/yr.
◇4	189 T/yr.		75.6 T/yr.
◇5	189 T/yr.		75.6 T/yr.
	598		

TOTAL ACTUAL TONS/YR. = 239.2

Total VOC/yr. figures correlate well with 1982/83 purchasing records for VOC raw materials. Current 1983 use projections would approimate 240 T/yr.

APPENDIX II CONT.
PROCESS FLOW EXPLANATION

Step ① Rubber is milled into sheets for use in cement making. No calculation of emissions is included in this application since only particulate emissions would be regulated and this source is a minor one which will be dealt with separately from VOC emissions.

How PM controlled

Step ② Rubber is combined with VOC (MEK/Toluene) and mixed to the desired viscosity for spreading.

AP How stored & transferred?

Step ③ Rubber cement is spread on cotton fabric in repeated passes of varying thicknesses utilizing a knife type applicator. This step forms the blanket carcass. VOC flashes off due to steam heated coils and is captured by overhead hoods.

How steam produced ?

Steps ④ & ⑤ Carcass is finished and moved in roll form to face spreaders 2 and 3 where top or face coats are applied to the blanket, solvent flashes off as in Step 3. The final pass is not dried, rather it is talced and recoiled with interleaving paper at which point it moves to Step 6.

Step ⑥ The blanket is then unrolled and hung open in the festooning area where the final pass dries. The blanket is virtually solvent free after 16 hours of air drying time.

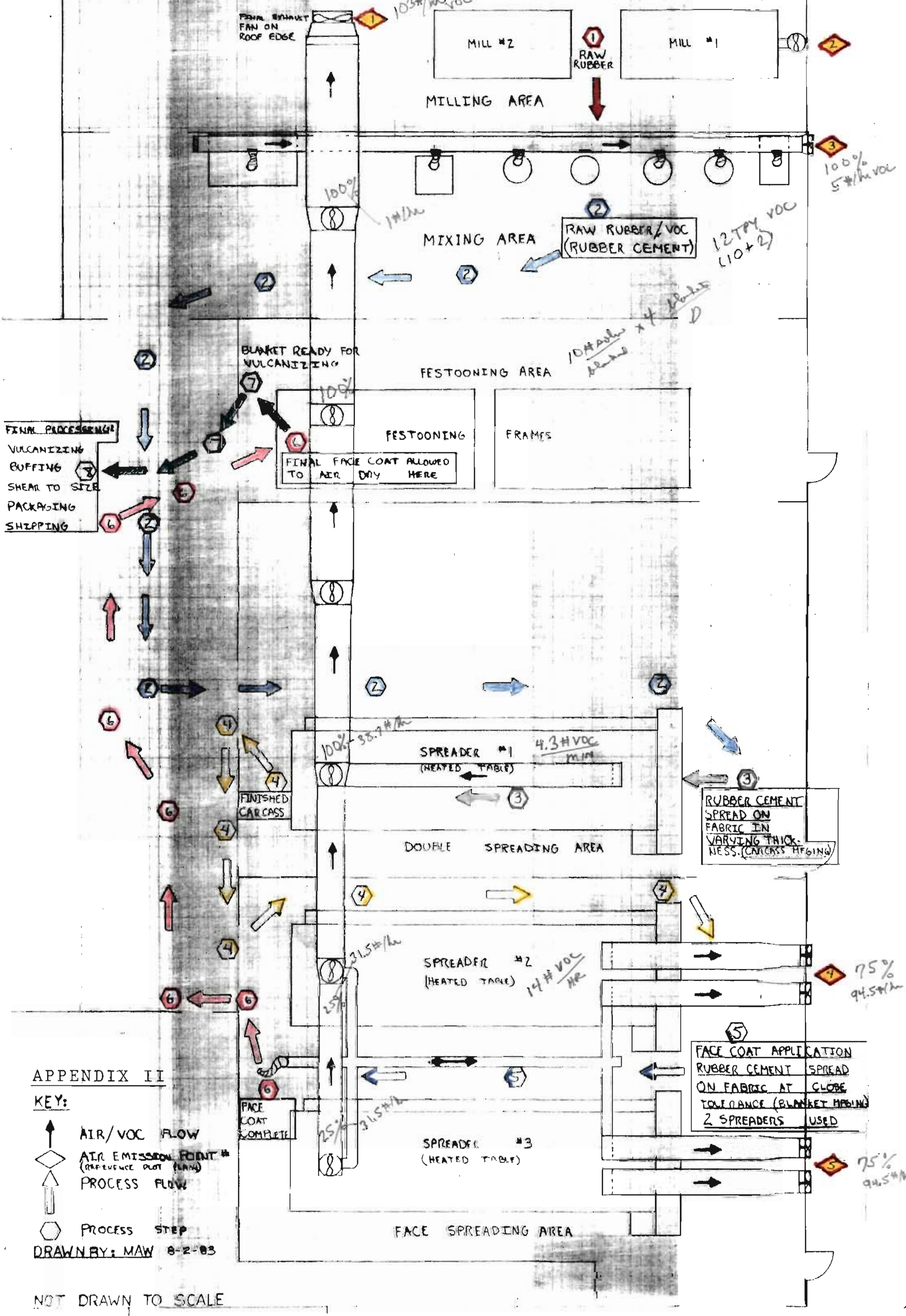
Step ⑦ The blanket is once again rolled up and is put into a vulcanizer which is actually an autoclave which puts the final cure on the blanket.

Source of heat

Step ⑧ Following final cure the blanket may be buffed or sheared and then packaged for shipping.

PM control

PROCESS LAYOUT AND FLOW DIAGRAM: VOC DATA

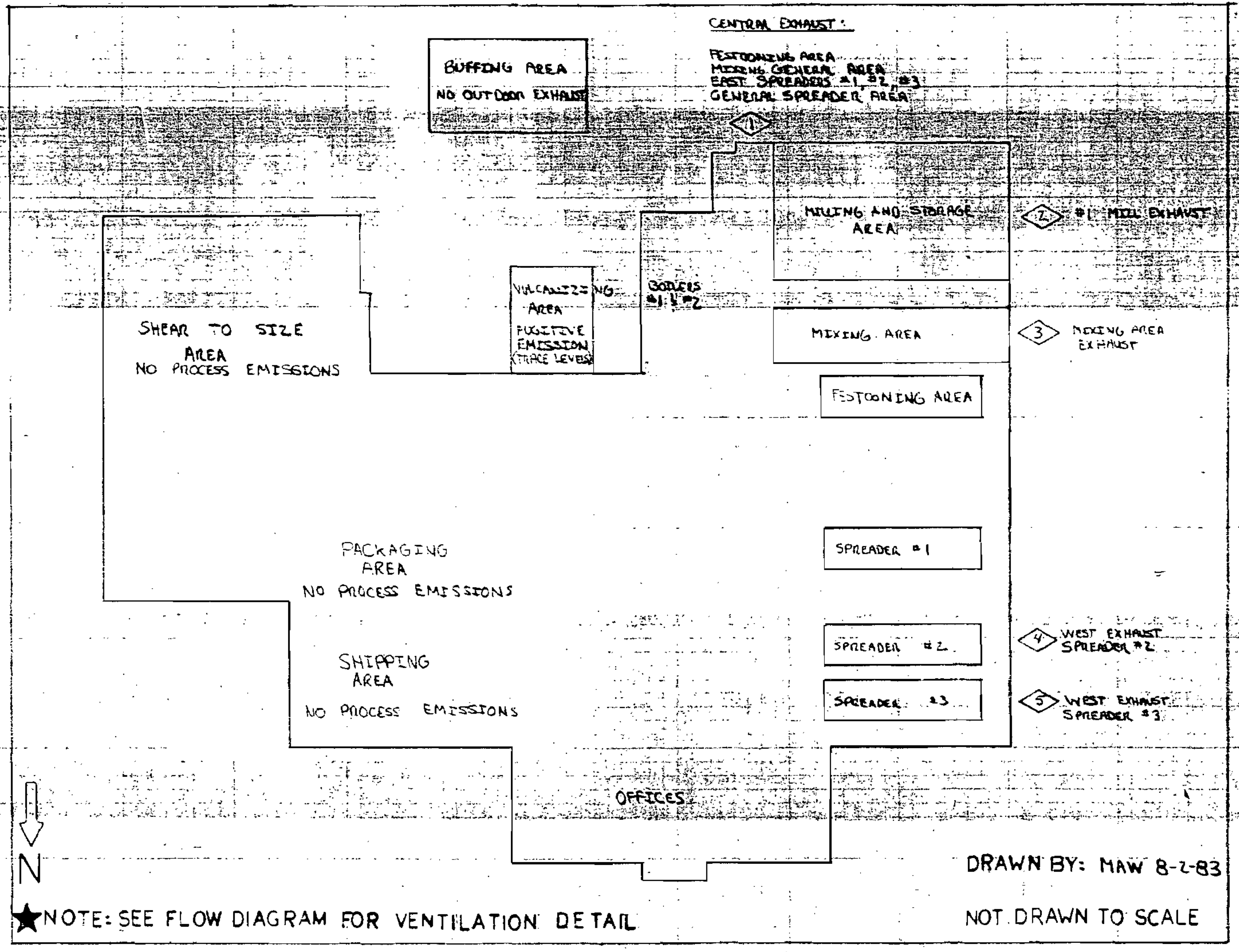


APPENDIX II

Best Available Copy

APPENDIX III

PROCESS LAYOUT AND EMISSION POINTS: ◇

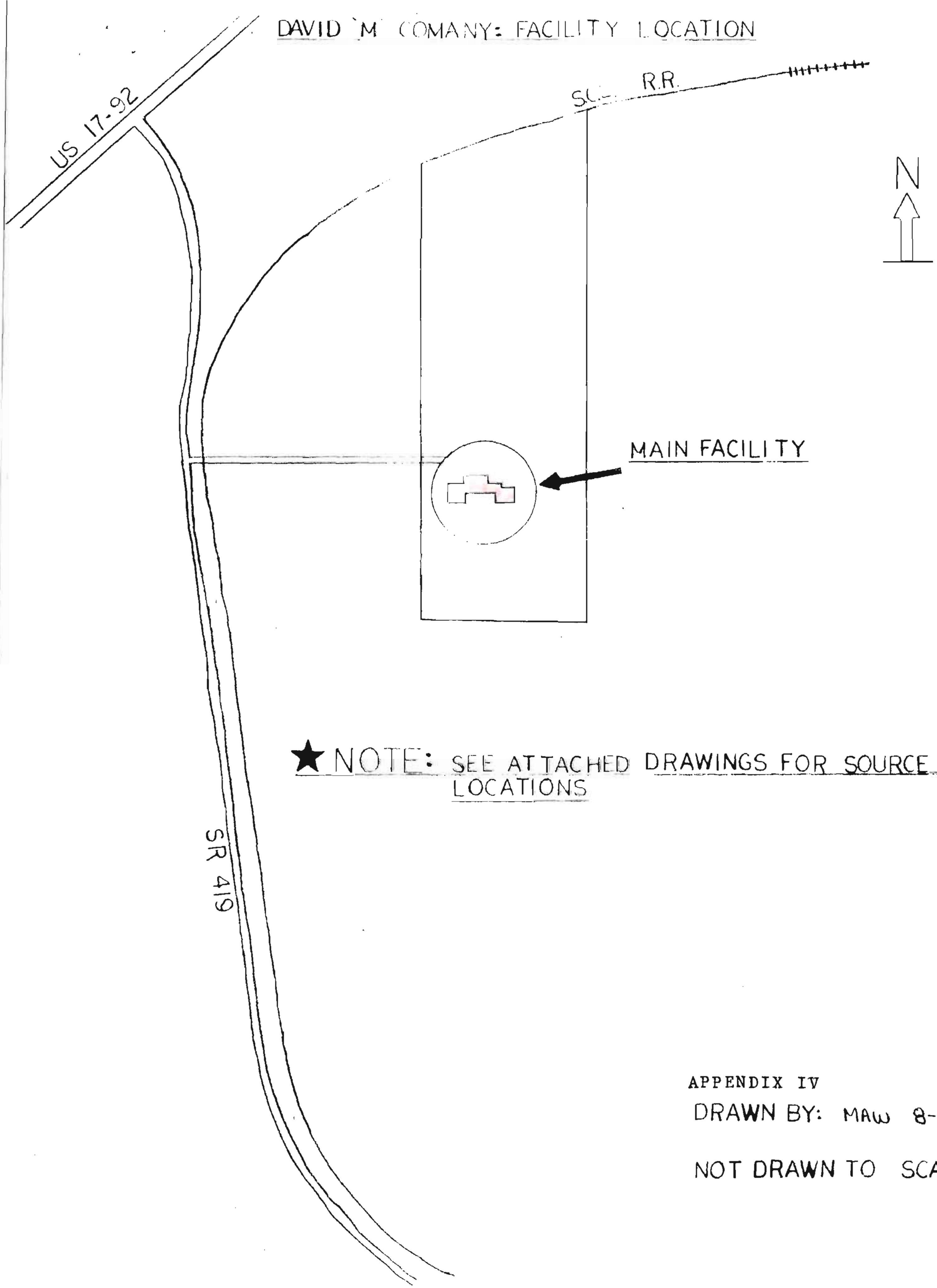


DRAWN BY: MAW 8-2-83

NOT DRAWN TO SCALE

★NOTE: SEE FLOW DIAGRAM FOR VENTILATION DETAIL

DAVID `M` COMANY: FACILITY LOCATION

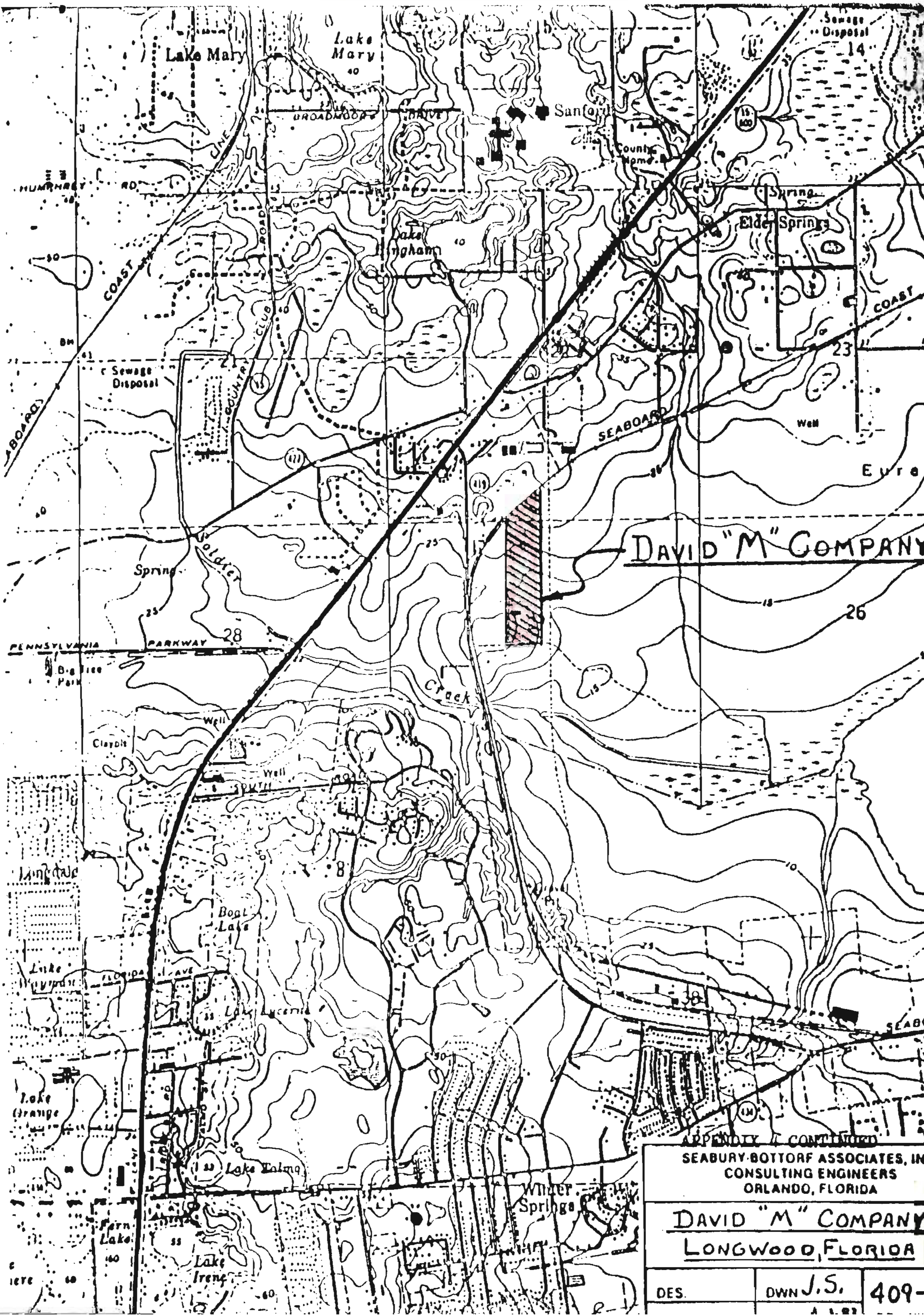


★ NOTE: SEE ATTACHED DRAWINGS FOR SOURCE LOCATIONS

APPENDIX IV

DRAWN BY: MAW 8-2-83

NOT DRAWN TO SCALE



APPENDIX C CONTINUED

SEABURY-BOTTORF ASSOCIATES, IN
CONSULTING ENGINEERS
ORLANDO, FLORIDA

DAVID "M" COMPANY
LONGWOOD, FLORIDA

DES.
DWN J.S.
409-

% voc in raw mat'l.

COMPOUND	# SAMPLES ANALYZED	AVG LBS. TOLUENE/100 LBS.	AVG LBS RUBBER/ 100 LBS.
7002	48	58.9	41.1
5503	22	63.7	36.3
1101	48	47.8	52.2
6607	40	63.4	36.6
1100	23	49.3	50.7
1492	20	61.2	38.8
6609	31	66.5	33.5
106E	1	63.3	36.7
7001	2	62.1	37.9
108	12	32.7	67.3
1280	12	57.1	42.9
106	9	65.6	34.4
105	13	33.8	66.2
3303	2	64.9	35.1
7007	7	62.0	38

Note: Encompasses all but 3 compounds currently used in production and would be a suitable cross section of those compounds used most frequently.

8. How many pounds of volatile organic compounds will be in a gallon of applied coating?

The chart below delineates lbs. solvent/gallon of applied coating for the most frequently used compounds.

#VOC/gal

COMPOUND	HI	LO	AVERAGE	NUMBER TESTED
7007	5.6	4.8	5.3	16
5503	6.1	5.4	5.7	8
6607	5.8	4.6	5.2	21
1492	5.4	4.6	5.2	4
3303	5.3	5.6	5.4	2
1280	5.1	4.9	5.0	2
1100	5.6	4.6	4.9	9
1101	5.0	4.3	4.7	16
105	4.1	3.8	3.9	9

* The above examples are typical of those compounds current in use, however, they do not include all compounds currently in use.

9. a) How will Talc be received, stored and conveyed to the process?

Talc is received, stored and conveyed to the process in 55 pound bags.

talc

b) What air pollution control equipment or operation practices will be used to minimize Talc emissions?

S.E. or plant description.

Appendix III contains a drawing of the bag house and ancillary piping and collectors to be used in the talcing operation for the purpose of dust collection.

c) How much Talc will be emitted to the atmosphere?

I/c talc emissions?

Talc emissions will be fugitive since the collector will be located in-doors. The dust collector supplier is being contacted in order to ascertain estimated collection and removal efficiencies for the purpose of a fugitive emissions estimate. We will transmit that information to you as soon as it becomes available.

10. Will solvent laden air discharged from the plant contain any particulates or oil mist?

PM

I/c How much PM

The solvent laden air will contain only fugitive particulates and no oil mist. Should solvent recovery be the selected control device, air discharged will be filtered at an efficient removal level of 99.0%+ of particles ≥.3 microns in diameter.

11. a) What will be the particulate and VOC emissions from emission point No. 2 mills?

No. 2 mill Emissions

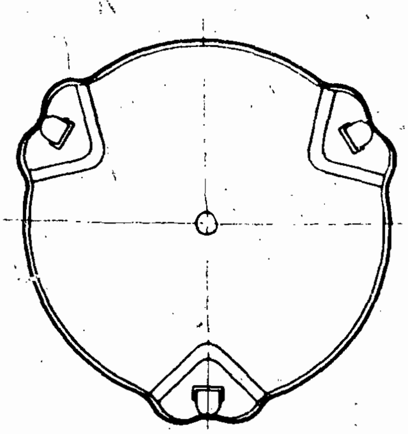
Particulate and VOC emissions combined from the milling operation would approximate 1.7 - 8.0 lbs/day. These numbers were generated by weighing all the individual components to be added to a batch before milling and then weighing the total batch post milling and noting the lost material. The plasticizers used in the milling process are not appreciably volatile. Appendix IV contains several example data sheets on plasticizers commonly used in the milling operation and Appendix V contains volatility data on many plasticizers used in the rubber industry.

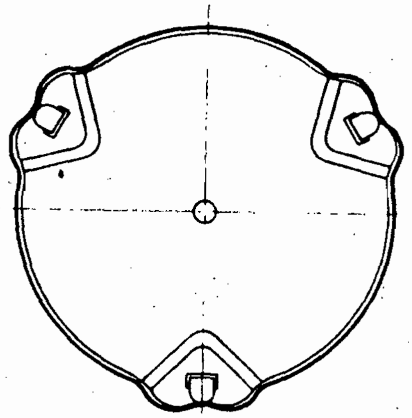
b) What control equipment will be used to limit particulate emissions from the mills?

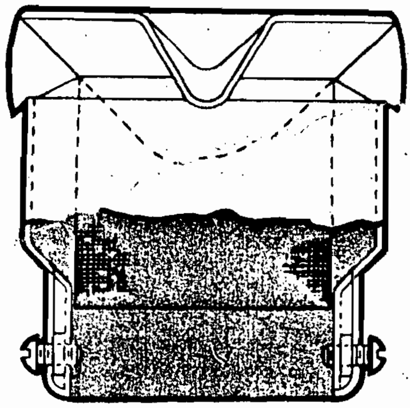
No PM from mills (limit VE)

Since nearly all rubber compounds are compounded from masterbatches, particulate emissions are quite low and as such no control devi~~d~~ce is currently proposed for the operation, see (11a) above.

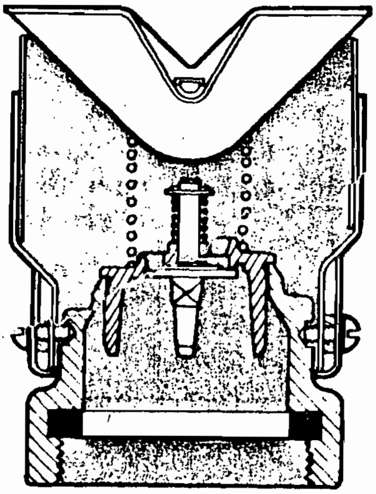
OPW 23







OPW 23



OPW 523

OPW 523

OPW 23, 523, 523-S VENTS

The OPW 23 Vent has an aluminum body and a 40-mesh brass screen. The OPW 23 is an open vent and directs vapors upward in accordance with NFPA Code 30. Set screws make installation easy. Available in 1½", 2" and 3" sizes.

The OPW 523 Pressure Vacuum Vent is an upward vapor discharge vent and is available with either an 8 oz. or 12 oz. pressure setting and a ½ oz. vacuum setting.

The 523 is available in 2" size, and is attached to the 2" threaded vent pipe.

The OPW 523-S Pressure Vacuum Vent is similar to the 523 above, except it is attached to the vent line with set screws rather than pipe threads. A gasket is provided.

Available in 2" size.

The rated maximum flow pressure drop for all OPW 523 Vents is 28 oz. per square inch at 7000 SCFH.

Wheelabrator-Frye Inc.
Graphic Supplies Division
7520 University
Des Moines, Iowa 50311
Tel.(515) 274-4901

November 1, 1983

DER
NOV 03 1983
BAQM

Mr. Willard Hanks
Engineer
State of Florida
Department of Environmental Regulation
2600 Blair Stone Road
Twin Towers Building
Tallahassee, FL 32301

Dear Mr. Hanks:

I'd like to take this opportunity to thank you, Bill Thomas and Nancy Wright for the courtesies extended myself and Herb Mycroft during the course of our recent meeting in Tallahassee. In accordance with our conversations at that time, please find enclosed additional data gathered pursuant to Mr. C.H. Fancy's request for same dated September 2, 1983.

Should you require further information and/or assistance in processing David "M" Company's air pollution permit application, please don't hesitate to contact me directly.

Sincerely,

Michael A. Ware

Michael A. Ware
Graphics Div. Env. Coord.
Chemicals & Coatings Group
Wheelabrator-Frye, Inc.

