APPLICATION TO CONSTRUCT

AN AIR POLLUTION SOURCE

7

29-094451

BIG BEND TERMINAL

TAMPA

SUBMITTED BY

AGRICO CHEMICAL COMPANY

Agrico

ONE OF THE WILLIAMS COMPANIES

October 12, 1984

Mr. Roger Stewart
Director
Hillsborough County Environmental Protection Commission
1900 Ninth Avenue
Tampa, FL 33605

Dear Roger:

Re Agrico Chemical Company's Proposed Prilled Sulfur Ship Unloading and Storage Installation, Big Bend Port Facility, Hillsborough County, Florida

Enclosed is Agrico Chemical Company's application to modify the proposed prilled sulfur ship unloading and storage installation at the Big Bend port facility, Hillsborough County, Florida. The application seeks to modify both the proposed installation and the existing air construction permit, AC 29-5954. These modifications are specifically described in Attachment 1 to the application form. However, the single most significant modification is the enclosure of the entire storage pile within a building. The building and several other new significant pollution control measures will cost Agrico Chemical Company nearly 3 million dollars in excess of what is required by the current permit. Although we feel that the control measures specified in the current permit provide reasonable assurances that all applicable standards will be met, we are willing to incur this added expense for the purpose of dispelling any misconceptions that it will not be a clean and environmentally sound operation.

Please note that we are estimating that with the addition of these new control measures, particulate matter emissions from the proposed installation will not exceed 3.197 lbs./hour, even though the application proposes to increase the annual throughput from 300,000 to 600,000 tons. This is less than the allowable emission rate of 5 lbs./hour authorized under the current permit. See Permit No. AC 29-5954, Specific Condition 19. As you know, the Department's rules only govern "Any physical change in, or change in the method of operation of, or addition to a stationary facility which increases the actual emissions of air pollutants...." (emphasis added) FL Administrative Code Rule 17-2.100(102). Consequently, pursuant to Section 120.60(2), Florida Statutes, we request that you inform us within 30 days of the receipt of this application whether this modification is exempt from the Department's regulatory authority.

As you know, Agrico Chemical Company applied to the Department on June 4, 1984, for a renewal of Permit No. AC 29-5954. The Department's review of this permit renewal was deferred by mutual agreement to December 15, 1984. We request that you treat the present application separate and apart from the renewal proceeding. After the present application is granted and a new permit issued, Agrico Chemical Company will withdraw its renewal application and abandon Permit No. AC 29-5954. However, if the Department should deny the present application or determine that the proposed modification will not require agency approval, we intend to proceed with renewal of the existing permit. We hope this clarifies our position on this matter.

The appropriate permit fees are attached for Hillsborough County and the Department of Environmental Regulation.

If you have any questions, please do not hesitate to contact us.

Sincerely yours,

H. W. Long, Jr.

HWL:GNC
Attachments

cc: Mr. Clair Fancy
Mr. Dan Williams

PAID OCT 16 1984
AC 29-094451

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

D. E. R.

OCT 16 1984

SOUTH WEST DISTRICT
TAMPA

SOUTHWEST DISTRICT
7601 HIGHWAY 301 NORTH
TAMPA, FLORIDA 33610-9544

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

RICHARD D. GARRITY, PH.D.
DISTRICT MANAGER

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Prilled Sulfur Terminal [x] New[1] [ ] Existing[1]

APPLICATION TYPE: [X] Construction [ ] Operation [X] Modification (Re: AC 29-5954)

COMPANY NAME: Agrico Chemical Company COUNTY: Hillsborough

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) Transfer and Storage

SOURCE LOCATION: ~~XXXXXX~~ Big Bend Terminal City N.A.

UTM: East 360,945 M North 3,076,218 M

Latitude 27 ° 48' 19 "N Longitude 82 ° 24 ' 40 "W

APPLICANT NAME AND TITLE: Harold Long, Jr., Manager, Environmental Control

APPLICANT ADDRESS: P. O. Box 1110, Mulberry, FL 33860

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Agrico Chemical 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 control facilities in such a manner as to comply with the provision of Chapter 403, Florida 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-transferable and I will promptly notify the department upon sale or legal transfer of the permitted establishment.

*Attach letter of authorization
See Attachment 1A

Signed: Harold Long Jr.

Harold Long, Jr., Manager, Environmental Contro
Name and Title (Please Type)

Date: 10/9/84 Telephone No. (813) 428-1431

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 have been designed/examined by me and found to be in conformity with modern engineering principles applicable to the treatment and disposal of pollutants characterized in the 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 *Raymond T Schneider*

Raymond T. Schneider
Name (Please Type)

Jacobs Engineering Group, Inc.
Company Name (Please Type)

P. O. Box 2008, Lakeland, FL 33803
Mailing Address (Please Type)

Florida Registration No. 12008 Date: *10/10/84* Telephone No. (813) 665-1511

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.

See Attachment 1

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

Start of Construction See Attachment 2 Completion of Construction --

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.)

See Attachment 3

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

See Attachment 4

E. Requested permitted equipment operating time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ;

if power plant, hrs/yr_____; 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? -

   b. If yes, has "Lowest Achievable Emission Rate" been applied? -

   c. If yes, list non-attainment pollutants. -

2. Does best available control technology (BACT) apply to this source? If yes, see Section VI. No

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? --

   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.

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

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

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Prilled sulfur	N.A.	N.A.	N.A.	1 - 9
			(Transfer Operation)	

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

1. Total Process Input Rate (lbs/hr): See response to Item V-1

2. Product Weight (lbs/hr): See response to Item V-1

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	
~~Sulfur~~ Particulate			*	N.A.			1-9
2% Moisture	3.197	5.22			18,840	9.42	
3% Moisture	1.663	3.00			10,080	5.04	

* See Attachment 5

[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)
Water spray	Sulfur Particulate	50-85	N.A.	See Attachments
Covered building	"	97	N.A.	20-21-22
Covered conveyors	"	75 - (Windage)	N.A.	
Shielded hopper	"	" "	N.A.	
(3 sides)				

E. Fuels

N.A.

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: ______ Percent Ash: ______

Density: ______ lbs/gal Typical Percent Nitrogen: ______

Heat Capacity: ______ BTU/lb ______ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ______

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

Annual Average N.A. Maximum ______

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

See Attachments 6, 12

N.A.

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

Stack Height: ______ ft. Stack Diameter: ______ ft.

Gas Flow Rate: ______ ACFM ______ DSCFM Gas Exit Temperature: ______ °F.

Water Vapor Content: ______ % Velocity: ______ FPS

SECTION IV: INCINERATOR INFORMATION

N.A.

Type of Waste	Type O (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) ______

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.

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

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.

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

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

[ ] Yes [ ] No N.A.

Contaminant	Rate or Concentration

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

[ ] Yes [ ] No

Contaminant	Rate or Concentration

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

Contaminant	Rate or Concentration

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.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

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:

2.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

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

j. Applicability to manufacturing processes:

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

3.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

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:

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:

1. Control Device:

2. Efficiency:[1]

3. Capital Cost:

4. Useful Life:

5. Operating Cost:

6. Energy:[2]

7. Maintenance Cost:

8. Manufacturer:

9. Other locations where employed on similar processes:

a. (1) Company:

(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

A. Company Monitored Data N.A.

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.

LIST OF ATTACHMENTS

SECTION V: Supplemental Requirements

SECTION V: SUPPLEMENTAL REQUIREMENTS

(1) The total process input rate and the product weight is a function of the moisture of the received product and further water additions to the material at transfers, storage and loadout.