MAW;bjw
Encl.

cc: Wayne Brady
Jerry Spangler
Herb Mycroft
Bob Baddeley
J. H. Gamble
T. J. Lucas

11/1/83

SUPPLEMENT TO DAVID 'M' COMPANY
APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

Prepared By: Michael A. Ware

1. What will be the maximum production and operation time (hour/day) of the plant?

may be wrong 300 #/hr 30 #/hr per mo calc

no process weight

The maximum uncontrolled emissions of the plant will be 300 tons/year based upon a two shift, 16 hours/day operation. The potential emissions incorporating an end of pipe control device capable of delivering 90% removal efficiency would approximate 30 tons/year. The 300 ton/year two shift operation is based upon the following historical information:

YEAR	OPERATING HOURS/DAY	ESTIMATED % NORMAL BUSINESS VOLUME	ANNUAL EMISSIONS
1982	10	90%	271 Tons
1983	16	80%	255 Tons (Annualized Estimate)

2. What percent of the maximum production was the emission and raw material data in the application based upon?

30 TPY VOC Emission

The application was based upon 80% of the historically derived 300 tons/year uncontrolled emission number and reflected current economic conditions which approximate 70-80% of the usual demand for lithographic printing blankets. Should blanket demand return to 100% of the normal level, 300 tons uncontrolled and/or 30 tons controlled would approximate annual emissions without subtracting rubber cement containing VOC's which are disposed of at Emille, Alabama.

?

3. Will solvents other than MEK and Toluene be used at this plant?

Yes, small amounts of Naptha and Isopropyl Alcohol will be used at this facility for the purpose of manually cleaning blankets during inspection. The additional fugitive type emissions from the use of these materials will approximate

Limit Other VOC

5,000 lbs/yr	Ispropyl Alcohol
2,000 lbs/yr	Naptha

4. How many gallons per year of each solvent will be consumed at the maximum production of the plant?

83,000 gal Toluene x 7.2#/gal = 298.8 TONS

84000 Gallons MAX prod of plt

Approximately 75,000 gallons Toluene and 9,000 gallons MEK will be used at the maximum production of the plant. Were the use of MEK to be discontinued in order to facilitate efficient recovery of Toluene, approximately 83,000 gallons of Toluene would be used annually at the maximum production of the plant.

5. How will the solvents be shipped to the plant? Submit a drawing showing the storage area and piping to the mixing area.

The solvents will be shipped via bulk tanker and Appendix I is a conceptualization of the storage area and piping to the mixing area.

6. a) How many storage tanks will be built at the plant?

storage tanks

Five, two for #2 diesel fuel, two for Toluene storage and one for MEK storage.

b) What air pollution control equipment will be used to minimize VOC emissions from the tanks?

S.C. or plt description storage tank controls

?

A coaxial vapor recovery system of the type 1 or 2 nature will be installed to minimize VOC emissions during off loading. In addition, an OPW 523, or 523 - S pressure vacuum vent will be installed on each tank vent line to minimize VOC emissions during storage. Appendix II contains example information on coaxial vapor recovery and OPW 523 and 523-S vents like those proposed for installation.

c) What will be emissions be from the tanks? Submit emissions calculation.

I/C, emission from storage tanks?

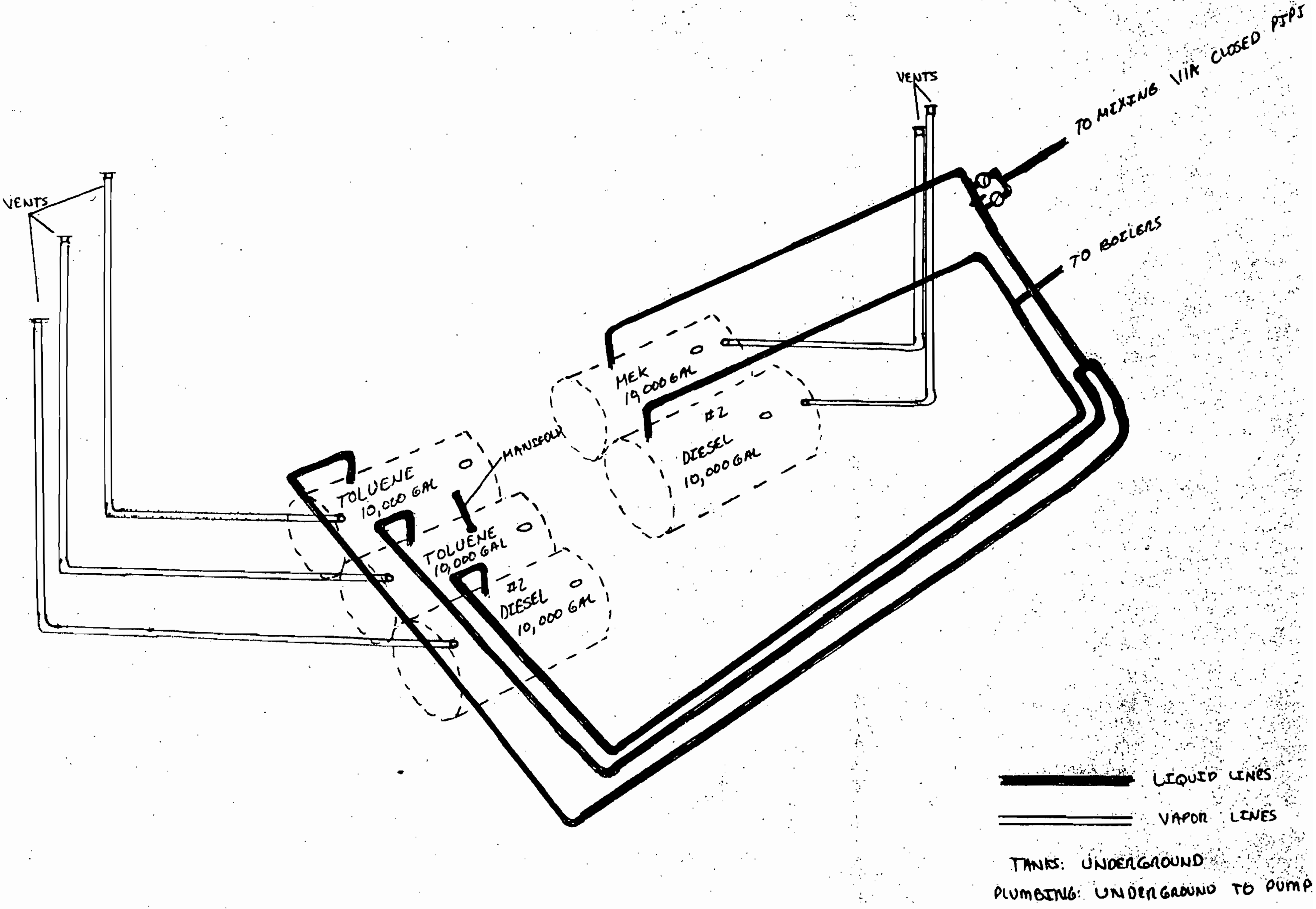
The equipment supplier has not as yet provided information concerning expected emissions from tanks equipped with coaxing recovery and pressure vents. We will endeavor to obtain this information as soon as possible.

7. What will be the mixing ratio of solvent to rubber in lbs/lb?

The chart below outlines the mixing ratio of solvent to rubber on a 100 lb. batch basis.

APPENDIX I

EXISTING SOLVENT STORAGE / DELIVERY SYSTEM



TANKS: UNDERGROUND

PLUMBING: UNDERGROUND TO PUMP

SECTION B

Coaxial Vapor Recovery Equipment

FOR USE IN STAGE I AND STAGE II SYSTEMS

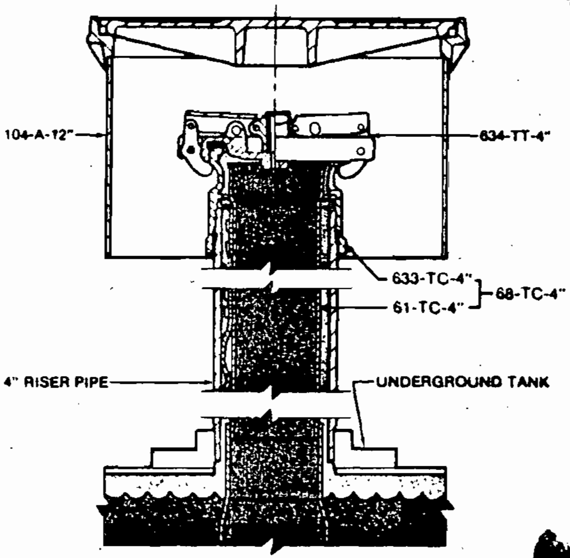
System C

TYPE 1 - 68-TC - 3" & 4" Series Fittings
(Non Poppeted)

TYPE 2 - 68-TCP - 3" & 4" Series Fittings
(Poppeted)

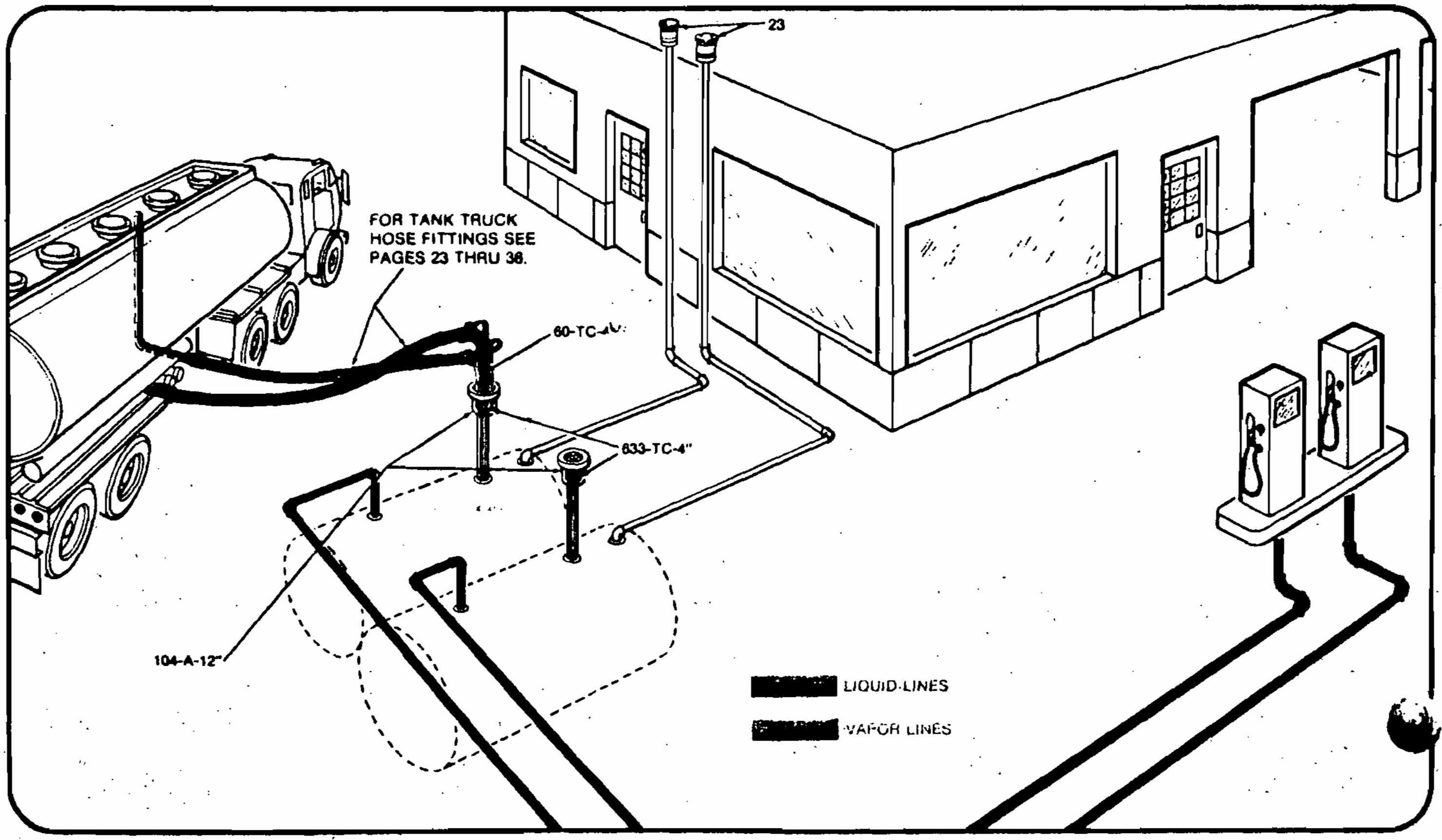
An easy, inexpensive means to convert existing conventional 3" & 4" size underground storage tank fill pipes to coaxial installations. Normally little to no digging or tearing up of concrete is necessary. Simply remove existing tight fill adaptor and fill pipe (if installation is so equipped), inserting Type 1 or Type 2 coaxial fill tube and adaptor as required.

NOTE: Type 2 poppeted fittings are certified by California Air Resources Board (CARB)



TYPE 1 68-TC - 4" SERIES (NON-POPPETED) FITTINGS

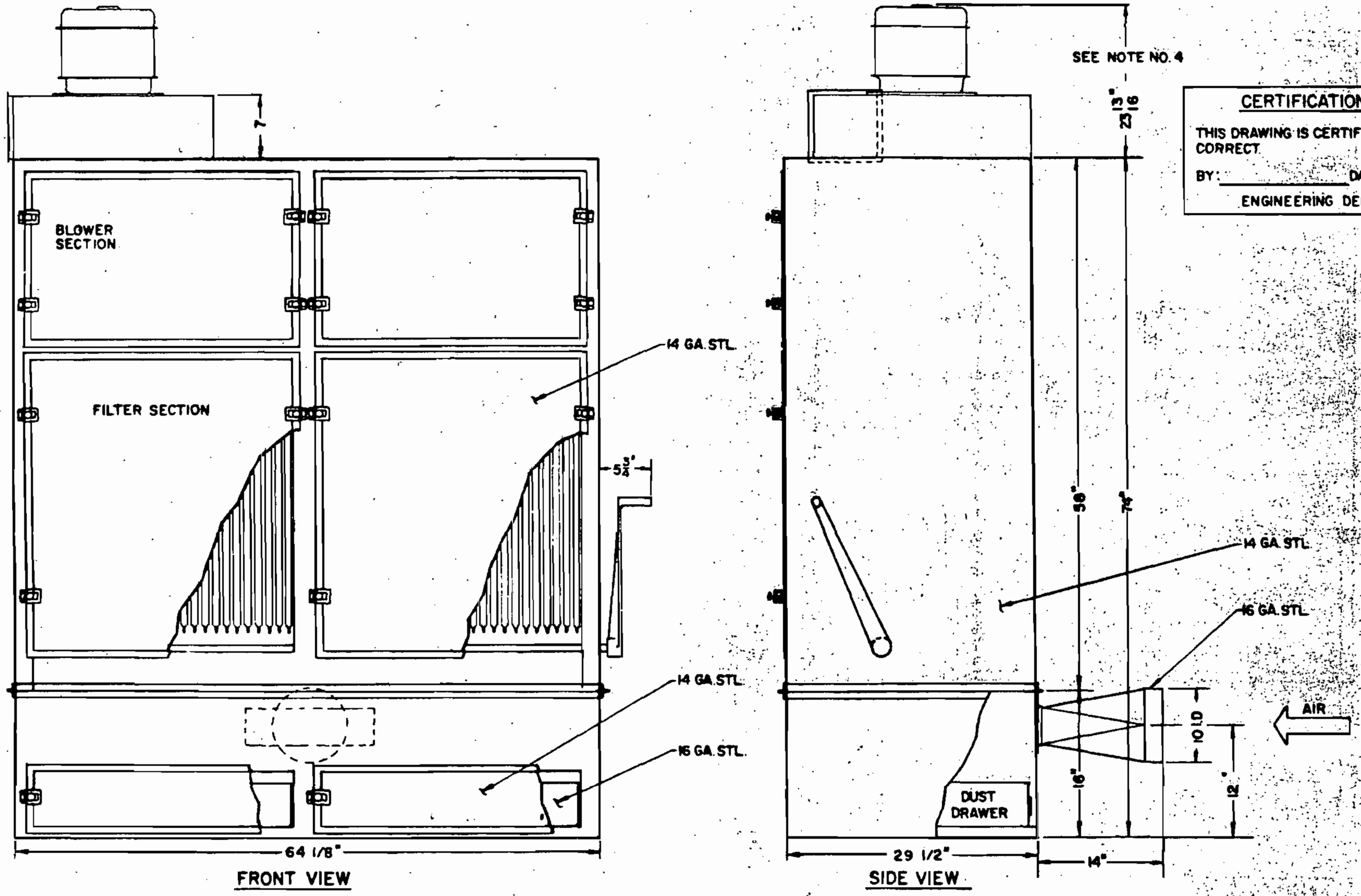
SHOWN BELOW IS A TYPE 1 - 68TC-4" TYPICAL INSTALLATION



FOR TANK TRUCK HOSE FITTINGS SEE PAGES 23 THRU 38.

APPENDIX III

talc bag Collector



FRONT VIEW

SIDE VIEW

CERTIFICATION

THIS DRAWING IS CERTIFIED TO BE CORRECT.

BY: ______ DATE: ______

ENGINEERING DEPT.

MULTIPLE RATING TABLES

C.F.M.	F.P.M.	EXT. S.P.	C.F.M.	F.P.M.	EXT. S.P.
3625	6654	4.65	1912	3351	12 15
3365	6179	5.70 *			
2995	5491	7 38			
2390	4386	9 95			

*

SPECIFICATIONS

1. MOTOR SHALL BE 10 HP ON NO. 124-20 5-10 3600 RPM, 230-460/60/3.
2. DUST STORAGE CAPACITY SHALL BE 4.4 CU. FT.
3. FILTER AREA SHALL BE 400 SQ. FT. (40 FILTERS 30" x 24" EACH.)
4. NET WT. 1100 SHIPPING WT. 1475

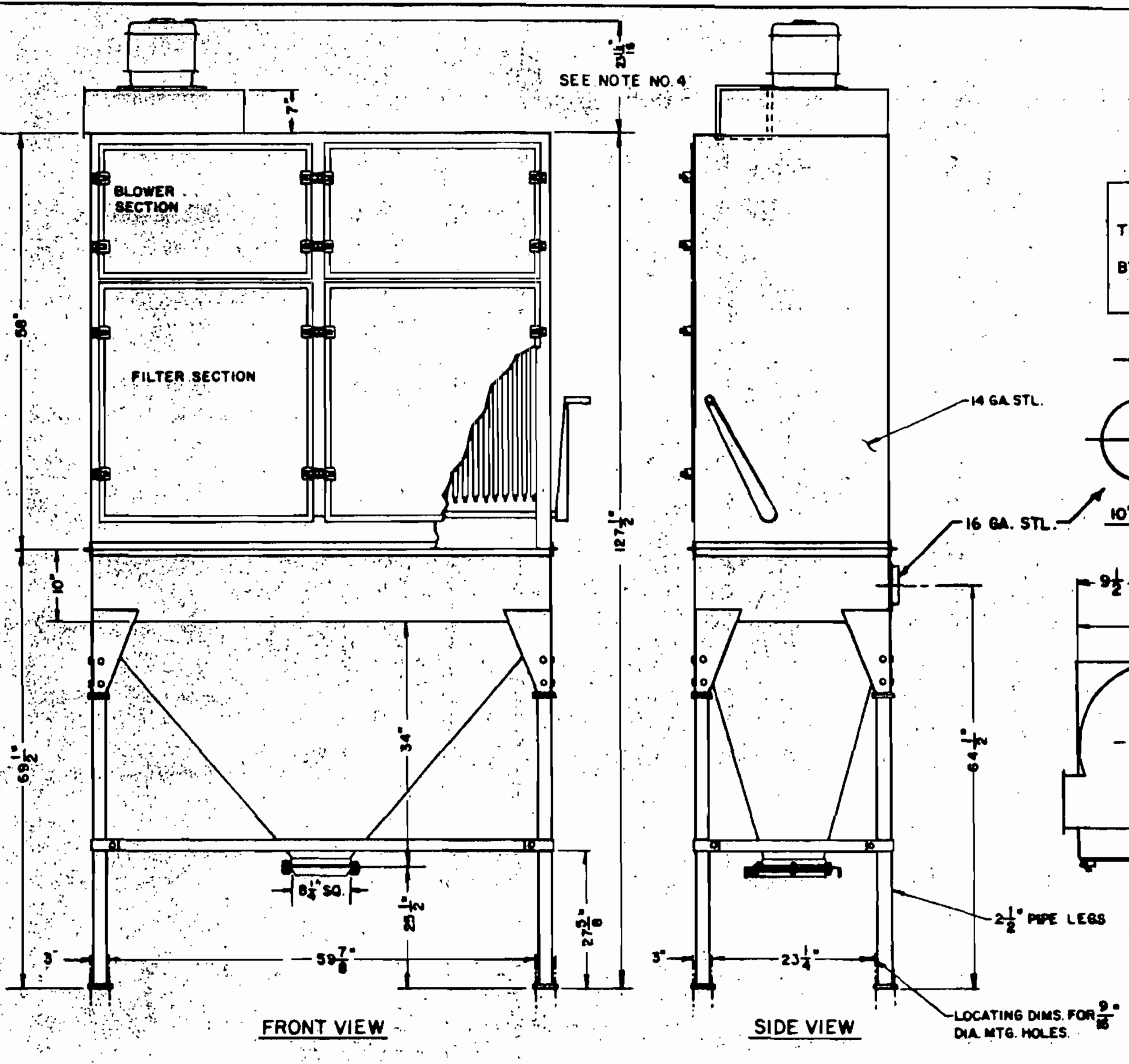
NOTES

1. THIS DRAWING IS FOR A 124-20-5-10 DUST COLLECTOR ANY DEPARTURE FROM THIS DESIGN SHALL REQUIRE SPECIAL FABRICATION AND AN INCREASE IN COST.
2. THIS DRAWING IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES UNLESS PROPERLY SIGNED BY TORIT.
3. ALLOW A MIN. CLEARANCE OF 5" HEAD ROOM FOR REMOVAL OF MOTOR & WHEEL ASS'Y
4. MOTOR HEIGH BASED ON STOCK, CAN VARY WITH MFRS.

TORIT DIVISION, DONALDSON COMPANY, INC.
P.O. BOX 1299 - MINNEAPOLIS, MINNESOTA 55440

SPECIFICATION CONTROL DRAWING
NO. 124-20-5-10 DUST COLLECTOR

DRAWN: T
APP'D:
DRWG. NO: 124-020
REV. E 2-25-72

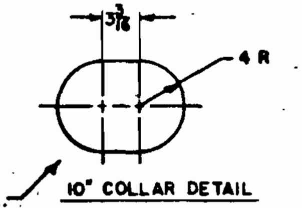


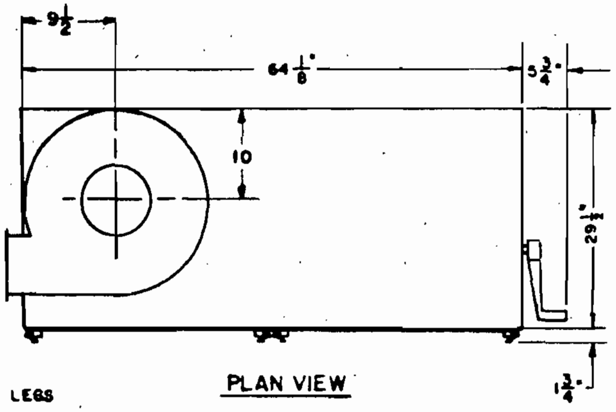
CERTIFICATION

THIS DRAWING IS CERTIFIED TO BE CORRECT.

BY:____________________ DATE:________

ENGINEERING DEPT.





MULTIPLE RATING TABLES

C.F.M.	F.P.M.	EXT. S.P.	C.F.M.	F.P.M.	EXT. S.P.
3625	6654	4.65	1912	3351	12.15
* 3365	6179	5.70 *			
2995	5491	7.38			
2390	4386	9.95			

SPECIFICATIONS

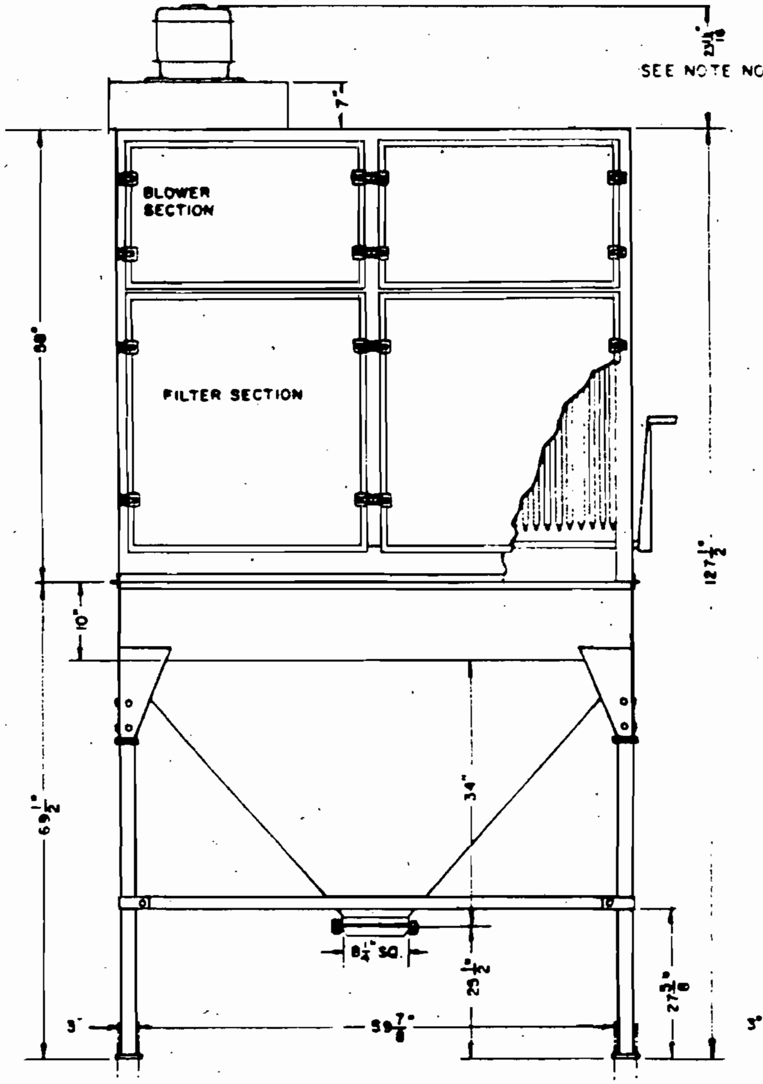
1. MOTOR SHALL BE 10 HP 3600 RPM, 230-460/60/3.
2. HOPPER CAPACITY SHALL BE 16.0 CU. FT.
3. FILTER AREA SHALL BE 400 SQ. FT. (40 FILTERS 30" X 24" EACH)
4. INLET LOCATION: CENTERED ON BACK OR CENTERED ON EITHER END
5. NET WT. 1070 SHIPPING WT. 1365
   1100 1405

NOTES

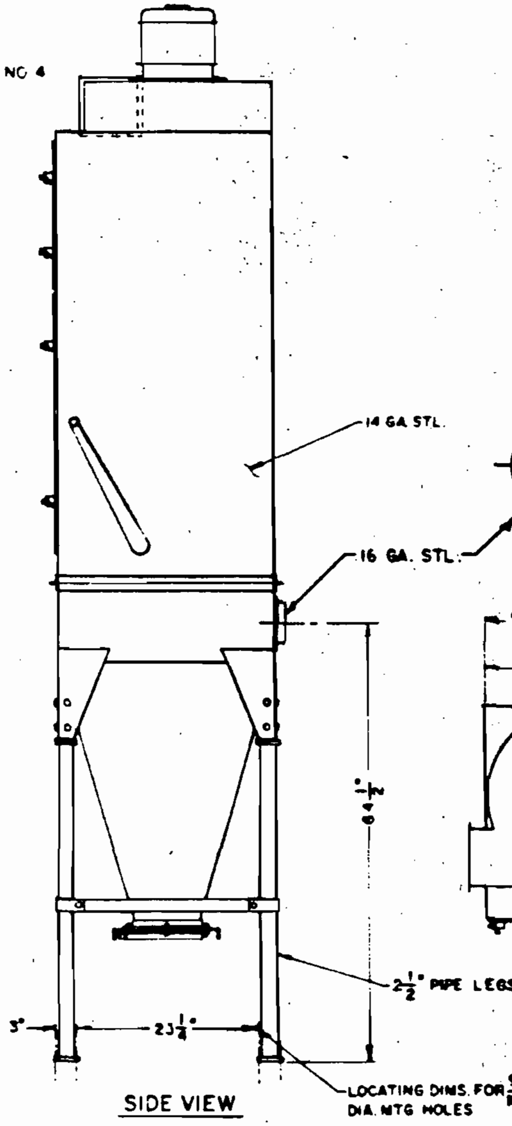
1. THIS DRAWING IS FOR A 124-20-5-10H DUST COLLECTOR. ANY DEPARTURE FROM THIS DESIGN SHALL REQUIRE SPECIAL FABRICATION AND AN INCREASE IN COST
2. THIS DRAWING IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES UNLESS PROPERLY SIGNED BY TORIT.
3. ALLOW A MIN. CLEARANCE OF 5" HEAD ROOM FOR REMOVAL OF MOTOR AND WHEEL ASY
4. MOTOR HEIGHT BASED ON STOCK CAN VARY WITH MFRS.

TORIT DIVISION, DONALDSON COMPANY, INC.
P.O. BOX 1299 · MINNEAPOLIS, MINNESOTA 55440

SPECIFICATION CONTROL DRAWING
NO. 124-20-5-10H DUST COLLECTOR
DRAWN: T. Milm
APP'D: 7/12
DRWG. NO. 124-021
REV. C 1-83



FRONT VIEW



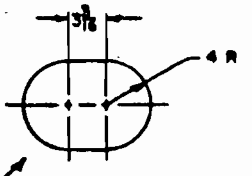
SIDE VIEW

CERTIFICATION

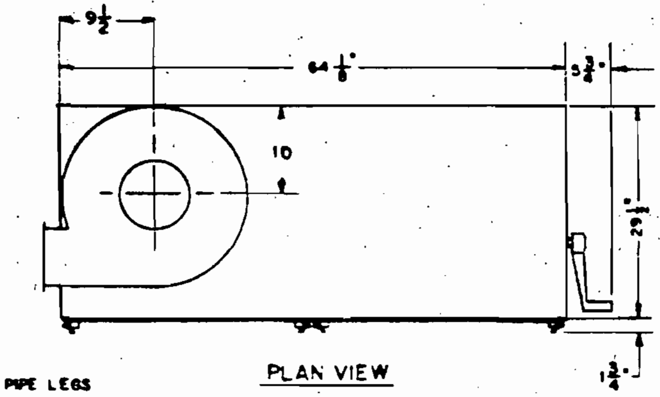
THIS DRAWING IS CERTIFIED TO BE CORRECT.

BY:____________________ DATE:________

ENGINEERING DEPT.



10" COLLAR DETAIL



PLAN VIEW

MULTIPLE RATING TABLES

C.F.M.	F.P.M.	EXT. S.P.	C.F.M.	F.P.M.	EXT. S.P.
3625	6654	4.65	1912	3351	12.15
* 3365	6179	5.70 *			
2995	5491	7.38			
2390	4386	9.95			

SPECIFICATIONS

1. MOTOR SHALL BE 10 HP 3500 RPM, 230-460/60/3.
2. HOPPER CAPACITY SHALL BE 16.0 CU. FT
3. FILTER AREA SHALL BE 400 SQ. FT (40 FILTERS 30" X 24" EACH)
4. INLET LOCATION CENTERED ON BACK OR CENTERED ON EITHER END
5. NET WT. 1070 SHIPPING WT. 1365
   1100 1405

NOTES

1. THIS DRAWING IS FOR A 124-20-5-10H DUST COLLECTOR. ANY DEPARTURE FROM THIS DESIGN SHALL REQUIRE SPECIAL FABRICATION AND AN INCREASE IN COST
2. THIS DRAWING IS NOT CERTIFIED FOR CONSTRUCTION PURPOSES UNLESS PROPERLY SIGNED BY TORIT.
3. ALLOW A MIN. CLEARANCE OF 5" HEAD ROOM FOR REMOVAL OF MOTOR AND WHEEL ASY
4. MOTOR HEIGHT BASED ON STOCK CAN VARY WITH MFRS.

TORIT DIVISION, DONALDSON COMPANY, INC.
P.O. BOX 1299 · MINNEAPOLIS, MINNESOTA 55440

SPECIFICATION CONTROL DRAWING
NO. 124-20-5-10H DUST COLLECTOR
DRAWN: T.W.J.
APP'D:
DRWG. NO. 124-021
REV C 1-82

'ansfer agent: fungistat
plant disease control:
.tant for polyesters.

OOH.
crystals: b.p. sublimes:
in hot water. alcohol.

:) $(C_6H_5)_2CHCN$.
e powder: m.p. 73-
very soluble in alcohol.
.cetic acid: synthesis of

e. See diphenadione.

aniline) $(C_6H_5)_2NH$.
sh crystals. Soluble in
ohol. and ether: insolu-
p. 52.85°C: b.p. 302°C;
on temp. 1173°F: com-

rmula weights of aniline
in autoclave. The prod-
ochloric acid to remove
residue is distilled.
ce and fused.
-lined paper bags: fiber

skin. Tolerance. 10 mg

and accelerators: solid
; dyes: pharmaceuticals:
preservation of apples:
nalytical chemistry.

adamsite: phenarsazine
H)C₆H₄.
stals. Sublimes readily.
. 410°C (dec): insoluble
e. xylene. carbon tetra-

enylamine with arsenic

halation and ingestion:

od treating.
Poison label. Not ac-
Rail) Tear gas label.

$(C_6H_5)_2$.
48-250°C: insoluble in-
oluble in toluene.

ength shifter in solution

ienyl.

$H_2C_6H_4NHC_6H_5$.
soluble in water: slightly
iatic hydrocarbons. Sen-

id fuming sulfuric acid.

See benzidine.
id nitrites.

diphenylbromoarsine $(C_6H_5)_2AsBr$.
Properties: White crystals. M.p. 54–56°C.
Derivation: (a) Hydrobromic acid and diphenylarsenious oxide are heated together for about 4 hours at 115–120°C: (b) by action of arsenic tribromide on triphenyl arsine at 300–350°C.
Hazard: Highly toxic: strong irritant.
Shipping regulations: (Rail. Air) Arsenical compounds, solids. n.o.s.. Poison label.

1,3-diphenyl-2-buten-1-one. See dypnone.

diphenylcarbazide $(C_6H_5NHNH)_2CO$.
Properties: White crystals or flakes. Insoluble in water; soluble in alcohol and benzene. M.p. 173°C. Decomposes in light.
Derivation: Phenylhydrazine and urea.
Use: Determination of copper and other metals.

diphenylcarbinol. See benzhydrol.

diphenyl carbonate $(C_6H_5O)_2CO$.
Properties: White, crystalline solid. Can be halogenated and nitrated in characteristic manner. Readily undergoes hydrolysis and ammonolysis. Soluble in acetone, hot alcohol. benzene, carbon tetrachloride, ether, glacial acetic acid and other organic solvents; insoluble in water. B.p. 302°C; m.p. 78°C; sp. gr. 1.1215 (87.4°C).
Grade: Technical.
Uses: Plasticizer and solvent; synthesis of polycarbonate resins.

diphenylchloroarsine $(C_6H_5)_2AsCl$.
Properties: Colorless crystals or dark-brown liquid, which slowly becomes semi-solid. Decomposed by water (slowly). Soluble in carbon tetrachloride, chloropicrin. phenyldichloroarsine; practically insoluble in water. Sp. gr. 1.363 (40°C) (solid), or 1.358 (45°C) (liquid): b.p. 333°C (in CO_2 atmosphere); m.p. 41°C.
Derivation: Benzene and arsenic trichloride are heated in presence of aluminum chloride.
Grade: Technical.
Hazard: Highly toxic by inhalation; strong irritant to tissue.
Use: Military poison gas.
Shipping regulations: (Rail) Tear Gas label. (Air) Poison label. Not accepted on passenger planes.

diphenyldecyl phosphite $(C_6H_5O)_2POC_{10}H_{21}$.
Properties: Nearly water-white liquid; sp. gr. [illegible] (25/15.5°C); m.p. 18°C; refractive index [illegible] 25/D). Combustible.
Uses: Chemical intermediate; stabilizer for [illegible] and polyolefin resins.

diphenyldichlorosilane $(C_6H_5)_2SiCl_2$.
Properties: Colorless liquid; b.p. 305°C; f.p. [illegible] sp. gr. 1.19 (20°C); refractive index (n 25/D) [illegible] flash point (COC) 288°F. Readily hydroly[illegible] moisture, with liberation of hydrochloric [illegible] Combustible.
Derivation: (a) Reaction of powdered silicon [illegible] chlorobenzene in the presence of copper pow[illegible] catalyst; (b) reaction of phenylmagnesium [illegible] with silicon tetrachloride.
Grade: Technical.
Hazard: Highly toxic: strong irritant to tissue.
Use: Intermediate for silicone lubricants.

Plasticizers

APPENDIX IV

Derivation: Reaction of didodecyldichlorosilane with phenyl lithium.
Hazard: Probably toxic.
Use: High-temperature lubricant.

diphenyldimide. See azobenzene

diphenyldimethoxysilane $(C_6H_5)_2Si(OCH_3)_2$.
Properties: Liquid: sp. gr. 1.080 (25°C): b.p. 191°C (53 mm): refractive index 1.5404 (25°C). Soluble in acetone. benzene. methyl alcohol: combustible.
Hazard: Probably toxic.
Uses: Treatment of powders. glass. paper. and fabrics.

diphenyleneimine. See carbazole

alpha-**diphenylenemethane.** See fluorene.

diphenylene oxide (dibenzofuran) $C_{12}H_8O$ (tricyclic).
Properties: Crystalline solid: m.p. 87°C: b.p. 288°C: insoluble in water: slightly soluble in alcohol. ether and benzene.
Derived from coal-tar.
Hazard: Probably toxic.
Use: Insecticide.

1.1-diphenylethane. See uns-diphenylethane.

1.2-diphenylethane. See sym-diphenylethane.

uns-**diphenylethane** (1.1-diphenylethane) $(C_6H_5)_2CHCH_3$.
Properties: Colorless liquid. Soluble in chloroform: ether. carbon disulfide. B.p. 286°C: sp. gr. 1.004 (20°C): f.p. −21.5°C. Flash point 264°F: combustible.
Derivation: Action of acetaldehyde on benzene in presence of concentrated sulfuric acid.
Uses: Solvent for nitrocellulose: organic synthesis.

sym-**diphenylethane** (bibenzyl: dibenzyl; 1.2-diphenylethane) $C_6H_5CH_2CH_2C_6H_5$.
Properties: White. crystalline needles or small plates. Soluble in alcohol. chloroform. ether. carbon disulfide: insoluble in water. Sp. gr. 0.9782: b.p. 284°C: m.p. 52°C.
Derivation: (a) By treating benzyl chloride with metallic sodium. (b) Action of benzyl chloride on benzylmagnesium chloride.
Use: Organic synthesis.

diphenyl ether. See diphenyl oxide.

diphenylethylene. See stilbene.

N.N-**diphenylethylenediamine** (ethyl diphenyldiamine) $C_6H_5NHCH_2CH_2NHC_6H_5$.
Properties: Cream-colored solid: sp. gr. 1.14: softening point 54°C: insoluble in water; soluble in acetone. ethylene dichloride. benzene. and gasoline.
Use: Antioxidant in rubber compounding.

diphenylglycolic acid. See benzilic acid.

diphenylguanidine (DPG: melaniline) $HN:C(NHC_6H_5)_2$.
Properties: White powder: bitter taste: slight odor: sp. gr. 1.13: m.p. 147°C: decomposes above 170°C: soluble in ethyl alcohol. carbon tetrachloride. chloroform. hot benzene and toluene: slightly soluble in water
Derivation: Treatment of aniline with cyanogen chloride

[illegible]$C_6H_5CH:CHCCH:CHC_6H_5$.
Use: Wavelength shifter in solution scintillation counting.

diphenyl isophthalate (DPIP) $C_6H_5OOCC_6H_4COOC_6H_5$.
Properties: White solid; m.p. 138–139°C. Combustible.
Use: Manufacture of polybenzimidazoles. high temperature-resistant polymers.

diphenylketone. See benzophenone.

diphenylmethane (benzylbenzene) $(C_6H_5)_2CH_2$.
Properties: Long colorless needles. Soluble in alcohol and ether: insoluble in water. Sp. gr. 1.0056: m.p. 26.5°C: b.p. 264.7°C. Flash point 266°F: combustible.
Derivation: Condensation of benzyl chloride and benzene in presence of aluminum chloride.
Hazard: Probably irritant and narcotic in high concentrations.
Uses: Organic synthesis: dyes; perfumery.

diphenylmethane-4.4'-diisocyanate (MDI; methylene-diparaphenylene isocyanate: methylenebis(phenyl isocyanate) $CH_2(C_6H_4NCO)_2$.
Properties: Light-yellow. fused solid: solidification point 37°C: sp. gr. (70°C) 1.197; soluble in acetone. benzene. kerosine and nitrobenzene: combustible.
Derivation: para. para'-Diaminodiphenylmethane and phosgene.
Hazard: Highly toxic by inhalation of fumes. Strong irritant. Tolerance. 0.02 ppm in air.
Uses: Preparation of polyurethane resin and spandex fibers: bonding rubber to rayon and nylon.

99°F

diphenylmethanol. See benzhydrol.

diphenylmethyl bromide (benzhydryl bromide) $BrCH(C_6H_5)_2$.
Properties: Solid: m.p. 45°C; b.p. 193°C (26 mm). Decomposes in hot water: soluble in alcohol: very soluble in benzene.
Hazard: Strong irritant to eyes and skin.
Use: Organic synthesis.
Shipping reguations: (Air) Corrosive label. (Rail) Corrosive material. n.o.s., White label.

diphenylmethylchlorosilane $(C_6H_5)_2(CH_3)SiCl$.
Properties: Colorless liquid: sp. gr. 1.107 (25°C); b.p. 295°C: flash point 135°F. Combustible.
Derivation: Grignard reactoin of diphenyldichlorosilane with methylmagnesium chloride.
Hazard: Moderate fire risk. Probably toxic.
Use: Intermediate: end stopper for silicone oils.

diphenylnaphthylenediamine $C_{10}H_6(NHC_6H_5)_2$.
Properties: Silvery. crystalline plates. Slightly soluble in alcohol: insoluble in water. M.p. 164°C.
Derivation: By heating 2,7-dihydroxynaphthalene with aniline and aniline hydrochloride.
Use: Organic synthesis.

diphenylnitrosamine. See N-nitrosodiphenylamine.

2,5-diphenyloxazole (DPO) $\overline{OOC_6H_5:C}C_6H_5$.
Properties: White. fluffy solid; m.p. 70–72°C.
Grade: Scintillation.

types; curing and hardening of polymers (e.g., core-binding resins); corrosion inhibitor; propellant.

Shipping regulations: (Rail) Flammable liquids, n.o.s., Red label. (Air) Flammable Liquid label.

triethylborane (triethylborine; boron triethyl). $(C_2H_5)_3B$.

Properties: Colorless liquid. Sp. gr. (25°C); flash point −32°F; f.p. −93°C; b.p. 95°C; refractive index 1.3971; heat of combustion 20,000 Btu/lb. Miscible with most organic solvents; immiscible with water.

Derivation: Reaction of triethylaluminum and boron halide, or diborane and ethylene.

Hazard: Flammable, dangerous fire risk. Ignites spontaneously in air. Highly toxic by inhalation; strong irritant. Reacts violently with water and oxidizing materials.

Uses: Igniter or fuel for jet and rocket engines; fuel additive; olefin polymerization catalyst; intermediate.

Shipping regulations: (Rail) Pyrophoric liquid, n.o.s., Red label. (Air) Not acceptable.

triethyl borate (ethyl borate) $(C_2H_5)_3BO_3$.

Properties: Colorless liquid; mild odor. Hydrolyzes rapidly, depositing boric acid in finely divided crystalline form. B.p. 120°C; sp. gr. 0.863–0.864 (20/20°C); flash point 51.8°F (C.C.); wt/gal 7.20 lb. (20°C); refractive index 1.37311 (20°C).

Uses: Antiseptics; disinfectants; antiknock agent.

Hazard: Flammable, dangerous fire risk. Moderately toxic.

Shipping regulations: (Rail) Flammable liquid, n.o.s., Red label. (Air) Flammable Liquid label. (Air) Legal label name, ethyl borate.

triethylborine. See triethylborane.

triethyl citrate (ethyl citrate) $C_3H_5(COOC_2H_5)_3$.

Properties: Colorless, mobile liquid. Bitter taste; b.p. 294°C; b.p. (1 mm) 126–127°C; sp. gr. 1.136 (25°C); refractive index 1.4405 (24.5°C); pour point −50°F; solubility in water 6.5 g/100 cc; solubility in oil 0.8 g/100 cc. Flash point 303°F (COC); combustible. Low toxicity.

Derivation: Esterification of citric acid.

Grades: Technical; refined; F.C.C.

Containers: Metal drums and cans; tank cars.

Uses: Solvent and plasticizer for nitrocellulose and natural resins; softener; paint removers; agglutinant; perfume base; food additive (not over 0.25%).

triethylenediamine $N(CH_2CH_2)_3N$. Catalyst used in the production of polyurethanes. Combustible.

triethylene glycol (TEG) $HO(C_2H_4O)_3H$.

Properties: Colorless, hygroscopic, practically odorless liquid. Sp. gr. 1.1254 (20/20°C); b.p. 287.4°C; vapor pressure less than 0.01 mm (20°C); flash point 350°F (C.C.); wt/gal 9.4 lb (20°C); freezing point −7.2°C; viscosity 0.478 poise (20°C). Autoignition temp. 700°F. Soluble in water; immiscible with benzene, toluene and gasoline. Combustible; low toxicity.

Derivation: From ethylene and oxygen, as a by-product of ethylene glycol manufacture.

Grades: Technical; C.P.

Containers: 1-, 5-gal cans; 55-gal drums; tank cars.

Uses: Solvent and plasticizer in vinyl, polyester and polyurethane resins; dehydration of natural gas; humectant in printing inks; extraction solvent ("Udex" process).

triethylene glycol diacetate
$CH_3COOCH_2CH_2OCH_2CH_2OCH_2CH_2OOCCH_3$.

Properties: Colorless liquid. Sp. gr. (25°C) 1.112; refractive index n (25°C) 1.437; b.p. 300°C; f.p. less than −60°C. Combustible; low toxicity.

Use: Plasticizer.

triethylene glycol dibenzoate
$C_6H_5CO(OCH_2CH_2)_3OOCC_6H_5$.

Properties: Crystals; b.p. 210–223°C; m.p. 46°C; flash point 457°F (TOC); sp. gr. 1.168. Combustible. Low toxicity.

Uses: Plasticizer for vinyl resins; adhesives.

triethylene glycol dicaprylate (triethylene glycol dioctoate) $C_7H_{15}COO(CH_2CH_2O)_3OCC_7H_{15}$.

Properties: Clear liquid; sp. gr. 0.973 (20°C); acidity 0.3% max. (caprylic); moisture 0.05% max; f.p. −3°C; b.p. 243°C (5 mm). Soluble in most organic solvents. Combustible; low toxicity.

Uses: Low-temperature plasticizer for elastomers.

triethylene glycol dichloride. See triglycol dichloride.

triethylene glycol didecanoate
$C_9H_{19}COO(C_2H_4O)_3OCC_9H_{19}$.

Properties: Colorless liquid. B.p. 237°C (2.0 mm); sp. gr. 0.9584 (20/20°C); viscosity 28.6 cp (20°C). Combustible. Low toxicity.

Use: Plasticizer.

triethylene glycol di(2-ethylbutyrate)
$C_5H_{11}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_5H_{11}$.

Properties: Light-colored liquid; sp. gr. 0.9946 (20/20°C); 8.3 lb/gal (20°C); b.p. 196°C (5 mm); vapor pressure 5.8 mm Hg (200°C); solubility in water 0.02% by wt (20°C); viscosity 10.3 cp (20°C). Flash point 385°F. Combustible. Low toxicity.

Use: Plasticizer.

triethylene glycol di(2-ethylhexoate)
$C_7H_{15}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_7H_{15}$.

Properties: Light-colored liquid; sp. gr. 0.9679 (20/20°C); 8.1 lb/gal (20°C); b.p. 219°C (5 mm); vapor pressure 1.8 mm Hg (200°C); insoluble in water; viscosity 15.8 cp (20°C). Flash point 405°F. Combustible. Low toxicity.

Use: Plasticizer.

triethylene glycol dihydroabietate
$C_{19}H_{31}COO(C_2H_4O)_3OCC_{19}H_{31}$.

Properties: Liquid. Sp. gr. (25°C) 1.080–1.090; refractive index (20°C) 1.5180; vapor pressure (225°C) 2.5; flash point 226°C; insoluble in water. Combustible. Low toxicity.

Use: Plasticizer.

triethylene glycol dimethyl ether
$CH_3(OCH_2CH_2)_3OCH_3$.

Properties: Water-white liquid; mild ether odor; sp. gr. (20/20°C) 0.9862; refractive index 1.4233 (n 20/D); flash point 232°F; b.p. (760 mm) 216.0°C; (100 mm) 153.6°C; f.p. −46°C. Autoignition temp. 1166°F. Completely soluble in water and hydrocarbons at 20°C. May contain peroxides. Combustible. Low toxicity.

Containers: Glass bottles; cans; 55-gal drums.

Uses: Solvent for gases; coupling immiscible liquids.

triethylene glycol dioctoate. See triethylene glycol dicaprylate.

triethylene glycol dipelargonate
$C_8H_{17}COO(C_2H_4O)_3OCC_8H_{17}$.

Properties: Clear liquid; sp. gr. 0.964 (20/20°C); b.p. 251°C (5 mm); f.p. +1 to −4°C; refractive index 1.4470 (23°C); flash point 410°F. Almost insoluble in water; soluble in most organic solvents. Combustible. Low toxicity.

Use: Plasticizer.

triethylene glycol dipropionate
$C_2H_5CO(OCH_2CH_2)_3OOCC_2H_5$.

Properties: Colorless liquid. Sp. gr. (25°C) 1.066; refractive index (25°C) 1.436; b.p. (2 mm) 138–142°C; f.p. less than −60°C; solubility in water, 6.70% by weight. Combustible. Low toxicity.

Use: Plasticizer.

triethylene glycol monobutyl ether. See butoxytriglycol.

triethylenemelamine (tretamine; TEM; 2,4,6-tris(1-aziridinyl)-s-triazine)
$\underbrace{NC[N(CH_2)_2]NC[N(CH_2)_2]NC}_{}[N(CH_2)_2]$.