For example:

Process Weight:

Operation	TPH Rate	2% Moisture	3% Moisture
Ship Unload	672	-13.4 = 658.6	-20.2 = 651.8
Loadout	84	-1.7 = 82.3	-2.5 = 81.5

Product weight is determined by subtracting from the process weight any loss of product by emissions. Since emissions are controlled by wetness of product, we must assume that the emission displayed in Attachment 18 has the same moisture content as the parent material.

For example:

Operation	Process Weight at 2% Moisture	Emission TPH		Product Weight TPH
Ship Unload	658.6	-0.002032	=	658.59797
Loadout	82.3	-0.000900	=	82.2991

Operation	Process Weight at 3% Moisture	Emission TPH		Product Weight TPH
Ship Unload	651.8	-0.0009695	=	651.79903
Loadout	81.5	-0.0004899	=	81.49951

SECTION V: SUPPLEMENTAL REQUIREMENTS, Cont.

(2) See Attachment 18 for emission estimate at various moisture levels.

Method to be used to show proof of compliance with applicable standards.

(1) DER method 9 for visible emissions

(3) See Attachments 15, 16, 17 and 18 for basis of potential discharge.

(4) For the spray systems see Attachments 12 and 19. We also consider as air pollution control systems the enclosed conveyor systems, enclosed storage building and the enclosed loadout system. See Attachments 20, 21, and 22.

(5) We consider the emissions from the process to be a function of the moisture content of the product. The potential emission is the emission from product handling with no water sprays in operation.

To the spray systems we assign 50 percent control for water and 85 percent control with chemical wetting agent. See Attachments 20, 21, and 22.

For all partially enclosed systems we assign 75 percent control of windage. The average wind speed in Tampa area is 8 MPH. (8)(0.25)=2 MPH. We used 2 MPH in our calculations. See Attachments 20, 21, and 22.

SECTION V: SUPPLEMENTAL REQUIREMENTS, Cont.

(5) For the enclosed storage building we assigned 97 percent control or a 3 percent escape in our calculations. See Attachments 20, 21, and 22.

ATTACHMENT 1 A

Agrico
ONE OF THE WILLIAMS COMPANIES

November 22, 1983

To Whom It May Concern:

Please be advised that the undersigned is Senior Vice President, Mining, Agrico Chemical Company, a Delaware corporation, with its principal office in the National Bank of Tulsa Building, Tulsa, Oklahoma, hereafter called "Agrico". Mr. H. W. Long, Jr., Manager of Environmental Control of Agrico, is authorized to make, execute and submit to any appropriate federal, state or local government authority, in behalf of Agrico, any statement, application, request or the like, that is or shall be necessary, appropriate, or useful, for normal business activities.

Very truly yours,

AGRICO CHEMICAL COMPANY

By ____________________
R. G. Garcia
Senior Vice President

Sworn to and subscribed before me this 22nd day of November A.D. 1983.

____
Notary Public
State of Florida at Large

My commission expires December 9, 1983.

ATTACHMENT 1

SECTION II A

GENERAL PROJECT INFORMATION AND HISTORY

On September 19, 1977 Agrico Chemical Company applied to the Department of Environmental Regulation for an air construction permit to build a wet-form prilled sulfur ship unloading and storage installation at its existing Big Bend port facility in Hillsborough County, Florida. The application was assigned Permit No. AC 29-5954. As originally contemplated, the proposed installation would handle 300,000 long tons of prilled sulfur a year. The material would arrive at the installation in 30,000 long ton capacity ships and would be unloaded at the rate of 600 tons per hour with a traveling gantry using a seven yard covered tight lip bucket. The bucket would dump the sulfur into a hopper, which in turn would deposit the material on a 640 foot uncovered dockside conveyor belt. This conveyor would transfer the sulfur to a 415 foot incline covered conveyor belt, which would discharge to a 680 foot overhead tripper conveyor belt. This conveyor would form a 40 foot high open storage pile with a total capacity of 50,000 long tons. The sulfur pile would be oriented on an east to west axis. Sulfur would be removed from the pile with two 5 yard bucket loaders, which would discharge their cargo into a reloading hopper. The hopper would discharge into a 618 foot covered reclaim conveyor belt, which would transport the sulfur at a rate of 75 tons per hour to a 50 ton truck loading hopper. The sulfur would be transferred from this hopper by 25 ton capacity trucks to Agrico Chemical's South Pierce Chemical Works in Polk County, Florida. There the sulfur would be unloaded, melted and pumped into melting pits for eventual use in the on-site sulfuric acid plants.

The only potential air pollution emissions from the proposed installation would be unconfined emissions of sulfur particulate matter. Agrico proposed to control these emissions by a variety of means. First, Agrico would maintain the prilled sulfur in a moist condition. Second, water sprays would be provided at all the transfer points. Third, only a covered lip bucket would be used to unload the sulfur. Fourth, a movable apron would cover the opening between the dock and the discharge hopper in order to catch any spillage. Fifth, belt cleaners would be provided for all the belt conveyors, and the transfer and reclaim conveyors would be covered. Sixth, the storage pad, the reclaim aisle and the loading areas would be paved and curbed. Seventh, a full coverage spray system would be provided for the pile area. Finally, the truck loading hopper would be enclosed.

In order to control any wastewater discharges from the water sprays, Agrico proposed the construction of a recycle and treatment system. Any contaminated water would be collected from several sumps and the storage pile and drained into a lined storage pond. The contaminated water would then be discharged into a neutralization treatment area, where it would be treated with a liquid caustic in order to maintain a 6-9 pH. The treated water would then be used in the storage pile sprays. Fresh water would be used in the water sprays at the transfer points. The storage pond is designed to contain a 25 year 24 hour storm event. During periods of extreme rainfall, treated water from the storage pond would be diverted to a one-acre holding pond, where the water would be disposed of by evaporation and percolation.

In its Construction Permit Application Evaluation the Department calculated that the total controlled emissions of unconfined particulate matter would not exceed five pounds per hour. This estimate was based on

Emission factors for mineral aggregate storage piles contained in the then current edition of AP-42. Based on these emissions estimates, the Department calculated that the increase in ambient air concentrations of particulate matter for the proposed installation would not exceed 3.1 micrograms per cubic meter, maximum annual average, and 8.0 micrograms per cubic meter, maximum 24 hour concentration.

On January 20, 1978 the Department notified Agrico Chemical Company of its intent to issue the permit. The Department found:

1) The projected emissions are better than that allowed in the process weight table.
2) Ambient air standards for particulates will not be violated.
3) There will be no significant degradation of the ambient air quality.
4) In consideration of other bulk aggregate facilities and the possible explosion potential, the handling equipment and the controls to be employed are considered best technology.

However, before the Department could issue the permit, Freeport Sulphur Company and Sulphur Terminals Company, Inc., filed petitions challenging the proposed agency action. Standing to pursue these challenges was based on the alleged economic impact on the petitioners' competing molten sulfur ship unloading and storage installation in Hillsborough County. These challenges were not disposed of until they were dismissed by the Second District Court of Appeal in December 1981. See Agrico Chemical Company v. Department of Environmental Regulation, 406 So.2d 478 (Fla. 2d DCA 1981).

The Department issued the air construction permit on February 5, 1982. The permit provided for construction of the installation by September 30, 1984, the submission of an operation permit application by December 30, 1984, and the expiration of the permit on March 30, 1985. Additionally, the permit limited the material which can be handled to "prilled sulphur with minimum 2% moisture" and required that the tripper system have a telescoping discharge spout in order to limit the maximum free-fall to 10 feet when loading the storage pile. The permit limited total particulate emissions to 5 pounds per hour and prohibited all visible emissions in excess of 5% opacity from the storage pile and all transfer points.