Properties: White, crystalline, odorless powder; m.p. 160°C (polymerizes); polymerizes readily with heat or moisture; soluble in alcohol, water, methanol, chloroform, and acetone.

Grade: N.F.

Hazard: Highly toxic.

Uses: Medicine (see nitrogen mustards); insecticide; chemosterilant.

triethylenephosphoramide (tepa; tris-(1-aziridinyl)phosphine oxide; APO) $(\underbrace{NCH_2CH_2}_{})_3PO$.

Properties: Colorless crystals; m.p. 41°C; soluble in water, alcohol and ether. Combustible.

Derivation: From ethyleneimine.

Hazard: Highly toxic. Strong irritant to skin and tissue.

Uses: Medicine (see nitrogen mustards); insect sterilant. Also used with tetrakis(hydroxymethyl)phosphonium chloride (THPC) to form a condensation polymer suitable for flameproofing cotton. See also tris[1-(2-methyl)aziridinyl]phosphine oxide.

Shipping regulations: (Rail) White label. (Air) Corrosive label. Legal label name: tris(1-aziridinyl)-phosphine oxide.

See also tepa.

triethylenetetramine $NH_2(C_2H_4NH)_2C_2H_4NH_2$.

Properties: Moderately viscous yellowish liquid. Less volatile than diethylenetriamine but resembles it in many other properties. Soluble in water. B.p. 277.5°C; sp. gr. 0.9818 (20/20°C); m.p. 12°C; flash point 275°F (C.C.); wt 8.2 lb/gal (20°C). Combustible. Autoignition temp. 640°F.

Grades: Technical; anhydrous.

Containers: Cans; drums; tank cars.

Hazard: Strong irritant to tissue. Causes skin burns and eye damage.

Uses: Detergents and softening agents; synthesis of dyestuffs, pharmaceuticals and rubber accelerators.

Shipping regulations: (Air) Corrosive label.

tri(2-ethylhexyl)phosphate $[C_4H_9CH(C_2H_5)CH_2]_3PO_4$.

Properties: Light-colored liquid; sp. gr. 0.9260 (20/20°C); 7.70 lb/gal (20°C); b.p. 220°C (5 mm); vapor pressure 1.9 mm Hg (200°C); insoluble in water; viscosity 14.1 cp (20°C); pour point −74°C; flash point 405°F. Combustible; low toxicity.

Use: Plasticizer.

tri(2-ethylhexyl) phosphite $(C_8H_{17}O)_3P$.

Properties: Straw-colored liquid; sp. gr. 0.897 (25/15°C); m.p., glass at low temperature; refractive index 1.451 (n 25/D); flash point 340°F (COC). Combustible; low toxicity.

Uses: Plasticizer; intermediate.

tri(2-ethylhexyl) trimellitate $C_6H_3(COOC_8H_{17})_3$.

Properties: Clear liquid, mild odor; sp. gr. 0.992 (20/

core-
n.o.s.

C); flash
refractive
Btu lb.
miscible with

and boron

Ignites
inhalation;
and oxi-

engines; fuel
intermedi-

liquid, n.o.s.,

Hydrolyzes
crys-
0.864 (20
7.20 lb.

agent.
Moderately

liquid, n.o.s.,
label (Air) Legal

Bitter taste; b.p.
1.136 (25°C);
pour point −50°F;
solubility in oil 0.8
combustible.

acid

tank cars.
nitrocellulose and
removers; agglutinant;
over 0.25%).

Catalyst used in
Combustible.

practically odor-
b.p. 287.4°C;
(20°C); flash point
(20°C), freezing point
(20°C). Autoignition
immiscible with ben-
combustible, low toxicity.
as a by-product

drums; tank cars.
vinyl, polyester and
tion of natural gas;
action solvent ("Udex"

fractive index n (25°C) 1.437; b.p. 300°C; f.p. less than −60°C. Combustible; low toxicity.
Use: Plasticizer.

triethylene glycol dibenzoate
$C_6H_5CO(OCH_2CH_2)_3OOCC_6H_5$.
Properties: Crystals; b.p. 210–223°C; m.p. 46°C; flash point 457°F (TOC); sp. gr. 1.168. Combustible. Low toxicity.
Uses: Plasticizer for vinyl resins; adhesives.

triethylene glycol dicaprylate (triethylene glycol dioctoate) $C_7H_{15}COO(CH_2CH_2O)_3OCC_7H_{15}$.
Properties: Clear liquid; sp. gr. 0.973 (20°C); acidity 0.3% max. (caprylic); moisture 0.05% max; f.p. −3°C; b.p. 243°C (5 mm). Soluble in most organic solvents. Combustible; low toxicity.
Uses: Low-temperature plasticizer for elastomers.

triethylene glycol dichloride. See triglycol dichloride.

triethylene glycol didecanoate
$C_9H_{19}COO(C_2H_4O)_3OCC_9H_{19}$.
Properties: Colorless liquid. B.p. 237°C (2.0 mm); sp. gr. 0.9584 (20/20°C); viscosity 28.6 cp (20°C). Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol di(2-ethylbutyrate)
$C_5H_{11}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_5H_{11}$.
Properties: Light-colored liquid; sp. gr. 0.9946 (20/20°C); 8.3 lb/gal (20°C); b.p. 196°C (5 mm); vapor pressure 5.8 mm Hg (200°C); solubility in water 0.02% by wt (20°C); viscosity 10.3 cp (20°C). Flash point 385°F. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol di(2-ethylhexoate)
$C_7H_{15}OCOCH_2(CH_2OCH_2)_2CH_2OCOC_7H_{15}$.
Properties: Light-colored liquid; sp. gr. 0.9679 (20/20°C); 8.1 lb/gal (20°C); b.p. 219°C (5 mm); vapor pressure 1.8 mm Hg (200°C); insoluble in water; viscosity 15.8 cp (20°C). Flash point 405°F. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dihydroabietate
$C_{19}H_{31}COO(C_2H_4O)_3OCC_{19}H_{31}$.
Properties: Liquid. Sp. gr. (25°C) 1.080–1.090; refractive index (20°C) 1.5180; vapor pressure (225°C) 2.5; flash point 226°C; insoluble in water. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol dimethyl ether
$CH_3(OCH_2CH_2)_3OCH_3$.
Properties: Water-white liquid; mild ether odor; sp. gr. (20/20°C) 0.9862; refractive index 1.4233 (n 20/D); flash point 232°F; b.p. (760 mm) 216.0°C; (100 mm) 153.6°C; f.p. −46°C. Autoignition temp. 1166°F. Completely soluble in water and hydrocarbons at 20°C. May contain peroxides. Combustible. Low toxicity.
Containers: Glass bottles; cans; 55-gal drums.
Uses: Solvent for gases; coupling immiscible liquids.

triethylene glycol dioctoate. See triethylene glycol dicaprylate.

triethylene glycol dipelargonate
$C_8H_{17}COO(C_2H_4O)_3OCC_8H_{17}$.
Properties: Clear liquid; sp. gr. 0.964 (20/20°C); b.p. 251°C (5 mm); f.p. +1 to −4°C; refractive index 1.4470 (23°C); flash point 410°F. Almost insoluble in water; soluble in most organic solvents. Combustible. Low toxicity.

triethylene glycol dipropionate
$C_2H_5CO(OCH_2CH_2)_3OOCC_2H_5$.
Properties: Colorless liquid. Sp. gr. (25°C) 1.066; refractive index (25°C) 1.436; b.p. (2 mm) 138–142°C; f.p. less than −60°C; solubility in water, 6.70% by weight. Combustible. Low toxicity.
Use: Plasticizer.

triethylene glycol monobutyl ether. See butoxytriglycol.

triethylenemelamine (tretamine; TEM; 2,4,6-tris(1-aziridinyl)-s-triazine)
$NC[N(CH_2)_2]NC[N(CH_2)_2]NC[N(CH_2)_2]$.
Properties: White, crystalline, odorless powder; m.p. 160°C (polymerizes); polymerizes readily with heat or moisture; soluble in alcohol, water, methanol, chloroform, and acetone.
Grade: N.F.
Hazard: Highly toxic.
Uses: Medicine (see nitrogen mustards); insecticide; chemosterilant.

triethylenephosphoramide (tepa; tris-(1-aziridinyl)phosphine oxide; APO) $(NCH_2CH_2)_3PO$.
Properties: Colorless crystals; m.p. 41°C; soluble in water, alcohol and ether. Combustible.
Derivation: From ethyleneimine.
Hazard: Highly toxic. Strong irritant to skin and tissue.
Uses: Medicine (see nitrogen mustards); insect sterilant. Also used with tetrakis(hydroxymethyl)phosphonium chloride (THPC) to form a condensation polymer suitable for flameproofing cotton. See also tris[1-(2-methyl)aziridinyl]phosphine oxide.
Shipping regulations: (Rail) White label. (Air) Corrosive label. Legal label name: tris(1-aziridinyl)phosphine oxide.
See also tepa.

triethylenetetramine $NH_2(C_2H_4NH)_2C_2H_4NH_2$.
Properties: Moderately viscous yellowish liquid. Less volatile than diethylenetriamine but resembles it in many other properties. Soluble in water. B.p. 277.5°C; sp. gr. 0.9818 (20/20°C); m.p. 12°C; flash point 275°F (C.C.); wt 8.2 lb/gal (20°C). Combustible. Autoignition temp. 640°F.
Grades: Technical; anhydrous.
Containers: Cans; drums; tank cars.
Hazard: Strong irritant to tissue. Causes skin burns and eye damage.
Uses: Detergents and softening agents; synthesis of dyestuffs, pharmaceuticals and rubber accelerators.
Shipping regulations: ~~(Air) Corrosive label~~

tri(2-ethylhexyl)phosphate $[C_4H_9CH(C_2H_5)CH_2]_3PO_4$.
Properties: Light-colored liquid; sp. gr. 0.9260 (20/20°C); 7.70 lb/gal (20°C); b.p. 220°C (5 mm); vapor pressure 1.9 mm Hg (200°C); insoluble in water; viscosity 14.1 cp (20°C); pour point −74°C; flash point 405°F. Combustible; low toxicity.
Use: Plasticizer.

tri(2-ethylhexyl) phosphite $(C_8H_{17}O)_3P$.
Properties: Straw-colored liquid; sp. gr. 0.897 (25/15°C); m.p., glass at low temperature; refractive index 1.451 (n 25/D); flash point 340°F (COC). Combustible; low toxicity.
Uses: Plasticizer; intermediate.

tri(2-ethylhexyl) trimellitate $C_6H_3(COOC_8H_{17})_3$.
Properties: Clear liquid, mild odor; sp. gr. 0.992 (20/20°C); distillation range at 3 mm, 278–284°C (5–95%); f.p., a gel at −35°C; refractive index 1.4846 (23°C); wt/gal 8.26 lb (20°C). Combustible; low toxicity.
Use: Plasticizer.

triethylmethane. See 3-ethylpentane.

triethylmethyl malonaldehyde diacetal. See 1,1,3-triethoxy-3-methoxypropane.

triethyl orthoformate (triethoxymethane) $CH(OC_2H_5)_3$.
Properties: Colorless liquid; pungent odor; b.p. 145.9°C; refractive index 1.39218 (18.8°C); sp. gr. 0.895 (20/20°C). Soluble in alcohol, ether; decomp. in water. Flash point 86°F (C.C.). Low toxicity.
Derivation: Reaction of sodium ethylate with chloroform or reaction of hydrochloric acid with hydrogen cyanide in ethyl alcohol solution.
Containers: 55-gal steel drums.
Hazard: Flammable, moderate fire risk.
Uses: Organic synthesis; pharmaceuticals.

triethyl phosphate (TEP) $(C_2H_5)_3PO_4$.
Properties: Colorless, high-boiling liquid. Mild odor; very stable at ordinary temperatures. Compatible with many gums and resins. Soluble in most organic solvents; completely miscible in water. When mixed with water is quite stable at room temperature, but at elevated temperatures it hydrolyzes slowly. F.p. −56.4°C; b.p. 216°C. flash point 240°F; refractive index 1.4055 (20°C); wt/gal 8.90 lb (68°F). Combustible.
Grades: Technical; 97%.
Containers: Drums; tank cars; tank trucks.
Hazard: May cause nerve damage but to less extent than other cholinesterase-inhibiting compounds.
Uses: Solvent; plasticizer for resins, plastics, gums; manufacture of pesticides; catalyst; lacquer remover.
Shipping regulations: (Rail, Air) Organic phosphate, liquid, n.o.s., Poison label. Not acceptable on passenger planes.

triethyl phosphite $(C_2H_5)_3PO_3$.
Properties: Colorless liquid; sp. gr. 0.9687 (20°C); b.p. 156.6°C; refractive index 1.413 (n 25/D); flash point 130°F; insoluble in water; soluble in alcohol and ether. Combustible.
Containers: Glass bottles; 5-, 55-gal drums.
Hazard: Moderate fire risk. May be toxic.
Uses: Synthesis; plasticizers; stabilizers; lube and grease additives.

O,O,O-triethyl phosphorothioate (triethyl thiophosphate) $(C_2H_5O)_3PS$.
Properties: Colorless liquid with characteristic odor. B.p. (10 mm) 93.5–94°C; sp. gr. 1.074; flash point 225°F (COC); combustible.
Containers: Bottles; drums.
Hazard: Toxic by ingestion; cholinesterase inhibitor.
Uses: Plasticizer; lubricant additive; antifoam agent; hydraulic fluid; intermediate.
Shipping regulations: (Rail, Air) Organic phosphate, liquid, n.o.s., Poison label. Not acceptable on passenger planes.

triethyl tricarballylate $(C_2H_5OCOCH_2)_2CHCOOC_2H_5$.
Properties: Colorless liquid. Sp. gr. (20°C) 1.087; refractive index (26°C) 1.4234; b.p. (5 mm) 158–160°C; solubility in water (20°C) 0.62% by weight. Combustible.
Use: Plasticizer.

ıer intermediate; sol-
parts and precision

thyl)trimethylammo-
OH]$_3$ · $C_6H_7O_7$-
on); drums.

hloroethylene (q.v.).

obaltic oxide.

tricyclamol chloride

oluble in alcohol; in-
(48°C): b.p. 234°C
ble.

ıers.

OOH. A saturated
ın natural fats or oils.
crystalline solid: m.p.
d in medical research
as chromatography.

$C_6H_4)_3BO_3$.
sp. gr. 1.065 (25°C):
x 1.5480 (24°C); flash
in all proportions in
hydrolyzes on contact

sis.

hate; TCP)
f isomers.
. odorless liquid. Sta-
refractive index 1.556
); wt/gal 9.7 lb; crys-
Miscible with all the
s, also with vegetable
point 437°F; autoigni-
e.
hosphorus oxychloride.
; tank cars.
ıngestion and skin ab-
highly toxic; its toler-
of air.
chloride, polystyrene.
for plastics; air filter
waterproofing; additive
s; hydraulic fluid and

P.
slight phenolic odor.
(20/4°C) 1.115; flash
uble in water; miscible
e, ether, and kerosine.

for plastics and resins.

[illegible]

der; faint characteristic odor; soluble in alcohol and in water.
Use: Medicine.

tricyclic. An organic compound comprised of three (only) ring structures, which may be the same or different, e.g., anthracene.

sym-**tricyclodecane.** See adamantane.

tricyclohexyl borate. See boric acid ester.

n-**tridecane** $CH_3(CH_2)_{11}CH_3$.
Properties: Colorles liquid. Soluble in alcohol; insoluble in water. Sp. gr. 0.755 (20/4°C); b.p. 225.5°C; f.p. −5.45°C; refractive index 1.4250 (20/D); flash point 175°F. Combustible; low toxicity.
Grades: 95%; 99%; research.
Containers: Glass bottles; 1-, 5-gal drums.
Uses: Organic synthesis; distillation chaser.

n-**tridecanoic acid** (tridecylic acid; tridecoic acid) $CH_3(CH_2)_{11}COOH$. A saturated fatty acid usually prepared synthetically.
Properties: Colorless crystals; m.p. 44.5°C; sp. gr. 0.8458 (80/4°C): b.p. 312.4°C, 192.2°C (16 mm); refractive index 1.4328 (50°C). Slightly soluble in water; soluble in alcohol and ether. Combustible; low toxicity.
Grade: 99% pure.
Uses: Organic synthesis; medical research.

tridecanol. See tridecyl alcohol.

tridecoic acid. See n-tridecanoic acid.

tridecyl alcohol (tridecanol). A commercial mixture of isomers of the formula $C_{12}H_{25}CH_2OH$.
Properties: Low-melting white solid with pleasant odor; b.p. 274°C; m.p. 31°C; sp. gr. (20/20°C) 0.845; wt/gal 7.0 lb; flash point (TOC) 180°F. Combustible; low toxicity.
Derivation: Oxo process (q.v.) from C_{15} hydrocarbons.
Grade: Technical.
Containers: 55-gal drums; tank cars.
Uses: Esters for synthetic lubricants; detergents; antifoam agent; other tridecyl compounds; perfumery.

tridecylbenzene (1-phenyltridecane) $C_6H_5(CH_2)_{12}CH_3$.
Properties: Colorless liquid; sp. gr. 0.85–0.86 (60/60°F); refractive index 1.4815–1.4830. Combustible.
Use: Detergent intemediate.

tridecylic acid. See n-tridecanoic acid.

tri(decyl) orthoformate $CH(OC_{10}H_{21})_3$.
Properties: Liquid; b.p. 194°C; f.p. −15 to −20°C; refractive index 1.448; insoluble in water; soluble in benzene, naphtha, ether, and alcohol.
Use: To remove small quantities of water from ethers or other solvents where acid catalysts can be employed.

tri(decyl) phosphite $(C_{10}H_{21}O)_3P$.
Properties: Water-white liquid; decyl alcohol odor; sp. gr. 0.892 (25/15.5°C); m.p. less than 0°C; refractive index 1.4565 (25°C). Flash point 455°F. Combustible.
Containers: 55-gal drums.
Uses: Chemical intermediate; stabilizer for polyvinyl and polyolefin resins.

tridihexethyl chloride
$C_6H_{11}C(C_6H_5)(OH)CH_2CH_2N(C_2H_5)_2 \cdot C_2H_5Cl$. (3-Diethylamino-1-phenyl-1-cyclohexylpropanol etho-

form, and in alcohol. Practically insoluble in ether and in acetone. Melting range 198–202°C.
Grade: N.F.
Use: Medicine.

2,4,6-tri(dimethylaminomethyl)phenol
$[(CH_3)_2NCH_2]_3C_6H_2OH$.
Properties: Liquid; refractive index 1.5181. Combustible.
Hazard: May be toxic.
Uses: Antioxidants, acid neutralizers, stabilizers, and catalysts for epoxy and polyurethane resins.

tri(dimethylphenyl)phosphite (trixylenyl phosphate) $[(CH_3)_2C_6H_3O]_3PO$.
Properties: Liquid. Sp. gr. 1.155; refractive index 1.5535; b.p. (10 mm), 243–265°C; flash point 450°F; solubility in water (85°C), 0.002% by weight. Combustible.
Use: Plasticizer.

"Tridione."[1] Trademark for trimethadione, U.S.P.

tridodecyl amine. See trilauryl amine.

tridodecyl borate. See boric acid ester.

tridymite SiO_2. A vitreous, colorless or white, native form of pure silica. Found variously but not so commonly as quartz (q.v.). Quartz will change into tridymite with a 16.2% increase in volume at 870°C. Unlike quartz, it is soluble in boiling sodium carbonate solution. Sp. gr. 2.28–2.3; Mohs hardness 7.

trietazine. Generic name for 2-chloro-4-diethylamino-6-ethylamino-s-triazine $ClC_3N_3[N(C_2H_5)_2]NHC_2H_5$.
Properties: Solid; practically insoluble in water.
Uses: Herbicide; plant growth regulator.

"Tri-Ethane."[177] Trademark for 1,1,1-trichloroethane (q.v.).

triethanolamine (TEA; tri(2-hydroxyethyl)amine) $(HOCH_2CH_2)_3N$.
Properties: Colorless, viscous, hygroscopic liquid with slight ammoniacal odor; m.p. 21.2°C; b.p. 335°C (dec); vapor pressure < 0.01 mm (20°C); sp. gr. 1.126; flash point (open cup) 375°F; wt/gal 9.4 lb; miscible with water, alcohol; soluble in chloroform; slightly soluble in benzene and ether; slightly less alkaline than ammonia. Commercial product contains up to 25% diethanolamine and up to 5% monoethanolamine. Combustible; low toxicity.
Derivation: Reaction of ethylene oxide and ammonia.
Grades: Technical; regular; 98%; U.S.P.
Containers: Drums; tank cars.
Uses: Fatty acid soaps used in drycleaning, cosmetics, household detergents, and emulsions; wool scouring; textile antifume agent and water-repellent; dispersion agent; corrosion inhibitor; softening agent, humectant, and plasticizer; insecticide; chelating agent; rubber accelerator.

triethanolamine lauryl sulfate
$(HOC_2H_4)_3NOS(O)_2OC_{12}H_{25}$. A liquid or paste.
Containers: Drums, tank cars; tank trucks.
Uses: Detergent; wetting, foaming and dispersing agent for industrial, cosmetic and pharmaceutical applications, especially shampoos.

triethanolamine methanearsonate
$CH_3As(O)[ONH(C_2H_4OH)_3]_2$.
Hazard: Highly toxic by ingestion.
Use: Herbicide.
Shipping regulations: (Rail, Air) Arsenical compounds.

triethanolamine oleate. See trihydroxyethylamine oleate.

triethanolamine stearate. See trihydroxyethylamine stearate.

triethanolamine titanate. See titanium chelate.

1,1,3-triethoxyhexane
$CH(OC_2H_5)_2CH_2CH(OC_2H_5)C_3H_7$.
Properties: Colorless liquid: sp. gr. 0.8746 (20/20°C); b.p. 133°C (50 mm): f.p. −100°C; wt/gal 7.3 lb; flash point 210°F. Insoluble in water. Combustible. Low toxicity.
Use: Synthesis of aldehydes, acids, esters, chloride, amines, etc.

triethoxymethane. See triethyl orthoformate.

1,1,3-triethoxy-3-methoxypropane (triethylmethyl malonaldehyde diacetal)
$(CH_3O)(C_2H_5O)CHCH_2CH(OC_2H_5)_2$.
Properties: Colorless liquid. Sp. gr. (25/4°C), 0.9300; b.p. (6 mm) 86°C. Combustible.
Grade: 99%.
Uses: Intermediate; crosslinking and insolubilizing agent.

triethylaconitate
$C_2H_5OOCCHC(COOC_2H_5)CH_2COOC_2H_5$.
Properties: Liquid. Sp. gr. (25°C) 1.096; refractive index (26°C) 1.4517; b.p. (5 mm) 154–156°C. Combustible.
Use: Plasticizer.

triethylaluminum (ATE; TEA; aluminum triethyl). $(C_2H_5)_3Al$.
Properties: Colorless liquid; sp. gr. 0.837; f.p. −52.5°C; b.p. 194°C; specific heat 0.527 (91.4°F). Miscible with saturated hydrocarbons. Flash point −63°F.
Derivation: By introduction of ethylene and hydrogen into an autoclave containing aluminum. The reaction proceeds under moderate temperature and varying pressures.
Grades: 88–94%.
Containers: Cylinders.
Hazard: Highly toxic; destructive to tissue. Flammable, dangerous fire risk; ignites spontaneously in air; reacts violently with water, acids, alcohols, halogens, and amines.
Uses: Catalyst intermediate for polymerization of olefins, especially ethylene; pyrophoric fuels; production of alpha-olefins and long chain alcohols; gas plating of aluminum.
Shipping regulations: (Rail) Red label. (Air) Not acceptable. (Rail) Legal label name; aluminum triethyl.

triethylamine $(C_2H_5)_3N$.
Properties: Colorless liquid; strong ammoniacal odor. B.p. 89.7°C; f.p. −115.3°C; sp. gr. (20/20°C) 0.7293; wt/gal (20°C) 6.1 lb; flash point (open cup) 20°F. Soluble in water and alcohol.
Derivation: From ethyl chloride and ammonia under heat and pressure.
Containers: 1-, 5-gal cans; 55-gal drums; tank cars.
Hazard: Flammable, dangerous fire risk. Explosive limits in air 1.2 to 8.0%. Tolerance, 25 ppm in air. Toxic by ingestion and inhalation; strong irritant to tissue.
Uses: Catalytic solvent in chemical synthesis; accelerator activators for rubber; wetting, penetrating and

P-AH TP-90B - SPGR, 0.97. High boiling, straw colored liquid; little or no odor; non-toxic in ordinary handling. Visc (27°C) 8 cps. Bp 660-760°F.