In May 1982 Agrico Chemical Company applied to the Department for a permit to construct an industrial wastewater treatment and disposal system in conjunction with the proposed wet form prilled sulfur ship unloading and storage installation at the Big Bend port facility in Hillsborough County, Florida. The application was assigned Permit No. IC 20-55453. The application encompassed the construction of the wastewater treatment and recycle system. The Department had previously issued a permit for this system, which expired in January 1979 due to the protracted litigation initiated by Freeport Sulphur Company and Sulphur Terminals, Inc.

Also, in May 1982 Agrico Chemical Company applied for an air construction permit to build a 600,000 long ton a year capacity wet form prilled sulfur rail car/truck unloading and melting installation at the South Pierce Chemical Works in Polk County, Florida. The application was assigned Permit No. AC 53-55780. Agrico Chemical Company had not previously applied for this permit.

Freeport Sulphur Company and Freeport Land Company, a wholly owned subsidiary, which was incorporated in Florida in January 1982, challenged both permit applications. They submitted information which was critical of Agrico's proposals and recommended denial of the applications. Also, with respect to the South Pierce air construction permit application, they initiated legal proceedings pursuant to Section 403.412, Florida Statutes. These actions had the effect of delaying a final decision in both proceedings. After considerable effort and nearly nine months of formal administrative proceedings, the Department issued the air construction permit for the prilled sulfur installation at the South Pierce Chemical Works on April 20, 1984. The permit application for construction of the industrial wastewater treatment and disposal system at Big Bend is still pending.

As a result of the repeated and protracted challenges by Freeport Sulphur Company and Freeport Land Company and the Department's rulemaking inquiry into the regulation of sulfur air pollution emissions, Agrico Chemical Company was unable to complete construction of the proposed installation at the Big Bend port facility by the September 30, 1984, deadline. On June 4, 1984, Agrico Chemical Company requested the Department to extend the completion and expiration dates of Permit AC 29-5954 by 24 months. On August 28, 1984 Agrico Chemical Company waived the 90-day permit review deadline for this renewal until December 15, 1984.

The instant permit application seeks to modify the proposed installation and certain conditions of Permit AC 29-5954. The application is not intended to modify nor to consolidate the pending renewal application. These modifications are being proposed in an effort to further control unconfined emissions of sulfur particulate matter from the proposed installation.

The present permit application increases the throughput capacity of the proposed installation from 300,000 long tons a year to 600,000 long tons a year. The application modifies the design of the dockside conveyor belt so that it is now enclosed along its entire length. The application proposes the installation of drip pans at the bottom of all the conveyor belts to collect any spilled material.

In addition to these changes, the application modifies the installation by proposing the construction of a building to completely enclose the storage pile and all prilled sulfur reclaim activity. This building would be situated on a north to south axis. The material would enter the north end of the building via a covered conveyor belt. Once inside the building, the prilled sulfur would be discharged into a storage pile with a total capacity of 50,000 long tons. The storage pile would be reclaimed with front end loaders, which would pick up the material through several entrances in the wall separating the pile from the reclaim portion of the building. The loaders would discharge their cargo into hoppers, which would feed a reclaim belt conveyor. When the belt conveyor leaves the building it would be enclosed and would discharge the sulfur into an enclosed truck loading hopper. The hopper would discharge the sulfur through a flexible spout into compartmentalized, 25-ton hopper trucks.

The present permit application also seeks modification of several conditions of the existing air construction permit. The application seeks to modify General Condition No. 2 to authorize the construction of the proposed installation in place of the installation originally proposed in the initial permit application. The application seeks to modify Sepcific Condition No. 1 to substitute completion and expiration dates, which occur 18 and 24 months, respectively, after the permit is issued (See Attachment 2). The application seeks to modify Specific Condition No. 8 to permit a maximum product input to the storage system of 600,000 long tons per year of prilled sulfur. The application seeks to modify Specific Condition No. 9 to increase the maximum hours of operation for the ship unloading from 768 hours per year to 1400 hours per year. The application seeks to modify Specific Condition 12 to eliminate the addition of a telescoping discharge spout to the tripper system. The application seeks to modify Specific Condition 13 to eliminate the requirement that the pile will be stored in an open area and the requirement to develop compliance testing to determine the minimum moisture content necessary to prevent dusting resulting in visible emissions. The application seeks to modify Specific Condition 17 to eliminate compliance testing to determine the moisture content of the sulfur in the storage pile. Finally, the application seeks to modify Specific Condition 19 to substitute the total particulate emission estimate contained in this application for the 5 pound per hour limit contained in the permit.

The present permit application contains several precautions, in addition to those proposed in the initial application, to control unconfined emissions of particulate matter. First and foremost, Agrico proposes to eliminate essentially all particulate matter emissions due to discharging the material into the pile, wind erosion of the pile, reclaiming the material by front-end loader and discharging the material into reclaim hoppers, by enclosing these operations in a building. Second, Agrico intends to eliminate nearly all particulate matter emissions from the dockside conveyor by enclosing the belt. Third, Agrico proposes to substantially eliminate the reintrainment of spilled sulfur particulate matter from the incline and reclaim conveyors by installing a drip pan under the belts. Finally, Agrico plans to install a water spray system in the building to control the moisture content of the prilled sulfur.

Agrico is modifying its proposed recycle and treatment system to eliminate any discharge of contaminated water to State Waters. As before, water will be collected from several sumps. This collected water will be transferred to a holding tank. Water from the holding tank will be applied to the storage pile and fresh water will be used in the water sprays at the transfer points. The wastewater will not be discharged into open ponds, the storage building will contain drainage from the sulfur pile and any excess water from the pile will either be removed when the sulfur is transported to the South Pierce Chemical Works or will be recycled to the holding tank.

Agrico is confident that these modifications will result in a clean and environmentally sound operation. Moreover, in order to eliminate any possible aesthetic impacts from the proposed installation, the building will blend in with the surrounding environment and additional trees, shrubbery and grass will be planted in the west end of the Big Bend port facility.

ATTACHMENT 2

SECTION II B

Start of construction within 180 days after the permit is issued or, if a formal administrative proceeding is initiated, within 180 days after the deadline for filing an appeal expires.

Completion of construction within 18 months after construction has commenced.

ATTACHMENT 3

SECTION II C

Estimated Costs Of Pollution Control Systems:

Piping (spray systems and fire protection building)	$ 424,900.
Pumps	15,800.
Ship unloader apron (spanning ship unloader to ship)	31,500.
Ship unloader wind screen	18,900.
Ship unloader belt feeder	9,500.
Concrete apron under receiving conveyor	30,000.
Conveyor transfer enclosure	4,500.
Transfer conveyor cover and drip pan	15,000.
Storage building	2,200,000.
Loadout conveyor cover and drip pan	8,400.
Loadout structure enclosure	8,800.
Surfactant system	20,000.
Neutralizer system	20,000.
Enclosure of receiving conveyor	160,000.
Total	$2,967,300.

1977 POLLUTION CONTROL COSTS

The concept of the Big Bend Sulfur Terminal has changed. The original concept envisioned loading dump trucks with front end loaders. Therefore the reclaim and loadout conveyor and structure was considered pollution control as the trucks changed to enclosed type.

The only items of the 1977 pollution control costs that are included in the 1984 costs are:

	1977 Costs
Spray water pump	$ 3,817.
Tanks and Hoppers	50,000.
Piping	48,004.
	$101,821.

Agrico is now investing $2,865,479 in pollution control systems above and beyond what is required under the existing permit in order to insure that sulfur particulate emissions will be completely controlled.