APPENDIX V

Volatility of Plasticizers

TABLE 15.3

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.: In Water	Solubility, % at 20° C.: Water in	Solubility, % at 20° C.: In Mineral Oil	Solubility, % at 20° C.: Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr.: 212° F. (100° C.)	Volatility of Free Plasticizer in Air, mg./sq. cm./hr.: 375° F. (191° C.)
	Simple Plasticizers											
1	Acetin	$C_5H_{10}O_4$	134	1.190 at 25° C.	1.445 at 25° C.	66.8 at 25° C.						
2	*o*- and *p*-Toluenesulfonamides (mixture)	$C_7H_9O_2NS$	171	1.353 solid		f.p. 105						
3	Diacetin	$C_7H_{12}O_5$	176	1.178	1.438 at 25° C.	35.7 at 25° C.						
4	[a]*N*-Ethyl-*p*-toluenesulfonamide	$C_9H_{13}O_2NS$	199	1.171 at 65° C.	1.522 at 65° C.	f.p. 59.0						
5	*N*-Ethyl-*o*- and *p*-toluenesulfonamides (mixture)	$C_9H_{13}O_2NS$	199	1.190 at 25° C.	1.540 at 25° C.	426 at 25° C.					0.55	101
6	Triacetin	$C_9H_{14}O_6$	218	1.157 (av.)	1.429 at 25° C.	15.1 at 25° C.						
7	Dimethyl phthalate	$C_{10}H_{10}O_4$	194	1.191	1.513 at 25° C.	16.3			0.5	0.34	>4.0	>1000
8	*o*-Nitrobiphenyl	$C_{12}H_9O_2N$	199	1.203 at 25° C.	1.613 at 25° C.	38 at 25° C.						
9	Diethyl phthalate	$C_{12}H_{14}O_4$	222	1.118	1.501 at 20° C.	12.6	0.15	0.7	2.8	1.1	3.40	> 500
10	Triethyl citrate	$C_{12}H_{20}O_7$	276	1.136 at 25° C.	1.441 at 24.5° C.							
11	Dimethyl sebacate	$C_{12}H_{22}O_4$	230	0.986 at 30° C.	1.436 at 30° C.	3.5 at 38° C.						

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence [a]: Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	% Loss, 4-mil Film: 24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	% Extraction, 10 days, 23° C., 4-mil Film: Oil	Spew, 2 days, 60° C., 100% Humidity [b]	Supplier [**]
	Simple Plasticizers													
1	Acetin												—	Kes
2	*o*- and *p*-Toluenesulfonamides (mixture)												—	Mon
3	Diacetin												—	Kes
4	*N*-Ethyl-*p*-toluenesulfonamide												—	Mon
5	*N*-Ethyl-*o*- and *p*-toluenesulfonamides (mixture)												—	Mon
6	Triacetin												—	Kes, TE
7	Dimethyl phthalate												—	Mon, TE
8	*o*-Nitrobiphenyl												—	Mon
9	Diethyl phthalate												—	Mon, TE, USI
10	Triethyl citrate												—	Pf
11	Dimethyl sebacate												—	Har

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
12	Di-*n*-butyl tartrate	$C_{12}H_{22}O_6$	262	1.094	1.444 at 25° C.	67.7 at 25° C.	0.5	0.7	0.3	2.4	1.50	143
13	Tri-*n*-butyl phosphate	$C_{12}H_{27}O_4P$	266	0.978	1.424 at 20° C.	3.4 at 25° C.	<0.07	6.0	*M*	*M*	>4	503
14	Monomethyl phthalate ethyl glycolate ester	$C_{13}H_{14}O_6$	266	1.227	1.504 at 25° C.	185	0.1	1.2	0.5	0.1	0.65	61
15	*N*-Cyclohexyl-*p*-toluenesulfonamide	$C_{13}H_{19}O_2NS$	253	1.125 solid		f.p. 87° C.					0.05	26
16	Monoethyl phthalate ethyl glycolate ester	$C_{14}H_{16}O_6$	280	1.186	1.498 at 25° C.	68.0 at 25° C.	<0.08	1.38	1.60	0.18	0.50	93
17	Di(methyl CELLOSOLVE) phthalate	$C_{14}H_{18}O_6$	282	1.169	1.501 at 25° C.	53	0.85	3.2	0.50	0.10	0.16	62
18	Triethyl acetylcitrate	$C_{14}H_{22}O_8$	318	1.13	1.439 at 23° C.							> 525
19	Diisobutyl adipate	$C_{14}H_{26}O_4$	258	0.957	1.428 at 25° C.	70 at 25° C.						
20	Tributyrin	$C_{15}H_{26}O_6$	302	1.036	1.433 at 25° C.	8.9 at 25° C.						
21	Methyl CELLOSOLVE laurate	$C_{15}H_{30}O_3$	258	0.894 at 25° C.	1.440 at 25° C.	7.5 at 25° C.						

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[**]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Simple Plasticizers (Continued)													
12	Di-*n*-butyl tartrate												——	Kes
13	Tri-*n*-butyl phosphate												——	CS
14	Monomethyl phthalate ethyl glycolate ester	55.4[c]							17.5		6.1	5.9	——	Mon
15	*N*-Cyclohexyl-*p*-toluenesulfonamide												——	Mon
16	Monoethyl phthalate ethyl glycolate ester												——	Mon
17	Di(methyl CELLOSOLVE) phthalate	46[a]							6.6		4.6	3.7	None	OA&TE
18	Triethyl acetylcitrate												——	Pf
19	Diisobutyl adipate												——	Cab
20	Tributyrin												——	TE
21	Methyl CELLOSOLVE laurate												——	Kes

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[26]

[**] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	***Simple Plasticizers* (*Continued*)**											
22	Di-*n*-butyl phthalate	$C_{16}H_{22}O_4$	278	1.048	1.493 at 20° C.	20.3	Insol.	0.46	34	30.0	0.98	148
23	Di(CELLOSOLVE) phthalate	$C_{14}H_{22}O_6$	310	1.120	1.491 at 25° C.	f.p. 31° C.	0.2	2.0	2	0.64	0.15	30
24	*n*-Butyl laurate	$C_{16}H_{32}O_2$	256	0.857 at 25° C.								
25	Methyl CELLOSOLVE myristate	$C_{17}H_{34}O_3$	286	0.895 at 25° C.								
26	Di(butyl CARBITOL) formal	$C_{17}H_{36}O_6$	336	0.97								
27	Triphenyl phosphate	$C_{18}H_{15}O_4P$	326	1.268 at 60° C.	1.552 at 60° C.	f.p. 49.9° C.					0.02	22
28	Bis(dimethylbenzyl) ether	$C_{18}H_{22}O$	286	1.008	1.553 at 25° C.	29.0						
29	*n*-Butyl cyclohexyl phthalate	$C_{18}H_{24}O_4$	304	1.078	1.508 at 20° C.	117.0						75
30	Mono-*n*-butyl phthalate *n*-butyl glycolate ester	$C_{18}H_{24}O_6$	336	1.103	1.490 at 25° C.	64.9	Insol.	0.37	4.65	2.70	0.08	31
31	Tri-*n*-butyl citrate	$C_{18}H_{32}O_7$	360	1.045	1.443 at 25° C.		Insol.	<0.2	10.0	14.5	0.16	44
32	Triethylene glycol di(2-ethylbutyrate)	$C_{18}H_{34}O_6$	346	0.995	1.440 at 20° C.	11.5	0.02	1.0	0.2	24.0	0.88	

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	***Simple Plasticizers* (*Continued*)**													
22	Di-*n*-butyl phthalate	41.4[c]							17.5		2.7	6.3	None	Bar, CS, Har, Mon, Nev, Pitt, TK, USI, DA
23	Di(CELLOSOLVE) phthalate												——	OA
24	*n*-Butyl laurate												——	AH
25	Methyl CELLOSOLVE myristate												——	AH
26	Di(butyl CARBITOL) formal	55.3[c]							10.1		15.6	14.5	None	Thi
27	Triphenyl phosphate												——	Dow, Mon, Pitt
28	Bis(dimethylbenzyl) ether												——	OA
29	*n*-Butyl cyclohexyl phthalate	58.8					+3	−20	6.5		0.6	8.8	None	Bar
30	Mono-*n*-butyl phthalate *n*-butyl glycolate ester	53.2[c]	3000	300					3.3		17	4.3	None	Mon
31	Tri-*n*-butyl citrate	55.1	2800	360			−4	−32	3.1		8.1	14.6	None	Pf
32	Triethylene glycol di(2-ethylbutyrate)												——	CCCO

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[36]

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
33	Butyl CELLOSOLVE laurate	$C_{18}H_{36}O_3$	300	0.882 at 25° C. (av.)	1.439 at 25° C.	6.5 at 25° C.						
34	Di-*n*-hexyl adipate	$C_{18}H_{34}O_4$	314	0.933 at 25° C.	1.439 at 25° C.	7.8 at 25° C.						
35	Di(1,3-dimethylbutyl) adipate	$C_{18}H_{34}O_4$	314	0.926	1.433 at 25° C.	5.6 ca. at 38° C.						
36	*Di-n-butyl sebacate*	$C_{18}H_{34}O_4$	314	0.936	1.440 at 25° C.	9.3	Insol.	1.6	*M*	*M*		63
37	Di(butyl CELLOSOLVE) adipate	$C_{18}H_{34}O_6$	346	0.997	1.442 at 25° C.	12.5						58
38	*n*-Butyl myristate	$C_{18}H_{36}O_2$	284	0.861 at 25° C.								
39	Tri(butyl CELLOSOLVE) phosphate	$C_{18}H_{39}O_7P$	398	1.022	1.434 at 25° C.	12.2	0.08	6.2	Almost miscible			
40	Cresyl diphenyl phosphate	$C_{19}H_{17}O_4P$	340	1.208 at 25° C.	1.563 at 20° C.	39.8						
41	*n*-Butyl benzyl phthalate	$C_{19}H_{20}O_4$	312	1.116 at 25° C.	1.538 at 20° C.	39.3 at 25° C.						29
42	Bis(dimethylbenzyl) carbonate	$C_{19}H_{22}O_3$	298	1.083	1.547 at 20° C.	155						32

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Simple Plasticizers (Continued)													
33	Butyl CELLOSOLVE laurate												——	Kes
34	Di-*n*-hexyl adipate												——	Kes
35	Di(1,3-dimethylbutyl) adipate												——	Har
36	Di-*n*-butyl sebacate	37.8[c]							7.2		0.4	16.5	None	Har, Pitt, RH
37	Di(butyl CELLOSOLVE) adipate	41.4[c]										18.0	None	Kes, OA
38	*n*-Butyl myristate												——	AH
39	Tri(butyl CELLOSOLVE) phosphate	43.7[c]							1.1		14.2	13.5	None	OA
40	Cresyl diphenyl phosphate	72	3000	292	64	475	4	−15		6.1	0.9	14.8	None	Mon
41	*n*-Butyl benzyl phthalate	59	2930	281	66	730	6	−11		9.5	0.6	7.8	None	Mon
42	Bis(dimethylbenzyl) carbonate	71	3000	284	63	450	2	− 9		11.8	1.5	9.2	——	OA

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[28]

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICISERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C. In Water	Water in	In Mineral Oil	Mineral Oil in	Volatility of Free Plasticiser in Air, mg./sq. cm./hr. 212° F. (100° C.)	375° F. (191° C.)
						Simple Plasticisers (Continued)						
43	Methyl pentachlorostearate	$C_{19}H_{33}O_2Cl_5$	471	1.204	1.497 at 20° C.	975.0						7
44	Methyl ricinoleate	$C_{19}H_{36}O_3$	312	0.925 at 25° C.	1.462 at 25° C.							
45	Methyl CELLOSOLVE palmitate	$C_{19}H_{38}O_3$	314	0.891 at 25° C.								
46	Methyl hydroxystearate	$C_{19}H_{38}O_3$	314			f.p. 48° C.						
47	Diphenyl phthalate	$C_{20}H_{14}O_4$	318	1.28 solid	1.572 at 74° C.	f.p. 69° C.					0.006	19
48	Dicyclohexyl phthalate	$C_{20}H_{26}O_4$	330	1.23		f.p. 63.5						
49	2-Ethylhexyl diphenyl phosphate	$C_{20}H_{27}O_4P$	362	1.092	1.511 at 20° C.	31.0						44
50	Di-n-hexyl phthalate	$C_{20}H_{30}O_4$	334	1.007	1.487 at 20° C.	29.5	Insol.	0.34				63
51	Di(2-ethylbutyl) phthalate	$C_{20}H_{30}O_4$	334	1.016	1.488 at 25° C.	56	Insol.	<0.05	*M*	*M*	0.20	66
52	Di(1,3-dimethylbutyl) phthalate	$C_{20}H_{30}O_4$	334	0.995	1.480 at 25° C.	28.8 cs. at 38° C.						> 150

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticised to Equivalence[a]: Plasticiser p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	[c] Stiffness at 23° C., p.s.i.	T_f, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	Oil	Spew, 3 days, 60° C., 100% Humidity[b]	Supplier[m]
						Simple Plasticisers (Continued)								
43	Methyl pentachlorostearate	69[d]	2900	338	64	600	− 6	−19	0.2		0.2	17.1	None	Hook
44	Methyl ricinoleate												——	Bak
45	Methyl CELLOSOLVE palmitate												——	AH
46	Methyl hydroxystearate												——	Bak
47	Diphenyl phthalate												——	Mon
48	Dicyclohexyl phthalate	64[e]	3000	290			+ 5	− 5	1.0		0	4.5	None	Bar, OA
49	2-Ethylhexyl diphenyl phosphate	60	2380	260	64	540	− 2	−28	1.6		0.2	14.8	None	Mon
50	Di-n-hexyl phthalate	57	2720	293	63	570	− 8	−31	3.8	11.6	0	13.5	None	CCCO, TE
51	Di(2-ethylbutyl) phthalate	45.3[e]							4.4		0.2	3.4	None	TE
52	Di(1,3-dimethylbutyl) phthalate												——	Has

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[38]
[d] Mixture of 1 part plasticizer to 2 parts FLEXOL plasticizer DOP.
[e] Mixture of 0.9 part plasticizer to 1 part FLEXOL plasticizer DOP.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
53	Di(butyl CELLOSOLVE) phthalate	$C_{20}H_{30}O_6$	366	1.063	1.483 at 25° C.	42.0	Insol.	0.63	2.80	6.50	0.06	24
54	Di(CARBITOL) phthalate	$C_{20}H_{30}O_8$	398	1.150	1.492 at 25° C.	82.0	Insol.	2.80	0.09	0.20	0.08	18
55	Tri-*n*-butyl acetylcitrate	$C_{20}H_{34}O_8$	402	1.046 at 25° C.	1.441 at 25° C.							61
56	*n*-Butyl palmitate	$C_{20}H_{40}O_2$	313	0.865 at 25° C.								
57	Tricresyl phosphate	$C_{21}H_{21}O_4P$	368	1.165	1.557 at 20° C.	120.0	Insol.	0.37	5.5	2.0	0.01	7
58	*n*-Butyl benzyl sebacate	$C_{21}H_{32}O_4$	348	1.004	1.479 at 25° C.	8.6 cs. at 38° C.						
59	Methyl acetylricinoleate	$C_{21}H_{38}O_4$	355	0.936	1.456 at 20° C.	23.1						
60	Methyl CELLOSOLVE oleate	$C_{21}H_{40}O_3$	341	0.902	1.453 at 25° C.	10.2					0.12	29
61	Di(2-ethylbutyl) azelate	$C_{21}H_{40}O_4$	357	0.930	1.442 at 25° C.	11.4						48
62	Propylene glycol monoricinoleate	$C_{21}H_{40}O_4$	357	0.950 at 25° C.								
63	Methyl CELLOSOLVE stearate	$C_{21}H_{42}O_3$	343	0.877 at 25° C.	1.443 at 25° C.	8.9 at 25° C.						30

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.[e]	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	% Loss, 4-mil Film: 24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	% Extraction, 10 days, 23° C., 4-mil Film: Oil	Spew, 2 days, 60° C., 100% Humidity[b]	
	Simple Plasticizers (Continued)													
53	Di(butyl CELLOSOLVE) phthalate	47.8[e]							2.1		4.8	11.4	None	OA
54	Di(CARBITOL) phthalate	54.4[e]							2.0		10.1	9.9	None	OA
55	Tri-*n*-butyl acetylcitrate												——	Pf
56	*n*-Butyl palmitate												——	AH
57	Tricresyl phosphate	75	2880	274	58	580	+5	−3	0.1		0.7	6.1	None	Cel, Mon, OA, Pitt
58	*n*-Butyl benzyl sebacate												——	Har
59	Methyl acetylricinoleate	47.8[e]							3.8		9.5	11.0	——	Bak
60	Methyl CELLOSOLVE oleate	50.5[e,f]							3.6		3.0	10.3	——	AH, Kes, OA
61	Di(2-ethylbutyl) azelate	44.5	2800	260				−40	5.2		1.5	18.0	None	Em
62	Propylene glycol monoricinoleate												——	Bak
63	Methyl CELLOSOLVE stearate												——	AH, Kes

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[e] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[38]

[f] Mixture of 0.63 part plasticizer to 1 part tricresyl phosphate.

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
64	n-Butyl ricinoleate	$C_{22}H_{42}O_3$	355									
65	Di(1,3-dimethylbutyl) sebacate	$C_{22}H_{42}O_4$	371	0.911	1.439 at 25° C.	9.2 cs. at 38° C.						
66	Di(2-ethylhexyl) adipate	$C_{22}H_{42}O_4$	371	0.927	1.447 at 20° C.	13.7	Insol.	0.12				41
67	Diisoöctyl adipate	$C_{22}H_{42}O_4$	371	0.928	1.448 at 25° C.	17.7					–	38
68	Dicapryl adipate	$C_{22}H_{42}O_4$	371	0.915	1.440 at 25° C.	8.3 cs. at 38° C.						
69	Diethylene glycol dipelargonate	$C_{22}H_{42}O_5$	387	0.963	1.447 at 20° C.	19						
70	Di(butyl CELLOSOLVE) sebacate	$C_{22}H_{42}O_6$	403	0.970							0.04	
71	Triethylene glycol di(2-ethyl hexanoate)	$C_{22}H_{42}O_6$	403	0.968	1.444 at 20° C.	16.1	Insol.	0.4	*M*	*M*	0.18	50
72	Triethylene glycol dicaprylate	$C_{22}H_{42}O_6$	406 (av.)	0.973								
73	Di(butyl CARBITOL) adipate	$C_{22}H_{42}O_8$	435	1.02 at 16° C.		15 at 22° C.						
74	n-Butyl stearate	$C_{22}H_{44}O_2$	341	0.858	1.444 at 20° C.	7.9 at 25° C.						59

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	% Loss, 4-mil Film: 24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	% Extraction, 10 days, 23° C., 4-mil Film: Oil	Spew, 2 days, 60° C., 100% Humidity[b]	
	Simple Plasticizers (Continued)													
64	n-Butyl ricinoleate												——	Dee
65	Di(1,3-dimethylbutyl) sebacate												——	Har
66	Di(2-ethylhexyl) adipate	51	2730	318	67	600	−15	−53	3.5	12.2	2.2	21.0	None	CCCC, Gdr, MWi, Kes, OA, Har
67	Diisoöctyl adipate												——	Kes, MWi, OA, Pitt, RCA, Har, Osb
68	Dicapryl adipate												——	Har
69	Diethylene glycol dipelargonate	51.3	2800	330			−15	−48	6.9		6.0	22.0	Yes	Em
70	Di(butyl CELLOSOLVE) sebacate												——	Dee
71	Triethylene glycol di(2-ethylhexanoate)	59	2680	300	69	800	−17	−50	4.7	12.4	2.0	22.6	None	CCCC
72	Triethylene glycol dicaprylate												——	RCA, Drew
73	Di(butyl CARBITOL) adipate												——	Thi
74	n-Butyl stearate												——	CS, AH, Har, Kes, OA

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.: In Water	Solubility, % at 20° C.: Water in	Solubility, % at 20° C.: In Mineral Oil	Solubility, % at 20° C.: Mineral Oil in	Volatility of Free Plasticizer in Air, mg./sq. cm./hr.: 212° F. (100° C.)	Volatility of Free Plasticizer in Air, mg./sq. cm./hr.: 375° F. (191° C.)
	Simple Plasticizers (Continued)											
75	n-Butyl oleate	$C_{22}H_{42}O_2$	339	0.864 at 25° C.	1.449 at 25° C.	7.7 at 25° C.						
76	Tetrahydrofurfuryl oleate	$C_{23}H_{42}O_3$	366	0.925	1.466 at 20° C.	17.8						
77	Methyl CELLOSOLVE acetylricinoleate	$C_{23}H_{42}O_5$	399	0.955	1.456 at 20° C.	42.1	Insol.	0.6	*M*	*M*		12
78	o-Xenyl diphenyl phosphate	$C_{24}H_{19}O_4P$	402	1.233	ca. 1.586 at 60° C.	30–55 at 60° C.	Insol.	0.35	2.22	0.3	0.005	20
79	Dibenzyl sebacate	$C_{24}H_{30}O_4$	382	1.055 at 30° C.	1.520 at 30° C.	13.0 ca. at 38° C.						
80	Di(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	390	0.986	1.486 at 20° C.	81.0	Insol.	0.20	*M*	*M*	0.02	34
81	Diisoöctyl phthalate	$C_{24}H_{38}O_4$	390	0.987	1.486 at 20° C.	83.0						19
82	Dicapryl phthalate	$C_{24}H_{38}O_4$	390	0.966	1.479 at 20° C.	66.7						22
83	Di(2-ethylhexyl) tetrahydrophthalate	$C_{24}H_{42}O_4$	395	0.969	1.466 at 20° C.	42.0	Insol.	0.26				30
84	Tetra-n-butyl thiodisuccinate	$C_{24}H_{42}O_8S$	491	1.064	1.462 at 20° C.	63.6	Insol.	0.22				6
85	Di(2-ethylhexyl) hexahydrophthalate	$C_{24}H_{44}O_4$	397	0.956	1.461 at 20° C.	38.9						37
86	n-Butyl acetylricinoleate	$C_{24}H_{44}O_4$	397	0.929	1.456 at 25° C.	35.2						30

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]: Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_f, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film: 10 days, 60° C.	% Loss, 4-mil Film: 24 hours, 70° C.	% Extraction, 10 days, 23° C., 4-mil Film: Water	% Extraction, 10 days, 23° C., 4-mil Film: Oil	Spew, 2 days, 60° C., 100% Humidity[b]	Supplier[m]
	Simple Plasticizers (Continued)													
75	n-Butyl oleate												——	AH, Kes
76	Tetrahydrofurfuryl oleate	59[d]	2590	297	67	650	−8	−34	0.8		0.2	17.2	None	AH, Em, Pitt
77	Methyl CELLOSOLVE acetylricinoleate	50.8[c]							2.4		1.3	14.5	None	Bak, Dee
78	o-Xenyl diphenyl phosphate												——	Dow
79	Dibenzyl sebacate	45.3[c]							0.7		0.3	11.8	None	Har
80	Di(2-ethylhexyl) phthalate	61	2360	253	67	700	−3	−31	0.7	5.1	0	15.5	None	Bar, CCCC, Har, Mon, MWi, OA, Pitt, TE, DA, Gdr
81	Diisoöctyl phthalate	56	2700	300			−1	−27					None	Bar, Cab, Har, MWi, OA, Pitt, RCA
82	Dicapryl phthalate	64	2500	270			−5	−35	0.6		0	33.8	None	RH, Har
83	Di(2-ethylhexyl) tetrahydrophthalate	66	2590	320	68	560	−12	−37	4.1	11.5	0.2	21.8	None	CCCC
84	Tetra-n-butyl thiodisuccinate	64	3200	318	62	760	−2	−22	0	2.5	0.8	15.2	None	CCCC
85	Di(2-ethylhexyl) hexahydrophthalate	64	2580	300	68	750	−10	−34		9.7	0	25.4	None	CCCC
86	n-Butyl acetylricinoleate	55.4[c]											Yes	Bak

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[28]

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
						Simple Plasticizers (Continued)						
87	Butyl CELLOSOLVE oleate	$C_{24}H_{46}O_3$	383	0.885 at 25° C.	1.454 at 25° C.	5.5 at 25° C.						
88	Dinonyl adipate	$C_{24}H_{46}O_4$	398	0.914 at 25° C.	1.445 at 25° C.	18.5 at 25° C.						
89	n-Octyl n-decyl adipate (mixture)	$C_{24}H_{46}O_4$ (est.)	398 (av.)	0.920	1.450 at 20° C.	15.4						
90	Polyethylene glycol di(2-ethylhexanoate)	$C_{24}H_{46}O_7$	447	0.989	1.447 at 20° C.	25.1	Insol.	1.4				44
91	Butyl CELLOSOLVE stearate	$C_{24}H_{48}O_3$	385	0.883	1.446 at 25° C.	13.3						26
92	Tri(2-ethylhexyl) phosphate	$C_{24}H_{51}O_4P$	435	0.926	1.443 at 20° C.	14.1	Insol.	1.4	*M*	*M*		39
93	Di(2-ethylhexyl) azelate	$C_{25}H_{48}O_4$	413	0.918	1.450 at 20° C.	20						20
94	n-Octyl n-decyl phthalate (mixture)	$C_{26}H_{42}O_4$ (est.)	418 (av.)	0.975	1.484 at 20° C.	72						8
95	Isoöctyl n-octyl n-decyl phthalate (mixture)	$C_{26}H_{42}O_4$ (est.)	418 (av.)	0.978	1.485 at 20° C.	42.9						
96	Di(2-ethylhexyl) sebacate	$C_{26}H_{50}O_4$	427	0.912	1.451 at 20° C.	19.9						13
97	Diisoöctyl sebacate	$C_{26}H_{50}O_4$	427	0.917	1.447 at 25° C.	20.4 at 25° C.						
98	Dicapryl sebacate	$C_{26}H_{50}O_4$	427	0.907	1.444 at 25° C.	13.0 ca. at 35° C.						