ATTACHMENT 4

SECTION II D

BIG BEND PERMITS

Permit No.	Date Issued	Date Expires
AC 29-2305	12/21/73	8/21/75
AC 29-2360	9/16/74	3/16/76
IC 29-2121	10/23/74	4/23/76
IO 29-2121	12/19/75	12/19/80
AC-29-2432	9/1/75	1/1/77
AO-29-2432	11/2/76	10/31/78
AO-29-12987	1/30/79	1/30/84
AO-29-14854	1/30/79	1/30/84
AO-29-14855	1/30/79	1/30/84
AO-29-79216	6/3/84	4/27/89
AO-29-79217	6/3/84	4/27/89
AO-29-86211	6/3/84	4/27/89
AO-29-79215	6/3/84	4/27/89
AC-29-25142		
AC-29-25149		
AC-29-25160		
AC-29-25161	1/29/80	8/31/85 (1)
AC-29-25162		
AC-29-25163		
AC-29-25164		
AC-29-5954	2/5/82	3/30/85 (2)
IC-29-5955	12/14/77	7/1/79 (3)

(1) Third extension requested and granted.
(2) Extension requested June 4, 1984.
(3) Refiled application May 1982 - still pending.

ATTACHMENT 5

SECTION III C

Allowed Emission Rate per Rule 17-2: Florida Administrative Code Rules 17-2.610(2) and 17-2.610(3).*

* The only air pollutant, which the proposed installation has the potential to emit, is unconfined sulphur particulate matter. The only emission limiting standards applicable to this type of emission are Florida Administrative Code Rules 17-2.610(2) and 17-2.610(3). These standards were applied to Agrico's prilled sulphur unloading and melting installation at the South Pierce Chemical Works, which was permitted on April 20, 1984. *See* Permit No. AC 53-55780.

JACOBS ENGINEERING GROUP, INC

Agrico Big Bend PN 28-7443

October 4, 1984

Spray Water Additions

Basis: One 30,000 LT ship = 33,600 short tons
50 hours to unload ship @ 672 T/HR
400 hours to load out @ 84 TPH

	Hours Operation	No. Nozzles	GPM per Nozzle	Lb Water Added
Ship Unloading				
Unloading Hopper	50	16	0.75	300,000
Transfer Point	50	4	0.23	23,000
Loadout				
Reclaim Conveyor	400	1	1.00	200,000
Transfer Point	400	1	1.10	220,000
TOTAL per shipload				743,000
Incremental Product Moisture - percent			1.09	

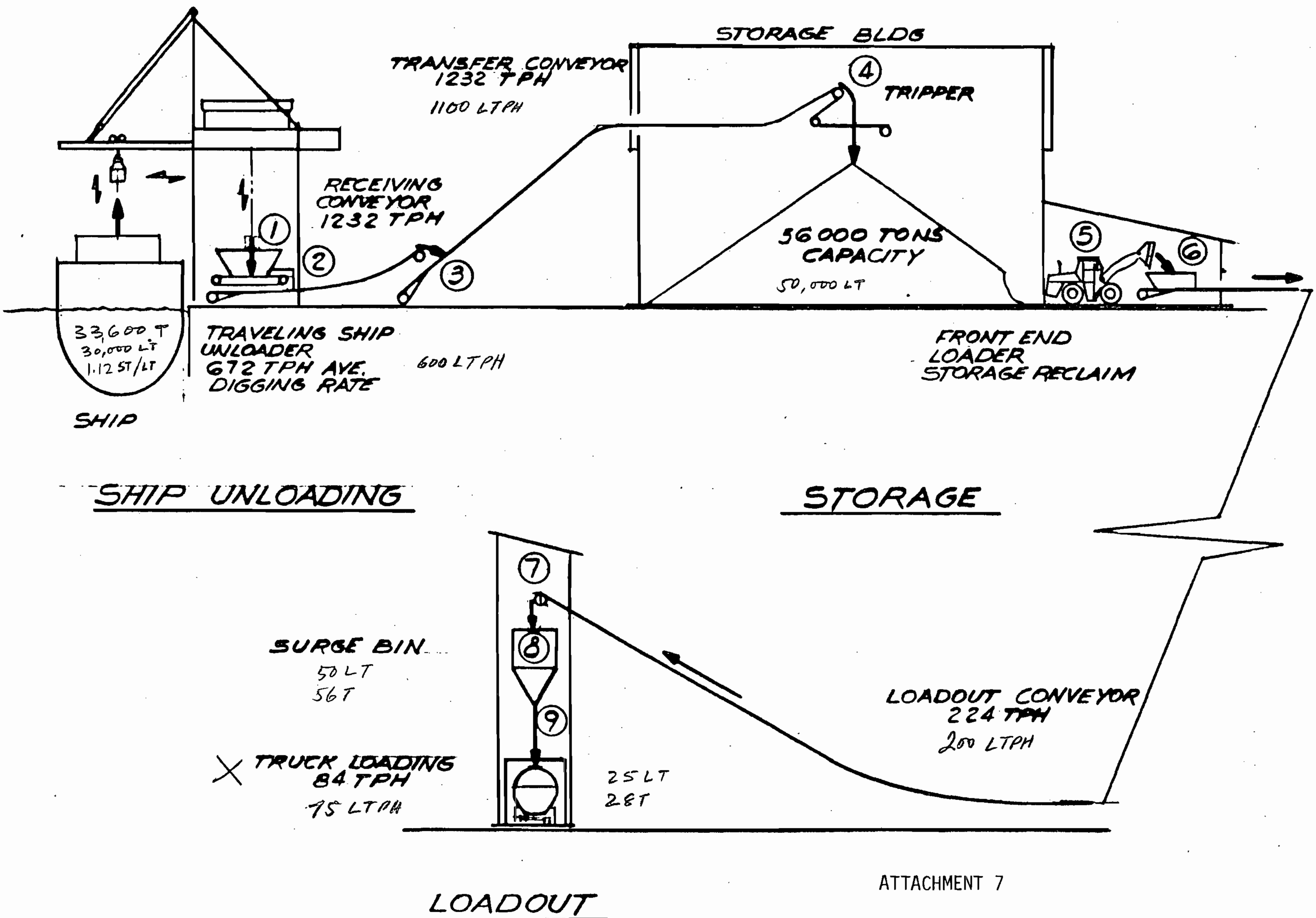
Holding Tank Size:

Tank need only be nominal size to provide surge to the recycle spray, and hold a nominal amount of water which may drain from the pile.