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
						Simple Plasticizers (Continued)								
87	Butyl CELLOSOLVE oleate												——	Kes
88	Dinonyl adipate												——	Pitt
89	n-Octyl n-decyl adipate (mixture)	53	2550	295	78	1050	−7	−54		5.5	0.3	23.5	None	Herc, OA
90	Polyethylene glycol di(2-ethylhexanoate)	62	2690	308	70	750	−12	−44	2.8	8.8	3.0	19.4	None	CCCC
91	Butyl CELLOSOLVE stearate												——	AH, Kes, OA
92	Tri(2-ethylhexyl) phosphate	59	2640	300	66	980	−16	−57	3.2	6.8	0.6	24.8	None	CCCC
93	Di(2-ethylhexyl) azelate	57	2590	334	66	750	−17	−56	0.5		0.4	22.5	None	Em
94	n-Octyl n-decyl phthalate (mixture)	63	2640	318	64	640	−8	−38	0.2		0.3	21.8	None	Herc
95	Isoöctyl n-octyl n-decyl phthalate (mixture)	67	2720	334	66	470	−12	−39		3.9	0	22.4	None	Herc
96	Di(2-ethylhexyl) sebacate	60	2420	293	67	1700	−19	−56	0.08	4.6	0.3	20.2	None	Dea, Har, MWi, RH
97	Diisoöctyl sebacate												——	Har, Pitt, MWi
98	Dicapryl sebacate												——	Har

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

[b] Dash (——) indicates no data available.

[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Simple Plasticizers (Continued)											
99	2-Ethylhexanoic acid diester of *N,N*-bis(2-hydroxyethyl)-2-ethylhexanamide	$C_{28}H_{53}O_5N$	484	0.956	1.458 at 20° C.	139.2	Insol.	0.5				12
100	Tri(*p-tert*-butylphenyl) phosphate	$C_{30}H_{39}O_4P$	495			f.p. 95–99.5 °C.						0.9
101	Glyceryl triricinoleate	$C_{57}H_{104}O_9$	933	0.959 at 25° C.	1.477 at 25° C.							
102	Glyceryl tri(acetylricinoleate)	$C_{63}H_{110}O_{12}$	1060	0.964	1.469 at 25° C.	271						0.7
	Resinous Plasticizers											
103	AROCLOR 1242, chlorinated biphenyl			1.378–1.388 at 25° C.	1.627–1.629 at 20° C.		Insol.	<0.1	*M*	*M*	2.50	146
104	FLEXOL plasticizer R-2H, polyester			1.055	1.469 at 20° C.	ca. 20,000	Insol.	1.0				0.5
105	G.E. 2557, polyester			1.028	1.459 at 20° C.	306						3
106	G.E. 2559, polyester			1.060	1.492 at 20° C.	4278						1
107	PARACRIL C, nitrile rubber			0.984								0.2
108	PARAPLEX G-25, polyester		ca. 8000	1.06	1.470 at 20° C.	300,000						

M = Miscible.

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Simple Plasticizers (Continued)													
99	2-Ethylhexanoic acid diester of *N,N*-bis(2-hydroxyethyl)-2-ethylhexanamide	64	2730	327	63	650	−3	−23	0.4	1.7	1.1	11.0	None	CCCO
100	Tri(*p-tert*-butylphenyl) phosphate												——	Dow
101	Glyceryl triricinoleate												——	Bak
102	Glyceryl tri(acetylricinoleate)	68.6[c,d]							1.4		2.5	9.5	None	Bak
	Resinous Plasticizers													
103	AROCLOR 1242, chlorinated biphenyl	56.2[h]							4.5		0.6	0.6	None	Mon
104	FLEXOL plasticizer R-2H, polyester	90	3080	360	57	440	+3	−10	0	0	0	3.4	None	CCCO
105	G.E. 2557, polyester	72	2730	310	63	580	−2	−18	0.9	3.5	3.1	17.0	Very slight	GE
106	G.E. 2559, polyester	90[i]	2110	215	72	740	6	−6	0.6	2.3	2.7	7.1	Very slight	GE
107	PARACRIL C, nitrile rubber	108	2500	410			+7	−54	0.5		0.2	0.6	None	Nau
108	PARAPLEX G-25, polyester	82	2600	310	60	480	−1	−25	0.2		1.0	0.6	None	RH

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[25]
[d] Mixture of 0.9 part plasticizer to 1 part tricresyl phosphate.
[h] Only composition tested, does not yield standard elongation.
[i] Highest plasticizer content tested. Elongation at 1000 p.s.i. = 64%.
[m] For key to supplier abbreviations see page 903.

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Resinous Plasticizers (Continued)											
109	PARAPLEX G-40, polyester		ca. 6000	1.15	1.472 at 20° C.	290,000						0.6
110	PARAPLEX G-50, polyester		ca. 2200	1.084	1.470 at 20° C.	3000						1
111	PLASTOLEIN 9720, polyester		ca. 850	1.043	1.462 at 20° C.	431						2
	Hydrocarbon-Type Plasticizers											
112	Dow 276-V2, polymolecular product derived from α-methylstyrene			1.021	1.582 at 20° C.							
113	HB 40, partially hydrogenated mixture of isomeric terphenyls			1.007	1.570 at 25° C.	112.8						115
114	KENFLEX L, hydrocarbon resin made by reaction of formaldehyde + dimethylnaphthalenes			1.01 at 15.6° C.		f.p. −1° C.						
115	NEVILLAC 10° (PHO), a hydrindyl phenol derivative		240 (av.)	1.075 to 1.10 at 15.6° C.	1.597 at 25° C.	23,500 at 25° C.						
116	NEVINOL			1.03 to 1.08 at 15.6° C.	1.596 (av.) at 25° C.	65 to 110 at 25° C.						
117	PANAPLEX BN-1, alkylated aromatic hydrocarbon mixture			0.955	1.561 at 20° C.	151.6						
118	SOVALOID C, alkylated aromatic hydrocarbon mixture			1.038		105						

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence[a]												Supplier[m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4, °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity[b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Resinous Plasticizers (Continued)													
109	PARAPLEX G-40, polyester	67[j]	2780	310	69	760	1	−15	0.3		1.0	5.2	Slight	RH
110	PARAPLEX G-50, polyester	75	2630	320	62	680	0	−16	0.3		1.3	6.5	None	RH
111	PLASTOLEIN 9720, polyester	69	2850	312	66	900	− 7	−23	0.3	1.8	1.9	14	None	Em
	Hydrocarbon-Type Plasticizers													
112	Dow 276-V2, polymolecular product derived from α-methylstyrene	74[b]	2420	315	62	650	− 5	−24	1.4		0.6	22.6	None	Dow
113	HB 40, partially hydrogenated mixture of isomeric terphenyls	63[d]	2890	298	66	940	− 1	−23	3.4		0.5	15.5	None	Mon
114	KENFLEX L, hydrocarbon resin made by reaction of formaldehyde + dimethylnaphthalenes												——	Ken
115	NEVILLAC 10° (PHO), a hydrindyl phenol derivative	56.3[c, h]							13.3		0.1	0.1	None	Nev
116	NEVINOL												None	Nev
117	PANAPLEX BN-1, alkylated aromatic hydrocarbon mixture	63[d]	2800	310	66	920	2	−21	6.1		1.3	16.8	None	Pan
118	SOVALOID C, alkylated aromatic hydrocarbon mixture	61.4[l]	3100	280			+ 4	−16	11.5		1.7	9.0	None	SV

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.
[b] Dash (——) indicates no data available.
[c] 100% elongation, 1000 p.s.i., constant rate of loading of 810 p.s.i. per minute. See Reed.[28]

TABLE 15.3 (*Continued*)

PROPERTIES OF COMMERCIALLY AVAILABLE PLASTICIZERS ARRANGED IN ORDER OF ASCENDING NUMBER OF CARBON ATOMS

No.	Name	Formula	Molecular Weight	Specific Gravity, 20° C.	Refractive Index	Viscosity, cp. at 20° C.	Solubility, % at 20° C.				Volatility of Free Plasticizer in Air, mg./sq. cm./hr.	
							In Water	Water in	In Mineral Oil	Mineral Oil in	212° F. (100° C.)	375° F. (191° C.)
	Miscellaneous Plasticizers											
119	ARNEEL TOD, mixture of oleic, linoleic, and cyclic nitriles		ca. 278	0.910		30.2						
120	*n*-Butyl acetyl polyricinoleate, PG16		362 (av.)	0.918 at 25° C.	1.460 at 25° C.							
121	Chlorinated paraffin 40			1.164	1.505 at 23° C.	3100 at 25° C.						
122	FLEXOL plasticizer B-400, polypropylene glycol mono-*n*-butyl ether			0.995	1.449 at 20° C.	152	0.1	3.3				ca. 60
123	Glyceryl polyricinoleate, No. 15 oil			1.031 at 25° C.	1.483 at 25° C.							
124	HARFLEX 500, monomeric ester type			0.932	1.488 at 20° C.	17.0						
125	HERCOFLEX 600, a pentaerythritol ester		538 (av.)	1.006	1.453 at 20° C.	48.3						
126	OHOPEX Q-10, octyl fatty-phthalic acid esters			0.952	1.475 at 25° C.	41						
127	PARAPLEX G-60, high-molecular-weight ester		ca. 1000	0.994	1.474 at 20° C.	340 to 360						0.9
128	Plasticizer DP-520, chlorinated aliphatic product			1.126 at 15.6° C.	1.478 at 25° C.	66.4 ca. at 54° C.						
129	Polyethylene glycol dilaurate			0.97 at 25° C.								
130	SANTICIZER 180			1.071	1.506 at 20° C.	234						
131	STAFLEX KA, monomeric ester type											

No.	Name	Comparison of Properties of Vinylite Resin VYNW-5 Specimens Plasticized to Equivalence [a]												Supplier [m]
		Plasticizer p.h.r. at 23° C., 75% Elongation, 1000 p.s.i.	Tensile Strength, p.s.i. at 23° C.	Ultimate Elongation, % at 23° C.	Shore Durometer A at 23° C.	Stiffness at 23° C., p.s.i.	T_4 °C.	Brittle Temperature, °C.	% Loss, 4-mil Film		% Extraction, 10 days, 23° C., 4-mil Film		Spew, 2 days, 60° C., 100% Humidity [b]	
									10 days, 60° C.	24 hours, 70° C.	Water	Oil		
	Miscellaneous Plasticizers													
119	ARNEEL TOD, mixture of oleic, linoleic, and cyclic nitriles	52.8	2900	390				−44	11.7		0.7	14.8	None	Arm
120	*n*-Butyl acetyl polyricinoleate, PG16		Incompatible at 55.3 p.h.r.										—	Bak
121	Chlorinated paraffin 40	68 •	2820	335	57	900	− 5	−28	1.0		0	20	None	Halo, Dia, Herc, Hook
122	FLEXOL plasticizer B-400, polypropylene glycol mono-*n*-butyl ether												—	CCCC
123	Glyceryl polyricinoleate, No. 15 oil												—	Bak
124	HARFLEX 500, monomeric ester type	63	2400	319	67	980	−10	−51	1.1		0.4	23.0	None	Har
125	HERCOFLEX 600, a pentaerythritol ester	58	2910	327	66	900	− 2	−28	0	1.1		12.8	None	Herc
126	OHOPEX Q-10, octyl fatty-phthalic acid esters												—	OA
127	PARAPLEX G-60, high-molecular-weight ester	60	2800	317	67	880	− 2	−21	0.2		0.4	11.1	None	RH
128	Plasticizer DP-520, chlorinated aliphatic product												—	Drew
129	Polyethylene glycol dilaurate												—	Gly
130	SANTICIZER 180	73	2670	308	67	430	− 2	−17		2.7	1.3	12.2	None	Mon
131	STAFLEX KA, monomeric ester type												—	Dec

---

[a] 1000 p.s.i. tensile modulus at 75% elongation at 23° C. on tensile machine with constant rate of loading of 15,000 p.s.i. per minute.

11. c) Will product scrap be recycled to the mills? If so, will VOC be emitted by the scrap?

No, and as such no VOC will be emitted by the scrap.

12. Are the flow rates listed in the application from points 4 and 5 correct?

Yes, each emission point has two (2) fans and the duct velocity in each is 800 fpm. Given the area of each duct (1.76 ft.^2), the flow would equate to 1415 ACFM. In the original application the velocities in the ducts were incorrectly shown in feet per second. Those numbers were actually in feet per minute. Please excuse the typographical error.

13. What will be the percent of the lower explosive limit (LEL) at peak solvent evaporation rates for each exhaust stream?

The new ventilation system will be designed around peak solvent evaporation rates of 40% of the lower explosive limit and will incorporate the use of a lower explosive limit detection and control system designed to enhance safe operation.

14. What will be the percent of the threshold limit values (TLV) near the discharge points ≈ 20 feet outside the plant during peak solvent evaporation rates?

The control device, which will provide at least a 90% removal efficiency can be expected to reduce emission levels 20 feet from the exhaust discharge points to well below the current (OSHA) TLV's for Toluene 200 ppm and MEK 200 ppm, however, without extensive modeling an estimated percent of the TLV at the property line cannot be established. Please advise of the necessity of performing said modeling in view of the proposed control program.

15. a) How many employees will work at this plant?

61 full-time employees.

b) What impact will the emissions from the plant have on the ambient air quality, vegetation and visibility near the plant?

With the incorporation of a control device capable to continuous operation at or above 90% removal efficiency, adverse effects on air quality, visibility and vegetation are not anticipated since the control program reflects state of the art air pollution control technology.

16. If the solvents were recovered, could they be used or sold to a reclamation plant?

Yes, either avenue is a possibility.

17. What is the current delivered cost of the solvents used at the plant?

Toluene	$1.30/gallon
MEK	$ .36/pound

18. Has the company made any studies on recovering and reusing the solvents at the plant and, if so, what conclusions were reached?

Yes, preliminary studies suggest that recovery and on-site re-use are well within the realm of feasibility, however, the necessary equipment requires a very substantial capital investment.

19. Please explain price estimate.

Enclosed you will find a copy of a budget quotation for a 25,000 SCFM solvent recovery plant (Appendix VI) which includes equipment and installation. Our original $700,000.00 figure also included ventilation rework estimates and process control system installation. At this time it is not possible to guarantee that a solvent recovery or thermal incineration device will be of this size or cost since efforts are now underway to reduce the size of the system, however, if a system of such size is necessary due to the nature of the process (non-continuous peak evaporation type), the original $700,000.00 figure is a very real number.

20. How many gallons of VOC per year will be shipped to Emille for disposal?

Approximately 220 (55 gallon drums) which would contain some 5,000 gallons of VOC. (By estimate.)

DISCUSSION:

In accordance with our recent conversation and the historical data provided in item one, David 'M' Company may be considered a major source of air pollution in an uncontrolled state. As such a B.A.C.T. type standard would be applicable and will likely approximate the 2.9 lbs. VOC/gallon of coating applied or 90% removal of VOC from the exhaust stream. David 'M' Company cannot meet the afore-mentioned low solvent technology standard and will be obligated to propose the control device intended for use in meeting the 90% removal standard referenced above. While I cannot guaranty at this time the exact type of control device which David 'M' Company will install, I can state that both recovery and thermal destruction techniques capable of delivering 90% removal of VOC's from exhaust streams are being evaluated.

The attached schedule estimates the time periods associated with specifying the type of control device and ultimately installing same. Would you please advise me of the proposed schedule's acceptability. We believe this schedule to be a fair appraisal of the time necessary to complete the installation of a project of this magnitude. Should you require further information and/or assistance, please do not hesitate to contact me directly.

Sincerely,

Michael A. Ware

Michael A. Ware
Graphics Div. Env. Coord.
Chemicals & Coatings Group
Wheelabrator-Frye, Inc.

MAW:bjw
Attach.

October 19, 1983

ESTIMATED

OVERALL COMPLIANCE SCHEDULE

DAVID M COMPANY VOC CONTROL PROJECT

PHASE	
Data Accumulation	January 1, 1984
Spreader Enclosure - (1) For Temperature Evaluation	January 15, 1984
Process Modifications and Development	April 1, 1984
Methods Comparison/Analysis - Thermal Incineration Vs. Recovery	May 15, 1984
Final Specification Development	July 1, 1984
Final Specification/Quotations and Analysis	September 1, 1984
Appropriations Request Development and Approval	December 1, 1984
Oven Enclosure and Exhaust System Installation	March 1, 1985
Solvent Recovery Delivery and Installation	August 1, 1985
Operational Shakedown, Debugging and Compliance Testing	December 1, 1985

APPENDIX VI

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~008020~~ 240189

COPY

YOUR REF:

OUR REF: E 0379
S 7212

DATE: 2 August 1983

PROPOSAL

FOR

SOLVENT RECOVERY SYSTEM

TO BE LOCATED AT:

DAVID M. COMPANY

201 VALENTINE WAY
LONGWOOD, FLORIDA

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908020~~ 240189

YOUR REF: OUR REF: S 7212 DATE: 2 August 1983

David M. Company
201 Valentine Way
Longwood, Florida

SOLVENT RECOVERY PLANT

ACTIVATED CARBON ADSORPTION UNIT

AIRFLOW....................................25,000 scfm.

AIR TEMPERATURE...........................140° F.

SOLVENT CAPACITY........................50 gph (360 lb/hr)

SOLVENT....................................Toluene

AUTOMATICALLY CONTROLLED

BY

GAS ANALYSER

PRELIMINARY PROPOSAL

PLANT DESCRIPTION

The solvent laden air would be filtered to remove dust, cooled to approximately 95° F by the air cooler and then delivered by the fan to the three adsorbers.

Two of the three adsorbers would normally be handling the solvent laden air whilst the other would be regenerating with steam to extract the solvent from the carbon or would be held on "stand-by" following "steaming" and a short dry/cool period.

The adsorbers would cycle consecutively and automatically with override of the cycle time and steam input by gas analyser control. The proposed adsorbers are of annular bed design, the solvent air after filtering and cooling passes through an automatic inlet valve into the outer annulus of the adsorber, through the carbon bed and then exhausts to atmosphere through the inner annulus and the automatic exhaust valve.

At the end of an adsorbing period the air inlet and outlet valves close and an automatic steam valve allows steam to enter the inner annulus of the adsorber and pass through the carbon bed to the outer annulus from which point the steam together with solvent vapour extracted from the carbon passes to the condenser. During steaming some condensation occurs on the outer shell of the adsorber and is drained through filters to join the main condensate flow from the condenser to the decanter.

At the end of the steaming period the adsorber automatic steam valve shuts and the air inlet and outlet valves open to allow solvent laden air to again pass through the adsorber for a short period to dry and cool the bed (during this dry/cool period the solvent laden air is shut off from the other adsorber). The inlet valve of the dried/cooled adsorber would then close and the adsorber would be held on "stand-by" until the gas analyser, sampling the exhaust of the other adsorber, or the override timer, gives the signal for that adsorber to change to the steaming cycle, the stand-by adsorber being first brought back into service, so that there is no interruption to the adsorber cycle.

Any incondensibles from the condenser return through the condenser vent pipe to the inlet duct for recycling through the adsorbers. The condenser vent is fitted with high temperature alarm to indicate overloading from excessive steam flow or shortage or failure of the cooling water supply.

Safety features include adsorber pressure and vacuum relief valves and liquid seals.

We would supply the following:

1. <u>AIR FILTER</u> - 25,000 scfm capacity

   a) <u>Pre-Filter Section</u>

   With removable and disposable fiberglass panels to protect and extend the life of the main filter.

   b) <u>Main Filter Section</u>

   With disposable filter elements of the HEPA type of fiberglass material, with an efficiency of better than 99% for particles down to 0.3 microns per standard tests.

   The whole of the above would be incorporated in a galvanized steel case with access doors to facilitate servicing.

   A differential resistance gauge would be fitted.

2. <u>AIR COOLER</u> - 25,000 scfm capacity.

   Would be of finned tube design with copper tubes and aluminum fins to cool the inlet airstream from 140° F to approximately 95° F when supplied with cooling water at a temperature of maximum 86° F.

   The air cooler coils would be housed in a galvanized steel case and would be drainable.

3. <u>FAN AND MOTOR</u>

   The fan would be of the high efficiency type with airfoil impeller capable of handling 25,000 scfm of solvent laden air, when at an actual temperature of approximately 95° F, at a total pressure of approximately 18" w.g., allowing for 2" w.g. suction before the air filters.

   The casing would be of substantial carbon steel construction and the unit would have spark-proof features to AMCA standards.

   The impeller would be driven through a flexible coupling by a 125 HP explosion proof motor to Class 1, Group D, Division 1, 460 volt, 3 phase, 60 cycles.

   A manually operated radial leaf damper would be fitted at the fan inlet for regulation of the airflow.

4. THREE ADSORBERS - 6'8" diameter x approximately 10'0" high shell.

Each capable of handling 12,500 scfm of solvent laden air calculated at 70° F, when at an actual temperature of approximately 95° F.

The adsorbers would be of the annular carbon bed type with the carbon contained between stainless steel panels formed up into cyclinders and reinforced by carbon steel stiffening bands. The activated carbon bed and screens would be supported upon a carbon steel tray to which would be connected the solvent laden air inlet valve, vapour piping to condenser and liquor drains. The air exhaust valve and the steam valve would be connected to the outlet branch of the adsorber.

The carbon bed and screens would be contained within a removable carbon steel shell, fitted with access and inspection holes with bolted cover plates. Flanged connections would be fitted to the tray so that the carbon could be easily and quickly run off into drums.

Vacuum and pressure relief valves would be provided for each adsorber.

Handrails would be fitted round the tops of the adsorbers, with a walkway over and between the adsorbers, and with an access ladder from ground level, in accordance with the requirements of OSHA.

5. ACTIVATED CARBON

We would provide the initial charge of approximately 6400 lbs of high quality carbon for each of the three adsorbers. The carbon would be manufactured by Sutcliffe Speakman and would be of the grade most suited to the required duty.

6. INLET AND OUTLET AIR VALVES - 26" diameter

We would provide an inlet and outlet valve for each adsorber 26" diameter of the mushroom type of substantial construction arranged for pneumatic operation through the automatic control mechanism.

Renewable seats would be fitted in the valve bodies and access holes with bolted cover plates provided. An indicator would be fitted to each valve so that the attitude of the valve could be easily ascertained.

7. CONDENSER

To condense the steam and solvent vapours leaving an adsorber during the steaming period.

The unit would be of the tubular surface type with the shell in 304 stainless steel and the tubes in 316 stainless steel The water boxes and tubeplates would be in carbon steel.

The condenser vent pipe (fitted with thermometer with high temperature alarm contacts) would be connected to the inlet duct so that any incondensibles displaced from the adsorbers would recycle.

8. ONE DECANTER - 3'0" diameter x 4'6" high

It would be of the self-adjusting decanting type to separate automatically the condenser water and solvent. The tank would be of carbon steel welded construction fitted with a bolted cover plate and all the necessary connections. A sight glass would be fitted in the solvent outlet.

9. TRUNKING

We would provide the interconnecting trunking between the air filter, air cooler, fan and adsorbers, but do not allow for any trunking prior to the inlet manifold of the air filter. The trunking would be of carbon steel of welded construction flanged at suitable intervals and be adequately supported.

10. THREE EXHAUSTS

An exhaust stack would be provided for each adsorber, of carbon steel welded construction, galvanized and would terminate about 6' above the adsorber platform.

11. PIPING AND VALVES

We would provide pipework to interconnect the above and manifold the service pipes to terminal flanges at the battery limits.

Vapour and liquor piping would be in 304 stainless steel, utility piping in carbon steel.

We include for all isolating valves, steam traps, pipe supports, etc.

12. PLANT CONTROL UNIT

Would consist of the following:

a) Gas Analyser (Infra-Red Type)

To measure the solvent content in the exhaust airstream of the adsorber next due for desorbing and to delay steaming until the set point was achieved. However, an adjustable override timer would be incorporated into the program to limit the period of such a delay.

A strip recorder for the exhaust gas concentration would be included and the unit would have a "high level" alarm.

b) Programmable Logic Controller

Of the solid state type which on receipt of the appropriate signals would cause the adsorber valves to sequence as appropriate. The program logic would be such that the next step would not be commenced until the previous one had been proven completed.

In the unlikely event of failure of the P.L.C. the solvent recovery plant could be operated manually by the use of pilot air solenoid valves inbuilt into the panel.

c) Annunciation Section

Of the 'Panalarm' type or similar to alarm:
"high level" - gas analyser output
"high temperature" - condenser vent

d) Control Panel

The above items would be mounted in a free-standing enclosure, suitable for indoor location in a non-hazardous area, assumed within 50' of the adsorbers.

The panel would be pre-wired and tubed to terminal points on the frame. We exclude the impulse tubing from the panel to the plant items.

13. INSTRUMENTS

We would provide the following indicating type instruments which would be locally mounted on the plant:

4 Dial type thermometers
1 Steam pressure gauge
1 Differential pressure gauge (resistance through air filter)
1 4-Point pressure gauge (air pressure and suctions within the plant)

14. STRUCTURES

We would provide structures to support items of the plant.

15. PAINTING

Where applicable, plant items would be primer coated before shipment.

16. COMPRESSED AIR

You to supply compressed air, clean, dry and oil free at a pressure of approximately 80 psig.

17. DRAWINGS AND INSTRUCTIONS

We would provide three (3) copies of each of the following:

Foundation drawing
Flowsheet
Plant arrangement drawing
Major assemblies

Plus two (2) copies of:

Erection drawings and instructions
Operating and Maintenance Manual

A list of recommended spares would also be provided.