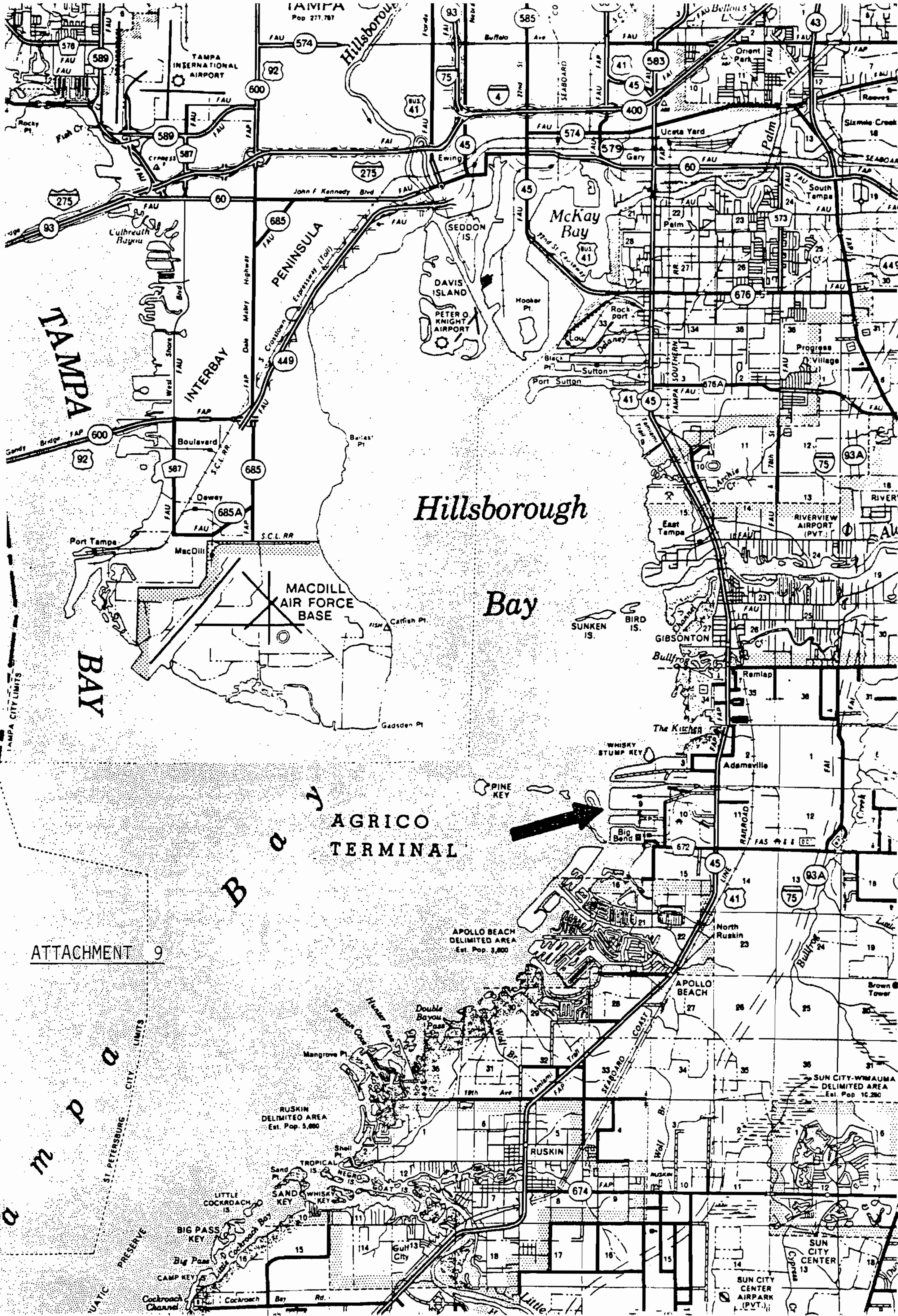
Recycle sprays require 500 GPM.

With 20 minute surge, tank size is 10,000 gal. (12' diameter x 12')

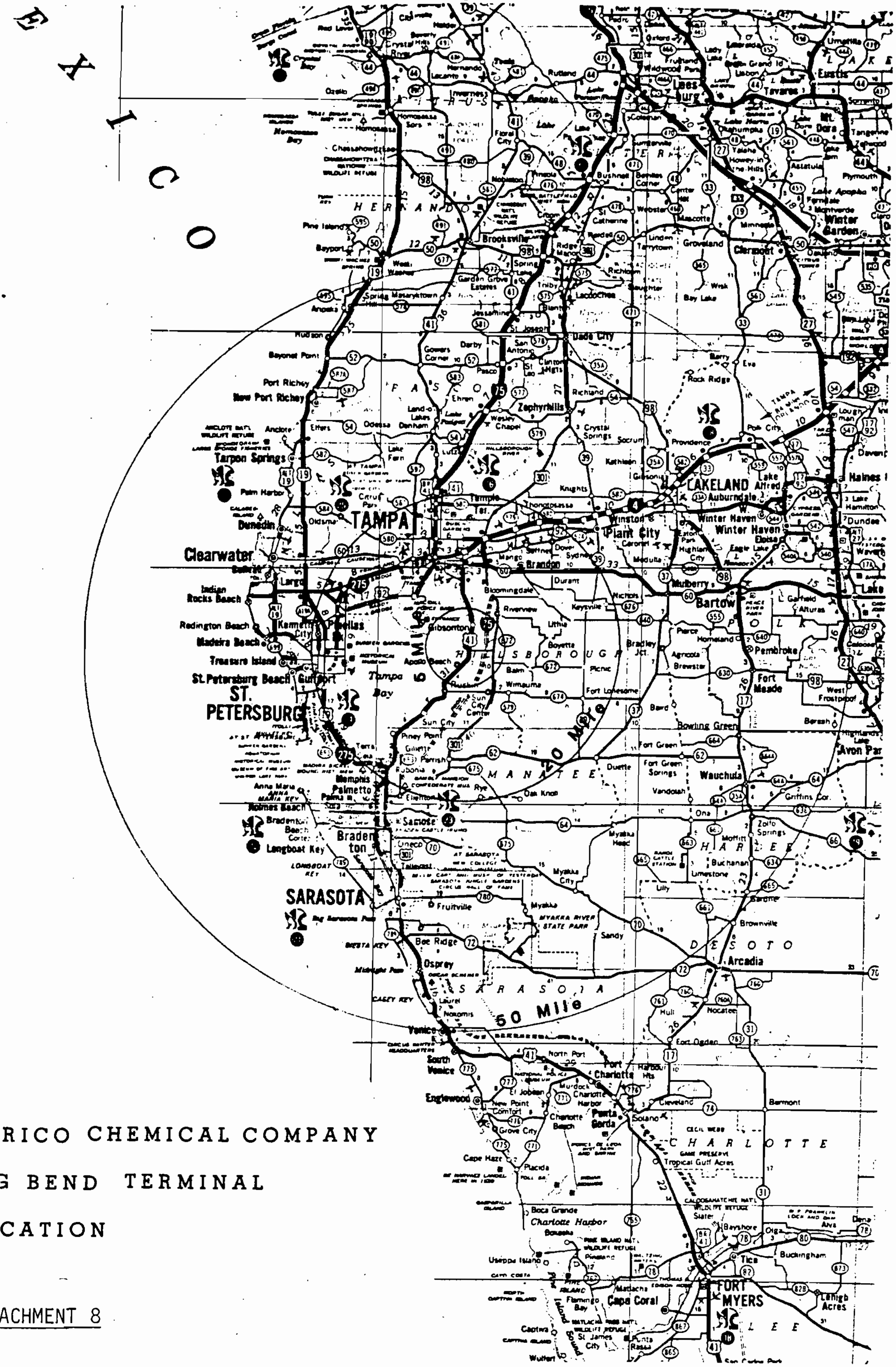
ATTACHMENT 6



ATTACHMENT 7



ATTACHMENT 9



AGRICO CHEMICAL COMPANY

BIG BEND TERMINAL

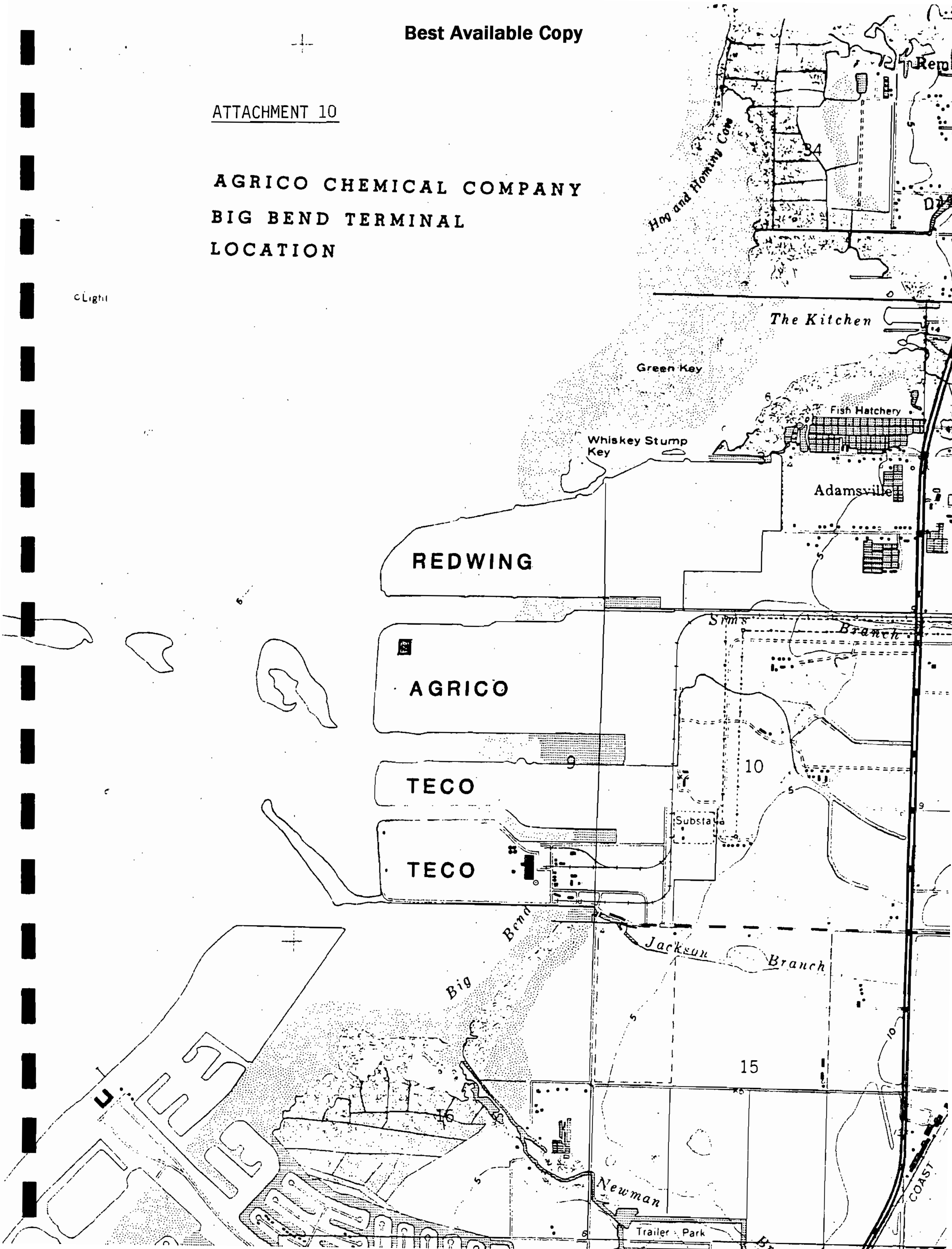
LOCATION

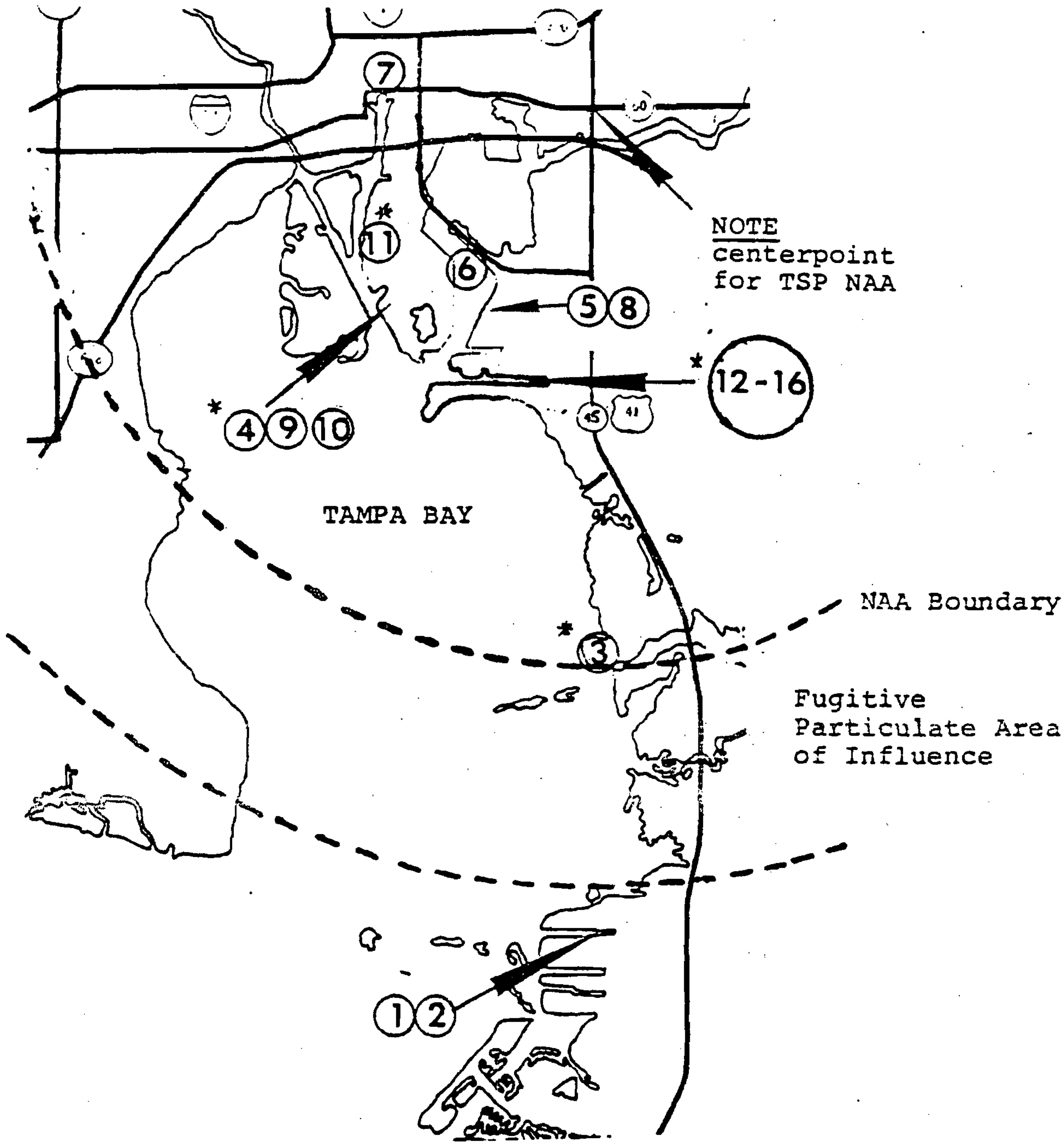
ATTACHMENT 8

Best Available Copy

ATTACHMENT 10

AGRICO CHEMICAL COMPANY
BIG BEND TERMINAL
LOCATION

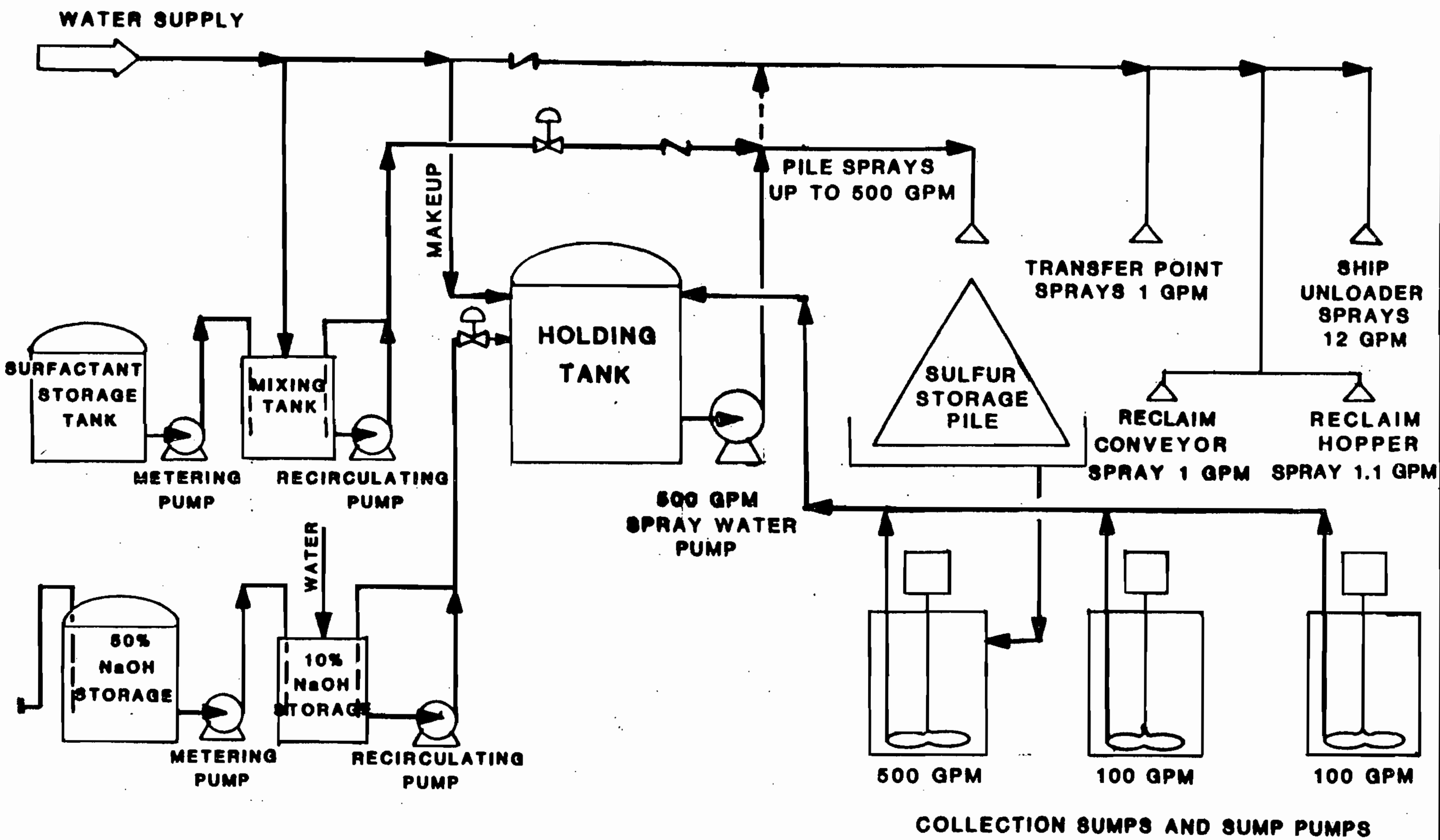




1 Agrico Chemical Company
2 Intercontinental Terminals Company
3 Gardinier (S)*
4 Texasgulf, Inc. (S)*
5 Rockport Terminals (SCL)
6 C. F. Industries
7 Detsco Terminal
8 Eastern Associated Terminals
9 Royster Company
10 South State Terminals
11 Sulphur Terminals (S)*
12 Duval Corporation (S)*
13 W. R. Grace & Company
14 IMC Phosphate Terminal
15 Paktank Florida
16 Pasco Terminals (S)*

*(S) denotes sulphur handling facilities.