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908020~~ 240189

YOUR REF: OUR REF: DATE: 2 August 1983

David M. Company
201 Valentine Way
Longwood, Florida

TERMS, PRICE AND CONDITIONS

PRICE OF PROPOSAL

PROPOSAL NO. S 7212

For the supply of the whole of the items as specified in this proposal, delivered only to your works in Longwood, Florida (offloading from the transport and installation by others) would be the sum of approximately..$ 370,000.00

(THREE HUNDRED SEVENTY THOUSAND DOLLARS)

Any Federal, State or local taxes that may be applicable are excluded.

TERMS OF PAYMENT

25% of quoted price with order.

45% of quoted price in three (3) equal payments pursuant to invoices on the following basis:

a) upon submission of preliminary drawings comprising plant arrangement and foundation drawings and flowsheet.

b) upon submission of confirmation that the manufacture is at least 40% complete.

c) upon submission of confirmation that the manufacture is at least 70% complete.

25% of quoted price upon despatch or when ready for despatch if despatch date is delayed by you.

5% of quoted price on start-up and successful operation, at latest three (3) months after despatch, or when ready for despatch, whichever is sooner.

Continued.........

TERMS, PRICE AND CONDITIONS...continued

DESPATCH

Approximately six (6) months from receipt of order assuming that there are no delays due to changes in specifications or approval of drawings.

EXCLUSIONS

We do not include for any motor controls, electrical wiring, or any special cold weather protection or insulation, or any parts, materials, work for services of any kind whatsoever except those specifically mentioned in the body of the proposal.

STANDARD OF MANUFACTURE

The goods described in this proposal would be manufactured to normal commercial standards and be suitable for the duty specified. Should you desire manufacture to any specific standards, codes or inspection schedules other than those allowed for then we will be pleased to comply with your requests, but any extra charges so incurred would be in addition to the prices quoted.

VALIDITY OF PROPOSAL

This proposal is open for acceptance for a period of thirty (30) days from the date of this quotation and after this period confirmation must be obtained that the terms and conditions contained herein are still valid.

SUTCLIFFE SPEAKMAN INCORPORATED

William C. Moses
Vice President

E. & O. E.

WCM/pmd

UTILITY REQUIREMENTS

The following are the approximate utility requirements of the plant when operating at design load conditions. The figures are subject to confirmation by our final design study.

STEAM	1190 lb/hr, dry saturated quality at 40 psig.
COOLING WATER	170 gpm, inlet 86°, maximum, return 115°.
POWER	100 KwH.
COMPRESSED AIR	20 scfh.

SPACE

The equipment, we estimate, would require a floor area of approximately 45' x 20'.

The height of the equipment would be approximately 18', but if it is to be located inside, then provision should be made for lifting of the adsorber shells.

APPENDIX 'A'

OUR PRELIMINARY PROPOSAL FOR THE TURNKEY INSTALLATION OF THE PLANT QUOTED IN MAIN PROPOSAL NO. S 7212

1. FOUNDATIONS

We would provide concrete foundations for the appropriate items of our equipment.

Our price is conditional on the understanding that the ground is of suitable load bearing capacity, that no rock blasting or piling would be required and that all work would be above the water table.

2. MOTOR CONTROL CENTER

We include the starters for the fan motor, the water cooling tower fan and the recirculating water pumps, and which would be suitable for location in a non-hazardous area which we assume will be by the control panel.

3. WATER COOLING TOWER

Corrosion Inhibitor is ?. Chromate

We would supply and install a water cooling tower designed to cool the required amount of water from 115° F to approximately 86° F. The tower would be of induced draft type and complete with fan and motor. The system would include two pumps with motors (one normally operating, one stand-by) and the water circulating piping and valves between the water cooling tower and the air cooler and condenser of the recovery plant, the water cooling tower to be at ground level and located adjacent to the recovery plant.

4. INSTALLATION

We include for the necessary labour, tools, moving and lifting gear including cranes, for the installation of the items of equipment specified in this proposal onto the foundation.

4. INSTALLATION...Continued

It is understood that the work would be undertaken during our normal working hours and that we and our sub-contractors or agents would be allowed free and unrestricted access to the site.

Any overtime worked at your request would be chargeable extra at the rate in force at the time.

You would be responsible for offloading from the transport any items delivered prior to the start of the installation work and provide suitable storage and protection for all parts close to the battery limits.

All temporary site support facilities including but not limited to water, electricity, steam, drain, office and telephone would be provided by you at your expense, adjacent to the site.

Note that the quoted price assumes we will have continuity of work on site.

5. SUPERVISION

We include for the services of our own suitably qualified supervisor to supervise and give instructions to the labour provided by our sub-contractors, to secure the installation of the equipment in a competent manner.

6. IMPULSE TUBING

The pneumatic tubing from the appropriate plant items to the control panel would be supplied and installed in a workmanlike manner. It is assumed that the tubing run is a maximum of fifty feet.

7. ELECTRICAL WIRING

We would supply and install all necessary electrical wiring, cable trays, etc. to interconnect the various items of plant to the motor control center and the control panel, assuming a maximum cable run of fifty feet from the adsorbers. Where appropriate, the wiring would be to explosion proof, classification.

8. INSULATION/WINTERIZATION

Insulation and heat tracing of appropriate equipment within our battery limits effected, assuming a minimum ambient temperature of 25° F.

9. START-UP

We include for the services of a skilled engineer for a period of two (2) consecutive weeks on site to start-up the plant and provide instructions to your personnel on its operation.

Any extra time required by you or non-continuity in attendance would be at additional cost.

10. INSURANCE

We would provide and maintain the following insurances and would require any and all sub-contractors employed by us at your site to procure and maintain the same type and amount of insurance.

a) Workman's Compensation and employer's Liability
 - $100,000.00 each accident and aggregate disease.

b) Comprehensive General Liability
 - Bodily injury and Property damage of up to $1,000,000 combined single limit.

c) Comprehensive Automobile Liability
 - To cover owned, non-owned, leased and hired cars, combined single limit $1,000,000.

Certificates of the above shall be provided to you prior to the start of our on site work.

In addition to the above and in order to insure the equipment from its delivery to your site, through installation to your acceptance of the plant, we would take out "all risks" insurance plus "builders risk" and "installation floaters" at the appropriate time and at your expense.

BUDGETARY PRICE

Our approximate additional price to that quoted in Main Proposal No. S 7212 for the turnkey installation of the plant as detailed in this Appendix 'A' would be the sum of ....$ 160,000.00.

(ONE HUNDRED SIXTY THOUSAND DOLLARS)

COMPLETION

We would expect to supply and install the specified plant in approximately nine (9) months from receipt of order.

TERMS AND CONDITIONS

Otherwise as Main Proposal No. S 7212.

SOLVENT RECOVERY

WITH

ACTIVE CARBON

SUTCLIFFE SPEAKMAN, INC.

Sutcliffe Speakman have specialised for over 50 years in the design and manufacture of Solvent Recovery plant. Their unique position in the industry stems from a background of almost 80 years experience in the manufacture of active carbon for general adsorption and catalytic applications.

SOLVENT RECOVERY WITH ACTIVE CARBON

Our recovery plants are in world-wide use in a great variety of solvent-using industries, ranging from coating, impregnation and printing of materials to the manufacture of man made fibres.

Our active carbon plants for the recovery of industrial solvents, from air or gas mixtures, can give a recovery efficiency of at least 99% by volume depending on the conditions. In addition to vapour phase recovery, active carbon plants can efficiently extract and recover solvents and organic compounds from water and other liquid mixtures.

MONEY SAVING

Recovery plants save industry millions a year and the dramatic savings on solvent costs ensure more economic production.

CLEAN AIR

The adsorption efficiency of Sutcliffe Speakman plant is extremely high, effecting an important contribution to clean air.

LIQUID EFFLUENTS

Can also be purified with an active carbon plant.

WORKING CONDITIONS

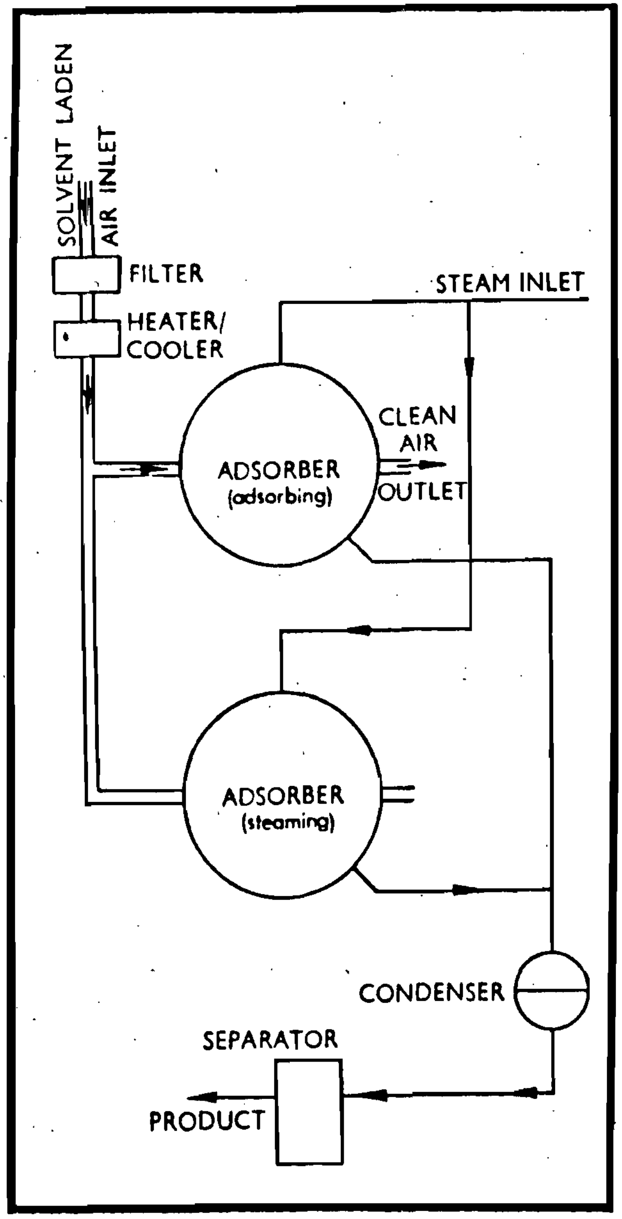
A general improvement in working and safety conditions often results from the effective collection system required to achieve high overall efficiency.

WHEN IS IT WORTHWHILE?

If you are using more than 200 gallons a week of alcohols, esters, ethers, ketones, hydrocarbons, chlorinated compounds and other organic solvents, it is certainly worth giving preliminary consideration to the economic potential of installing recovery plant. The actual economics depend upon the cost of new solvent, the concentration of solvent in air entering the plant, the number of hours per week which the process will operate and the possible ancillary equipment which may be necessary to prepare the recovered solvent for re-use. This may be required if the solvent is water miscible or where a mixture of different solvents may be recovered together and necessitate separation.

Sometimes solvent quantities as low as 1 gallon per hour can be economically recovered. WRITE TO US, WE WILL ADVISE WHETHER A DETAILED STUDY IS JUSTIFIED.

BASIC FLOW DIAGRAM



HOW IT WORKS

The Sutcliffe Speakman system draws air laden with solvent vapour through a ducting into the plant when, if necessary, it is first filtered to remove dust or other contaminants and then heated or cooled to a suitable temperature before passing into an adsorber which contains a bed of active carbon. The solvent vapour is adsorbed on the carbon and the clean air is discharged to atmosphere. When the carbon bed has adsorbed the designed charge of solvent, the vapour/air stream is switched to a second adsorber and steam at low pressure is introduced to the charged adsorber which causes the carbon to release, in vapour form, the solvent which it adsorbed. The steam/solvent vapour mixture is then condensed and the solvent recovered.

If the solvent is insoluble in water, a separator is provided to divide the condensate into a solvent layer and water layer which automatically leave the separator by gravity flow. If the solvent is water soluble, the condensate is taken to a distillation unit or liquid phase adsorption system for final separation.

CARBONS

The wide range of Sutcliffe Speakman carbons developed specially for solvent recovery give a high degree of adsorption efficiency at relatively high velocities. These carbons also have low retention characteristics, so that steam usage for the regeneration of beds is minimised. The most suitable carbon is selected to meet the particular conditions under which the plant will operate.

PLANT

Sutcliffe Speakman design their adsorbers to give maximum surface area of carbon, thereby ensuring the minimum resistance to air-flow, and a relatively lower power consumption. Adsorbers are designed with static or rotary beds.

Automatic operation of the adsorber valves with variable time cycle, is effected by instrumentation or by the robust Sutcliffe Speakman standard control unit.

In normal applications the adsorbers are not subjected to pressures of more than 0.5 lbs/square inch. Where necessary, plants can be designed for operating at higher pressures.

If required, plant can be designed for further extension to suit clients needs.

The rotary bed plants and a range of static units can be supplied as fully "packaged" plants. Wherever practicable, all plants are pre-assembled in our works before despatch. Full erection and maintenance services are available including contract visits by Technical Service Engineers.

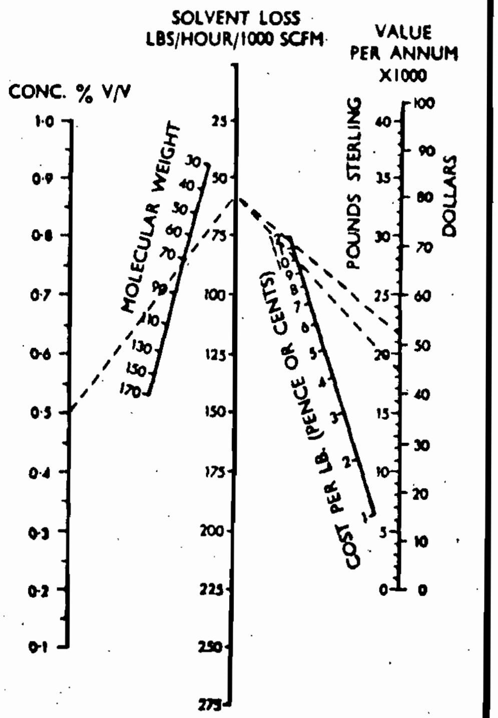
SOLVENT CONCENTRATION IN AIR

The adjacent diagram shows the quantities of solvent in relation to air flow at given volume/volume concentrations, corrected to the normal temperature and pressure conditions at the inlet to the recovery plant, with indication of solvent value per annum.

It is important that the concentration of solvent in the air stream from a process is, where applicable, well below the lower explosive limit of that particular solvent vapour in air, to ensure a satisfactory operational safety margin. It is normally considered that the quantity of air flow from a process should be sufficient to ensure that the concentration of solvent vapour in air is no more than a maximum of 50% of the lower explosive limit.

Conversely it is usually necessary to ensure that the concentration is not too low, or the size of plant required to handle air flow may be larger than can be justified economically in relation to the quantity of solvent to be recovered. The ideal concentration range is usually between 20%-40% of the lower explosive limit.

Sutcliffe Speakman technical staff are available to advise on the collection of solvent from your process to ensure that maximum overall recovery efficiency is achieved, and that the desirable air flow from an economic point of view is sufficient to collect the solvent vapours effectively.



EXAMPLE:

0·5% CON. METHYL ETHYL KETONE —M.W. 72·1

LOSS 56·5 LBS/HOUR/1000 SCFM OF AIR

VALUE PER ANNUM (OF 8000 HOURS) AT 10 PENCE/LB IS £18.800

VALUE PER ANNUM (OF 8000 HOURS) AT 11·5 CENTS/LB IS $52,000

TABLE OF MOLECULAR WEIGHTS AND LOWER EXPLOSIVE LIMITS FOR SOME TYPICAL INDUSTRIAL SOLVENTS

	A	B		A	B
Acetone	58.08	2.15	Methyl Acetate	74.08	4.1
Benzene	78.11	1.4	Methyl Alcohol	32.04	6.72
Butyl Acetate (Normal)	116.16	1.7	Methyl Ethyl Ketone	72.10	1.81
Butyl Acetate (Iso)	116.16	2.4	Methylene Chloride	84.93	Non-flam.
Butyl Alcohol (Normal)	74.12	1.45	Nonane	128.25	0.74
Butyl Alcohol (Iso)	74.12	1.68	Octane	114.23	0.95
Carbon Disulphide	76.13	1.0	Pentane (Normal)	72.15	1.3
Carbon Tetrachloride	153.84	Non-flam.	Pentane (Iso)	72.09	1.3
Chloroform	119.39	Non-flam.	Perchlorethylene	165.85	Non-flam.
Cyclohexane	84.16	1.35	Propyl Acetate (Normal)	102.3	2.0
Decane (Normal)	142.28	0.7	Propyl Acetate (Iso)	102.3	2.0
Dichloroethylene	97	9.7	Propyl Alcohol (Normal)	60.09	2.15
Ether (Diethyl)	74.12	1.85	Propyl Alcohol (Iso)	60.09	2.02
Ethyl Acetate	88.10	2.25	Tetrachlorethane	167.86	Non-flam.
Ethyl Alcohol	46.07	3.3	Tetrahydrofuran	72.10	1.84
Ethylene Dichloride	98.97	6.2	Toluene	92.13	1.3
Furfural	96.08	2.1	Trichlorethylene	131.4	Non-flam.
Heptane (Normal)	100.2	1.0	Xylene	106.16	1.0
Hexane (Normal)	86.17	1.25			

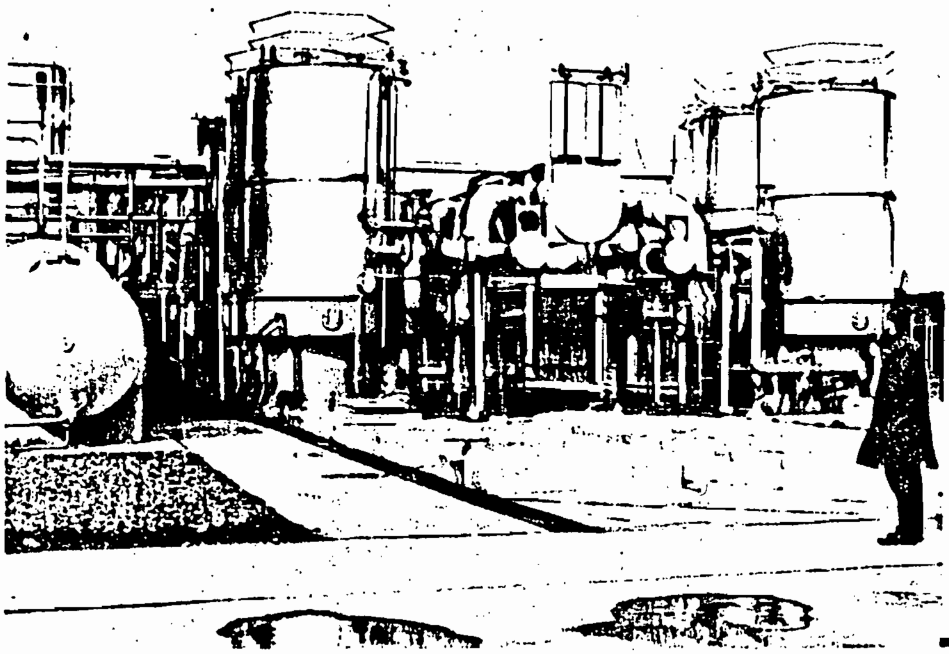
A Mol. Wt.

B Lower Explosive Limit in Air % V/V at 20°C and approx. atmospheric Pressure

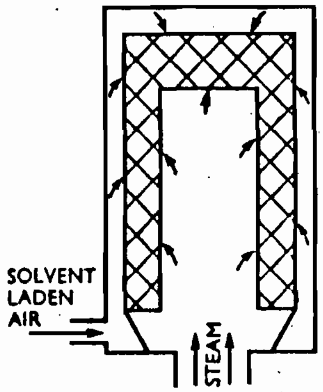
Sutcliffe Speakman manufacture two principal types of Gaseous Phase Recovery Plant—
Both types employ active carbon.

STATIC BED PLANT

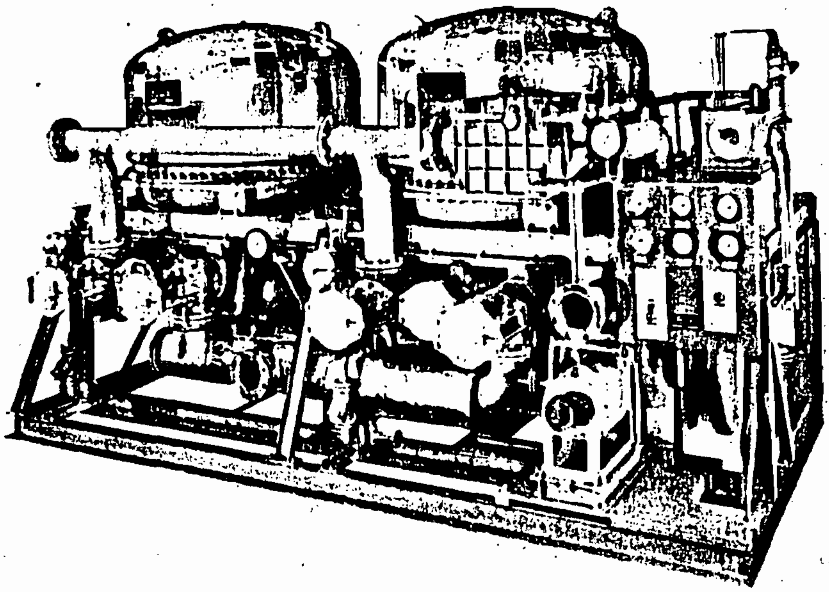
A static plant usually consists of two or more adsorbers each containing a vertical annular or flat bed of active carbon. One or more of the adsorbers receives the solvent laden air whilst one or more are being steamed out to recover the solvent. The adsorbers are suitably valved and cycle automatically so that the process is continuous. The smaller plants can be of packaged design, skid mounted. Plants are individually designed to meet customers specifications.



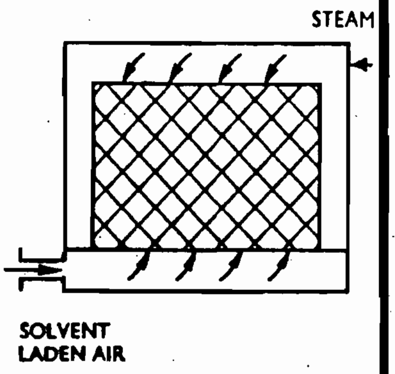
Adsorption section of a large recovery complex at an Acetate Fibre Factory in Belgium. The plant is arranged for future extension.



ANNULAR BED



Packaged type fully automatic plant of cylindrical flat bed design



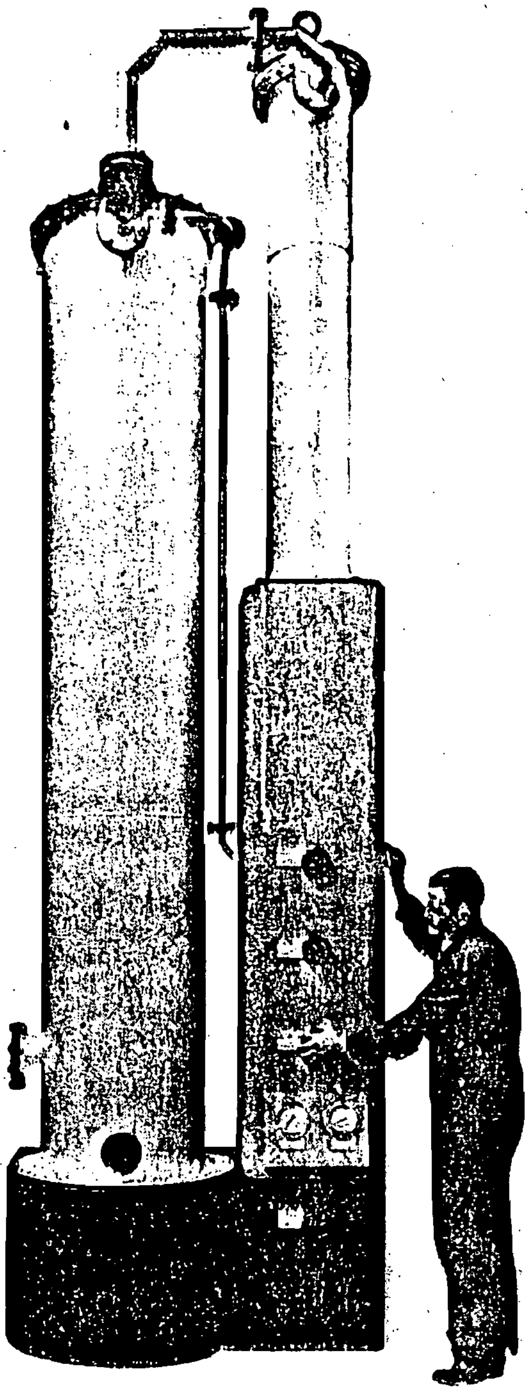
FLAT BED

LIQUID PHASE ADSORPTION

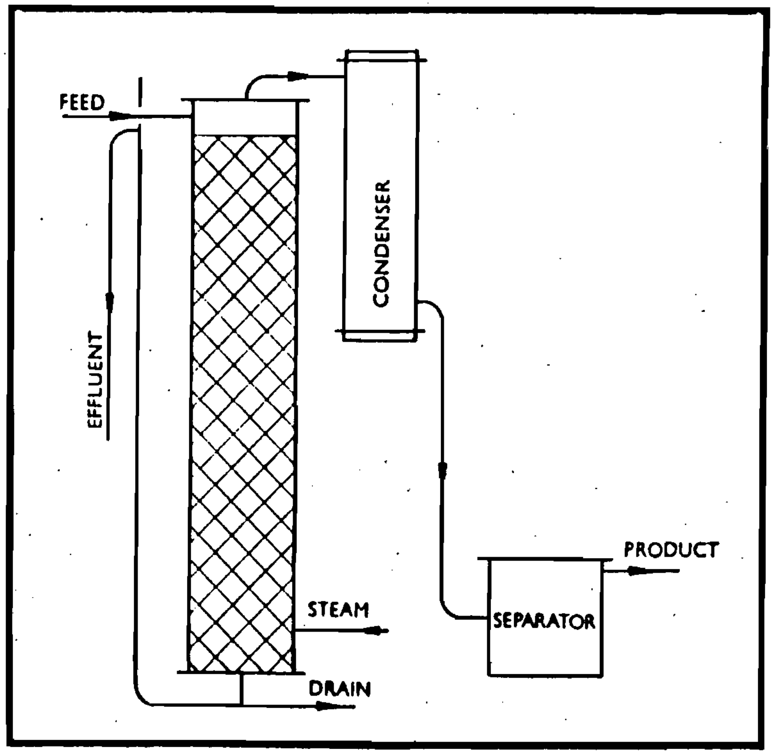
This system uses active carbon for the adsorption of small amounts of certain water-miscible solvents from solutions with water. The weak solvent/water liquor is passed through an active carbon bed and, when the carbon has adsorbed the designed charge of solvent, the solvent is distilled off by our patented system. This process effects substantial increase in concentration of a weak solvent/ water solution, the water in the inlet feed passing through the bed and to effluent drain. During steaming of the carbon a small amount of water is introduced and the products of steaming taken to a separating tank from which the water layer recycles through the system.

In certain cases the carbon can be used to adsorb selectively a particular solvent component from a mixture of solvents with water.

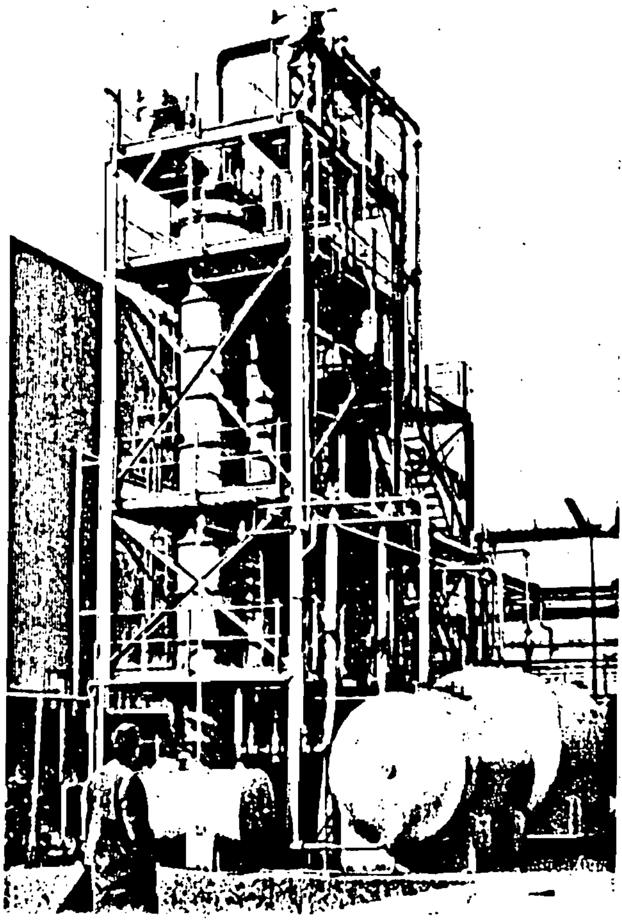
A particular feature of this system is the extreme simplicity of operation and control which can be manual or automatic.



Liquid phase adsorption unit.



DISTILLATION


Section of a large distillation complex.

Sutcliffe Speakman supply a complete range of distillation equipment, which may be required in the separation of water-miscible solvents from the products of recovery of the main adsorption plant, or for other purposes.

The range of distillation equipment includes both perforated plate and bubble cap designs, and the operations can be automatically controlled in relation to steam input and reflux ratio.

Stills can be supplied either for continuous or batch operation.

There is also a range of small units for the recovery of solvents from contaminated mixtures, i.e. by extraction of residues from waste lacquers or in cases where solvents are used for washing down printing and paint machines, etc., the solvent can be cleaned for further use.

ENQUIRIES

In submitting enquiries for evaluation, it is helpful if the following preliminary details can be submitted.

Gas or liquid flow rate

Operating pressures

Temperature and relative humidity of air or gas stream

Quantity, nature and value of compounds to be extracted

Other substances in air, gas or liquid stream of a contaminant or corrosive nature

Normal operating time of process

Details of steam, cooling water, power and compressed air services available.

TYPICAL SOLVENT RECOVERY APPLICATIONS

Acetate Fibre · Insulated Cables · Balata Belting · Leather Cloth · Hydrocarbon Extraction (Natural Gas) · Metallic Foil Printing and Lacquering · Compressed Asbestos Fibre Products Oil Extraction · Degreasing · Paper Impregnating and Lacquering · De-sulphurising of Gas Paper Printing · Dry Cleaning · Pressure-Sensitive Tapes · Explosives · Rotogravure Printing Film Casting · Rubber-Dipped Goods · Rubber-Spread Goods · Surgical Bandages Shoes, etc. · Solvent Manufacture · Tail Gas from Petroleum Wells · Viscose Fibre Viscose and Acetate Film · Weatherproof Sheeting · Process Off-Gas

SUTCLIFFE SPEAKMAN INC

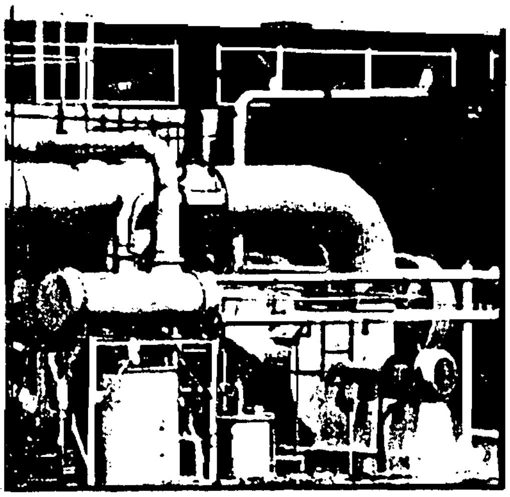
SUITE 200, HEAVER PLAZA,
1301 YORK RD. LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: 908020

The many facets of activated carbon

Reprinted from
Chemical Age 26 June 1981

activated carbon

and business advantages of solvent recovery



toluene and SBP2.

annular bed is the most efficient when it comes to steaming the solvent off the carbon bed (desorption). This is because the steam enters the inner annulus of the adsorber working its way outwards in contrast to other designs where the adsorber vessels have to be efficiently lagged to prevent waste of heat energy. With the annular bed design by the time the steam has worked its way through the carbon bed to the outer annulus it has performed its useful work, and the cooler outer shell of the adsorber vessel serves as an air condenser and relieves the load on the main condenser with regard to the amount of cooling water required.

The basic components of a typical solvent recovery plant are:

- Air filter (to remove any airborne particulate matter in the solvent-laden air stream).
- Air cooler/heater (to temperature adjust air stream for safe and good adsorption on the carbon bed).
- Main fan(s) (to provide correct rate of airflow through the adsorbers).
- Activated carbon adsorbers (where the solvent(s) are adsorbed/desorbed).
- Condenser (to condense solvent vapour and steam from the desorption cycle).
- Separator (decanter) — (where non-miscible solvent/water mixture separates).
- Product tank (for collection of solvent from the separator).

In operation the solvent-laden air is passed to two of the adsorbers while the solvent is desorbed (by steaming) in the third adsorber.

The process operates automatically and continuously, usually with infra-red gas analyser control to ensure optimum efficiency, and each adsorber consecutively undergoes an adsorption and desorption cycle.

The simplest type of solvent recovery is where there is a single solvent which is non-miscible with water, eg, xylene. This solvent will collect as the upper layer in the decanter and, being virtually insoluble in water, can simply be decanted for re-use whilst the lower (water) layer is passed to drain.

If, however, a mixture of solvents is being recovered and some of these are miscible with water then additional plant is necessary to separate the solvents. This usually takes the form of distillation and dehydration equipment depending on the solvents involved and the final specification required by the customer for the recovered solvents.

Each solvent recovery system has its own particular technique for recovery, but the basic adsorption/desorption on activated carbon is common to all. When designing a solvent recovery plant for a particular set of conditions one must have detailed information on such parameters as airflow, air temperature, humidity, solvent concentrations, maximum/minimum process conditions, and details of any impurities in the solvent-laden air stream. The last factor can be particularly important since it can have an important bearing on materials of construction and expected carbon life.

There are several aspects which require careful attention to ensure that the best efficiency of solvent recovery is achieved and that at the same time minimum energy is consumed in the running of the plant. The first practical step which can be taken to maximise recovery efficiency is to present as high a solvent concentration as is safely possible with minimum airflow.

This will be largely governed by the type of process upstream of the

Table 1: Some typical results of solvent adsorption by carbons

Solvent	*Concentration (%V/V)*	**Initial adsorption (%W/W)*	*§Cyclic adsorption (%W/W)*	***Steam ratio*	*Boiling point range (°C)*
Methylene chloride	1.0	28.3	17.3	1.4	40.5
Arklone P	0.5	44.9	20.8	1.4	47.6
Acetone	1.0	20.3	12.5	2.3	56
Tetrahydrofuran	0.5	22.0	9.0	2.0	66
Hexane	0.48	21.3	8.2	3.5	68.7
Ethyl acetate	0.5	27.6	13.6	2.1	77.2
Trichlorethylene	0.5	44.6	19.9	1.8	86.7
n-Heptane	0.12	22.4	5.9	4.3	98
Toluene	0.4	23.3	9.6	3.5	110
Methyl isobutyl ketone	0.2	22.0	9.0	3.5	115.9
Mixed rubber solvent	0.3	25.7	10.3	3.8	120-160
Shellsol E	0.3	35.6	11.9	3.7	153-193
3, 3, 5-trimethyl cyclohexyl acetate	0.1	36.4	7.9	4.5	206

**Initial adsorption refers to the solvent adsorbed by new carbon to 'breakpoint', i.e. when solvent can be detected in the effluent air stream. The 'slip' level at this point is normally of the order of 20 ppm.*

§Cyclic adsorption refers to the solvent which can be adsorbed and desorbed consistently at an economical steam consumption.

***Steam ratio refers to the total steam used to desorb the solvent from the adsorbent and is an overall figure inclusive of condensate and moisture condensed on the carbon bed.*

SUTCLIFFE SPEAKMAN INC

SENSOR CONTROLS

for SOLVENT RECOVERY

WITH PARTICULAR REFERENCE
TO THE USE OF INFRA-RED GAS ANALYSERS

Extract from paper prepared by
Dr. Robert D. Hill
Previously of Chemical Plant Division
Sutcliffe Speakman & Co. Ltd.

and

Presented at the 30th Annual Meeting of the
Gravure Technical Association
Chicago, April, 1979

There are many different types of sensors one can use on a solvent recovery plant but all function either to report information and/or to act on that information to control the solvent recovery plant's operation in some way. For example, proximity sensors can be used to sense whether a valve is open or shut, and flow metering and LEL meters can be used in conjunction with each other to measure the total solvent presented to an adsorber. My remarks will concentrate on using sensor control to optimize the conservation of energy, and maximize the efficiency of solvent recovery, and the role of the infra-red gas analyser in helping to achieve these aims.

The first practical step we can take in maximizing solvent recovery plant efficiency is to ensure that we are presenting, safely, as high a solvent load as possible in the minimum airflow passed to the solvent recovery plant. To a large extent this will be governed by the type of process upstream of the solvent recovery plant. Wherever possible, and economically achievable, recirculation of a portion of the solvent laden air should be considered. This will significantly increase the efficiency of solvent recovery across the carbon bed. The examples given below illustrate the typical improvement in efficiency of recovery of solvent which can be achieved:

(a) Inlet concentration 1000 ppm
Outlet concentration 35 ppm

$$\eta = \frac{1000-35}{1000} \times 100\% = 96.5\%$$

(b) Inlet concentration 2000 ppm
Outlet concentration 35 ppm

$$\eta = \frac{2000-35}{2000} \times 100\% = 98.25\%$$

The side benefits from ensuring maximum concentration of solvent vapor that is presented to the solvent recovery plant are that it will reduce the size of the solvent recovery plant required and with it the capital outlay, space needed, and services required to run it. The sensors applicable to this area of plant operation are typically LEL meters coupled to variable damper controls which will vary proportion of solvent laden air from the process which is recirculated and diluted with fresh air.

Let us now consider in some detail the adsorption/desorption cycles which are at the heart of the solvent recovery plant's operation.

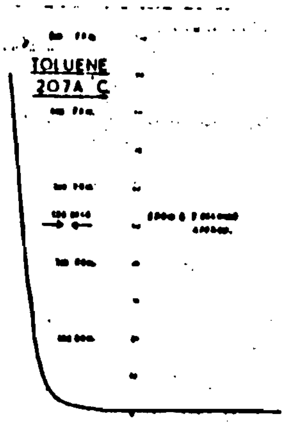


Figure 1

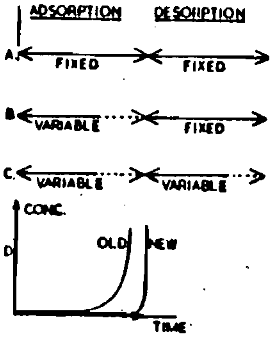


Figure 2

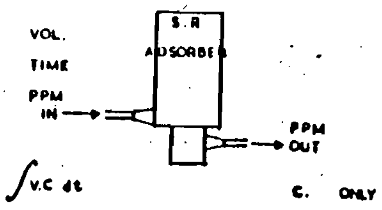


Figure 3

In Figure 1 we see the typical rise in solvent concentration as solvent (in this example - Toluene) starts to "slip" through the bed of activated carbon as an adsorption cycle nears its end. It can be seen that there is a rapid rise in solvent concentration - about 100 ppm in around 135 sec. With the particular sensor favored by Sutcliffe Speakman a rise of 5 ppm can readily be detected, and when a pre-selected concentration is reached (usually around 50 - 75 ppm) the sensor produces a signal which is used to initiate an automatic cycle controller which changes over the particular adsorber vessel being monitored from "Adsorb" to "Desorb" mode by opening/closing appropriate valves.

Let us now examine this process more closely. In Figure 2, on Line A, we have an "ideal" situation where a constant concentration of solvent in a constant airflow is presented to the solvent recovery plant. Provided constant conditions are maintained and the activated carbon's adsorptive properties also remain constant, then it is merely a matter of timing the length of the adsorption and steaming cycles to achieve optimum operating efficiency. This ideal situation is rare. What is frequently encountered in practice is that a variable concentration of solvent is presented to the solvent recovery plant. Now, if the adsorption cycle has been time controlled for the full designed load of solvent, and if, for example, half that load has been adsorbed on to the carbon bed in the preset time, not only will the carbon not be utilized fully, but an excessive amount of steam also will be consumed in the desorption cycle. As much as one third of the steam used for desorption could, for example, be wasted.

In Line B of Figure 2 we have the situation where we must be able to sense when the active carbon has adsorbed the optimum amount of solvent, and solvent "slip" is starting to occur through the carbon bed. In this case the length of the adsorbing cycle will be a variable and this is represented by the dotted part of the line in the figure.

However, what will be the situation if, in addition to the solvent concentration varying, we have a process in which there are airborne contaminants with the solvent which cause an unavoidable and progressive deterioration with time of the activated carbon (irrespective of the design or manufacture of the plant or source of carbon)? In some large, multi-adsorber plants associated with such processes it is often the practice to overhaul one adsorber at a time and to replace the poisoned carbon with a charge of new carbon. In this situation one can have an adsorber containing new carbon working in conjunction with one containing old carbon.

On Line D of Figure 2 we see a graphical representation of how the "slip" curves for old and new carbon compare.

In Figure 3 we see the two basic approaches used to measure when an adsorption cycle should be terminated. On the left side as solvent laden air enters the adsorber we can measure solvent concentration and flow rate, and compute, by integration with respect to time, the total quantity of solvent passed to the adsorber. When a predetermined amount of solvent has been passed a signal is generated which is used to change over the adsorber from Adsorb to Desorb mode. This approach, as used by some companies, seems to be a fundamentally less reliable approach in that it assumes a given carbon performance at all times. Furthermore, it can never give any useful information about what is happening inside the adsorber.

For example, an unusually high "slip" of solvent could indicate that valve seatings require renewal. It is considered that the fundamentally correct approach is to sense what is happening on the exhaust side of the adsorber and use this information for control purposes. It should be noted that this entails measuring only one parameter (solvent concentration in the air stream) against time. Now, whereas the inlet concentration is typically in the 1000 - 3000 ppm range we are now looking at a 0 - 100 ppm range on the outlet of the adsorber. For optimum efficiency we need a sensor which will be capable of measuring very low ppm's, have a fast response, be stable, be accurate, have high reproducibility, not be affected by water vapor and by other extraneous factors which are frequently encountered in the industrial situation. This tends to exclude the use of LEL meters (too insensitive), gas chromatography (slow response and not continuous), and flame ionization detectors, and brings us to the infra-red gas analyser.

Many gases absorb energy in the infra-red region because of the resonant molecular vibrations within the molecules of gas or solvent vapor. These resonances are highly specific and give rise to I-R spectra which are characteristic of the substances in question. The I-R spectrum of a molecule has been likened to the human finger print by means of which one specific wavelength depends on the concentration of absorbing molecules placed between the infra-red source and the detector, and this fact is utilized to determine the concentration of a selected component in a gas or vapor mixture.

Because of the complexity of typical gaseous infra-red spectra, some overlapping of absorption bands frequently occurs, and it is usually necessary to select a very narrow wavelength band to avoid cross sensitivity. Figure 4 shows the 1-8 microns region of the I-R spectrum of toluene and shows several characteristic absorption bands for this solvent.

There are several types of I-R gas analysers potentially available for use, and broadly they can be divided into single wavelength/single beam; single wavelength/double beam; and double wavelength/single beam instruments. In my experience all two-beam energy absorbing systems suffer from the inherent defect of

Figure 4

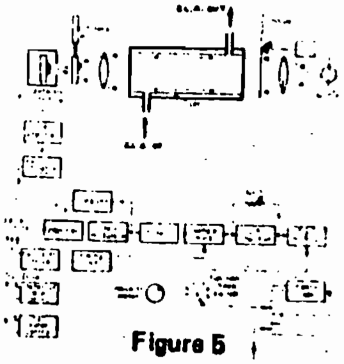


Figure 5

Figure 6

being sensitive to background absorptions caused by fouling of the sample cell windows, broad band absorptions in the sample gas (such as that caused by water vapor), and temperature differences between sample and reference beams. However, most of the disadvantages of the two beam system can be eliminated without losing the advantage of a continuous reference measurement by examining, alternately in time, the I-R energy transmission at the peak absorption wavelength of the measured component and that at a nearby wavelength which represents the "background" energy, but which is itself unaffected by the measured component. This can be achieved with a two wavelength/single beam instrument.

Such a system is shown in Figure 5. By having the source and detector units in optical alignment with each other, and arranging for a pair of very narrow band pass interference filters to be switched alternately in time into the beam (actually at 6 Hz) it is possible to produce a sensitive, accurate, reliable, I-R gas analyser which is immune from many of the extraneous factors which can plague other types of I-R gas analysers.

Let us now turn to the critical area of deciding what wavelengths to select for the solvent(s) in question. This is an area to which, I believe, too little consideration is often given - probably because it calls for expert knowledge in the field of infra-red spectroscopy.

If the solvent is toluene there are, as we can see from the I-R spectrum for this solvent (lower spectrum in Figure 6) several bands to choose from. Or are there? If we look at the spectrum of water (upper spectrum in Figure 6) we can see that there are several regions where water is absorbing energy strongly and has the potential ability to interfere. We must remember also that we are wanting to detect a 50 ppm level (say) which is only a 0.005% v/v concentration whereas if there is a 40% R.H. situation with respect to water vapor that corresponds to a 2.9% v/v concentration of water vapor - i.e. 580 times greater! The possibility of interference from water is obvious. However, if we select wavelengths 3.45 microns for toluene and 3.9 microns for the reference, then we can see that we shall meet the best criteria for having the solvent and reference wavelengths near to each other, but with the latter at a point of least interference from water. In this way we can ensure that even 100% RH will not affect this sensor's performance

Figure 7

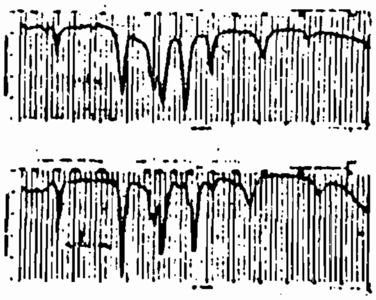


Figure 8

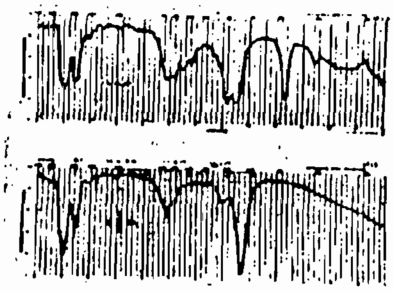


Figure 9

To illustrate just how complex the I-R spectrum of water vapor really is and how the effect of raised temperature can cause the molecules to become more agitated and resonate more stronly, Figure 7 shows the I-R spectrum for water vapor at 100° C, using an expanded scale between 5 and 8 microns. It will readily be appreciated that it is most important that the designer of a solvent recovery plant must have access to such specialized knowledge if the best sensor control design is to be achieved.

Let us now consider some other commonly used solvents: Figure 8 shows the I-R spectra for acetone and methyl ethyl ketone. Here the CH stretching absorbtion band at around 3.5 microns is relatively weak and it is usual to select the C=O (carbonyl) band at about 5.8 microns instead.

Figure 9 shows the I-R spectra for methyl alcohol and ethyl alcohol. Here one can use the CH band at around 3.5 microns as both alcohols have strong enough absorbtion bands.

Figure 10

Figure 10 shows the I-R spectra for ethyl acetate and hexane. Here we have a good illustration of the relative weakness of the CH band at 3.5 microns for ethyl acetate and the corresponding strength of the CH band for hexane at the same point in the spectrum.

In conclusion, in order to get the best out of a solvent recovery plant the following objectives should be achieved:

(1) Maximize the solvent concentration and minimize the airflow within safe/economic limits.

(2) Use I-R Gas Analyser control of the adsorption cycle to nullify the effects of varying solvent load and possibly also varying air flow in order to achieve the fullest use of the charge of active carbon in any particular adsorber.

(3) Select a 2 wavelength/single beam instrument which can guarantee:
(a) immunity from water vapor
(b) Virtual immunity from all normal extraneous factors such as voltage variation, temperature change, etc.
(c) fast and accurate response
(d) is fully automatic and requires virtually no attention.

(4) If the carbon is likely to have its activity modified by the process gas/vapor stream, then control the steaming cycle also by sensing a falling concentration of solvent in the steam/solvent mixture coming from an individual adsorber.

As manufacturers of their own activated carbon for the past 75 years plus solvent recovery plant which embraces the sensor technology, I have described, I believe, that Sutcliffe Speakman have one of the best systems for optimizing efficiency and minimizing the use of energy.

SUTCLIFFE SPEAKMAN INC

SUITE 200, HEAVER PLAZA,
1301 YORK ROAD, LUTHERVILLE, MARYLAND 21093
TELEPHONE: 301-337-2800
TELEX: ~~908020~~ 240189

YOUR REF: OUR REF: DATE: 4 August 1983

DESIGN FOR EXPANDABILITY!

Mr. Michael A. Ware
Environmental Coordinator
Wheelabrator-Frye Incorporated
Graphic Supplies Division
Chemicals and Coatings group
2010 Indiana Street
Racine, Wisconsin 53405

Dear Mr. Ware:

We have pleasure in referring to the discussions with your colleagues and yourself during the visit to David M. Company, Longwood, last Friday, and we appreciated the opportunity to discuss the project for the recovery of toluene from the three rubber spreading machines.

For your preliminary information we have pleasure in enclosing our Preliminary Proposal No. S 7212, in triplicate, for a plant to recover up to 50 gallons per hour of toluene from 25,000 scfm airflow, as you requested, for your initial studies. We understand that consideration is being given to the possibility of making changes to the process operations to reduce the peak evaporation rates of solvent so that the capacity of the recovery plant might be reduced.

The proposed plant is quoted on the basis of supply only, with the addition of a preliminary proposal, Appendix 'A', for the turnkey installation of the plant which we would be pleased to firm up after further study of site conditions.

The proposed plant is very similar to a considerable number of installations that we have supplied for operation with rubber spreading machines in which particular industry we have over 40 years experience.

We will be pleased to quote also for the supply of suitable hoods for the spreading machines and a collection system when you so require.

We trust that the enclosed information is sufficient for your immediate requirements but we will be very pleased to discuss any aspects further with you at your convenience.

Yours sincerely,

William C. Moses
Vice President

WCM/pmd