Phosphate and Related Chemical Terminal Facilities in the Tampa Bay Region

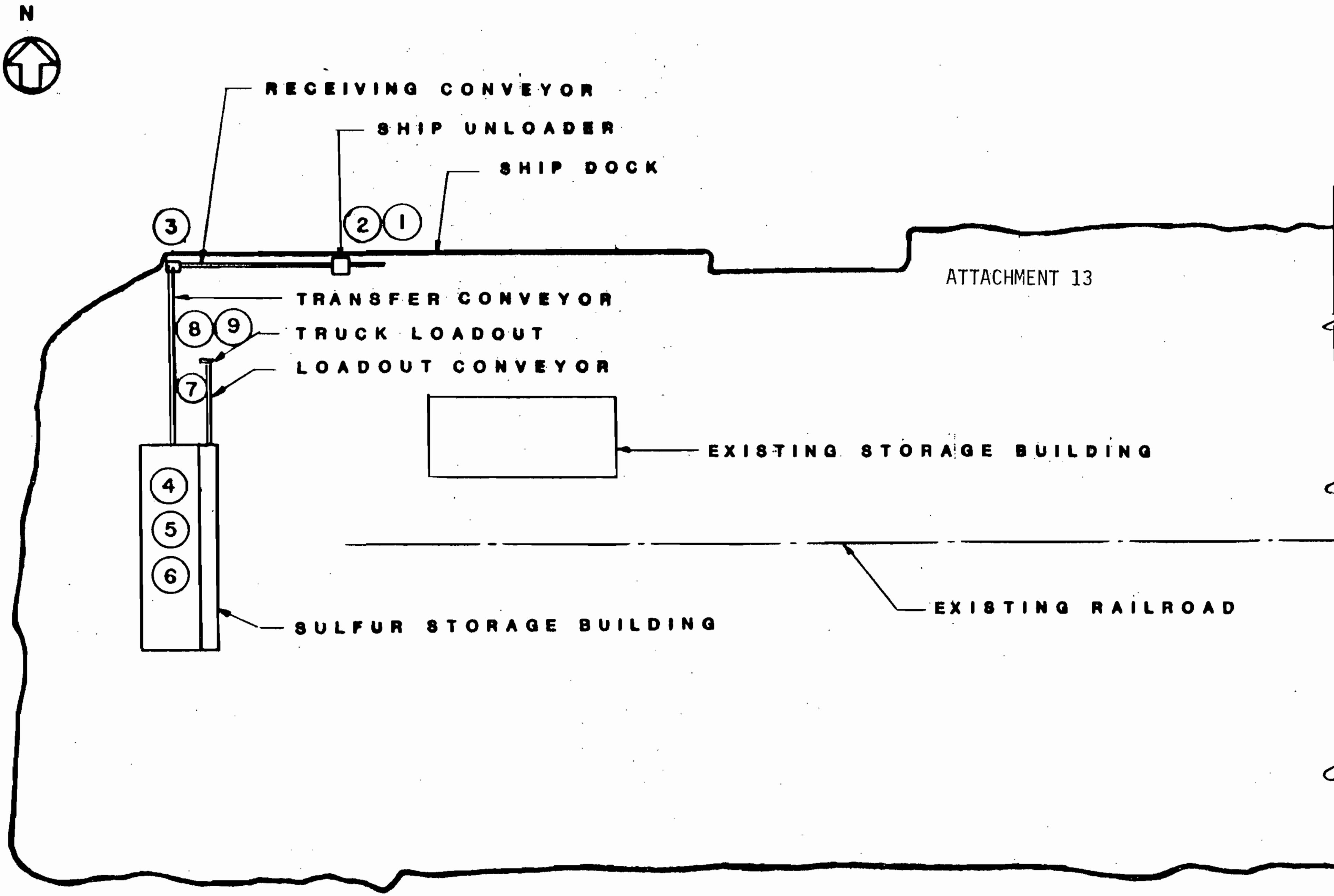


ATTACHMENT 12

AGRICO BIG BEND
SULFUR TERMINAL
PROCESS WATER FLOWSHEET

AUGUST 30,1984

JACOBS ENGINEERING GROUP



AGRICO BIG BEND TERMINAL

PLOT PLAN

ATTACHMENT 14

BIG BEND TERMINAL
TOTAL PARTICULATE EMISSIONS

EXISTING INSTALLATIONS

Permit No.	Allowable Particulate Emission Lbs./Hr.	Allowable Particulate Emission Tons/Year
AO 29-79216	3.15	4.7
AO 29-79217	1.52	0.38
AO 29-86211	1.52	0.38
AO 29-79215	11.27	2.8
	17.46	8.26

BIG BEND TERMINAL
TOTAL PARTICULATE EMISSIONS

PROPOSED PERMITTED EXPANSION

Permit No.	Proposed Allowable Particulate Emission Lbs./Hr.	Proposed Allowable Particulate Emission Tons/Year
AC 29-25142	15.33	7.95
AC 29-25149	11.5	5.95
AC 29-25160	13.68	7.1
AC 29-25161	9.2	3.6
AC 29-25162	15.32	6.01
AC 29-25163	9.20	3.68
AC 29-25164	6.12	2.44
	80.35	36.73

Total Particulate	Lbs./Hr.	Tons/Year
Existing	17.46	8.26
Proposed Expansion	80.35	36.73
	97.81	44.99

ATTACHMENT 15

PREDICTIVE EMISSION FACTOR EQUATION FOR BATCH DROP OPERATIONS

$$E = k(0.0018) \frac{\left(\frac{s}{5}\right) \left(\frac{U}{5}\right) \left(\frac{H}{5}\right)}{\left(\frac{M}{2}\right)^2 \left(\frac{Y}{6}\right)^{0.33}} \text{ (lb/ton)}$$

where: E = emission factor (lb/ton of material transferred)
s = material silt content (%)
U = mean wind speed (mph)
H = drop height (ft)
M = material moisture content (%)
Y = dumping device capacity (yd^3)
k = particle size multiplier (dimensionless)

Particle Size Range (µm)	k
≤ 30	0.73
≤ 15	0.48
≤ 10	0.36
≤ 5	0.23
≤ 2.5	0.13

SOURCE

EPA DOCUMENT NO. PB83-250720
COMPILATION OF AIR POLLUTION EMISSION FACTORS
THIRD EDITION, SUPPLEMENT NO. 14
(INCLUDING SUPPLEMENTS 1-7)
AP-42

ATTACHMENT 16

PREDICTIVE EMISSION FACTOR EQUATION FOR VEHICULAR TRAFFIC ON PAVED ROADS

$$E = k(0.090)I\left(\frac{4}{n}\right)\left(\frac{s}{10}\right)\left(\frac{L}{1,000}\right)\left(\frac{W}{3}\right)^{0.7} \quad \text{(lb/VMT)}$$

where:
- E = emission factor
- I = industrial augmentation factor (dimensionless)
- n = number of traffic lanes
- s = surface material silt content (%)
- L = surface dust loading (lb/mile)
- W = average vehicle weight (tons)
- k = particle size multiplier (dimensionless)

Particle Size Range (μm)	k
≤ 30	0.86
≤ 15	0.64
≤ 10	0.51
≤ 5	0.32
≤ 2.5	0.17

SOURCE

EPA DOCUMENT NO. PB83-250720
COMPILATION OF AIR POLLUTION EMISSION FACTORS
THIRD EDITION, SUPPLEMENT NO. 14
(INCLUDING SUPPLEMENTS 1-7)
AP-42

ATTACHMENT 17

DR. DALE LUNDGREN

EMISSION FACTOR EQUATION

$$E = \frac{k\ (S)\ [1 + (\frac{u}{10})^2]\ \ (\frac{h}{5})}{(\frac{M + 0.3}{4})^2\ \ (\frac{Y}{0.33})^{0.33}} \quad (F_s) \quad (\#/\text{Ton})$$

where: E = emission factor (#/Ton)

h = material drop height (ft)

u = mean horizontal wind speed (mph)

M = material moisture content (%)

Y = material discharge rate (tons/hour)

S = S_1, S_2, S_3 as follows:

S_1 = material silt content (%) if moisture < 1%

or S_2 = constant = 1 if material moisture > 2%

S_3 = weighted average of S_1 & S_2 if moisture > 1% & <2%

k = particle size multiplier (dimensionless) (as in AP-42

value yet to be determined therefore assume K=1

F_s = laboratory determined emission factor for

sulfur prill = 0.007 #/Ton for S = 1%,

u = 0, h = 5 ft., M = 3.7% and Y = 0.33 ton/hr

SOURCE

SUMMARY REPORT ON THE DUST
EMISSION FACTOR FOR WET PRILLED SULFUR

August 10, 1984

DALE A. LUNDGREN, Ph.D., P.E.

ATTACHMENT 18

JACOBS ENGINEERING GROUP, INC

Agrico 28-7443
October 2, 1984

EMISSION RATES

2% Moisture	TPH	Emission Factor E	Bldg Factor	Emission Rate lb/hr, Per Cent Control: 0	50.000	85.000	Hrs/Yr	Emission Rate TPY, Per Cent Control: 0	50.00	85.00
Activity										
Ship to Storage										
Clamshell to Hold	672.00	0	1.00	0	0	0	1000.00	0	0	0
Clamshell to Hopper	672.00	0.0005579	1.00	0.375	0.187	0.056	1000.00	0.19	0.09	0.03
Hopper to Belt	672.00	0.0017819	1.00	1.197	0.599	0.180	1000.00	0.60	0.30	0.09
Belt Transfer	672.00	0.0035637	1.00	2.395	1.197	0.359	1000.00	1.20	0.60	0.18
To Storage Pile	672.00	0.0089093	0.03	0.180	0.180	0.180	1000.00	0.09	0.09	0.09
Pile Activity										
Pile Erosion		0	0.03	0	0	0	8000.00	0	0	0
Payloader Pickup	84.00	0	0.03	0	0	0	8000.00	0	0	0
Payloader Dump	84.00	0.0006533	0.03	0.002	0.002	0.002	8000.00	0.01	0.01	0.01
Vehicle Traffic	84.00	0.0909427	0.03	0.229	0.229	0.229	8000.00	0.92	0.92	0.92
Truck Loadout										
Belt Transfer	84.00	0.0049547	1.00	0.416	0.208	0.062	8000.00	1.66	0.83	0.25
Bin Dump	84.00	0.0070782	1.00	0.595	0.297	0.089	8000.00	2.38	1.19	0.36
Bin to Truck	84.00	0.0070782	1.00	0.595	0.297	0.089	8000.00	2.38	1.19	0.36
				5.983	3.197	1.246	TOTALS	9.42	5.22	2.27

3% Moisture	TPH	Emission Factor E	Bldg Factor	Emission Rate lb/hr, Per Cent Control: 0	50.000	85.000	Hrs/Yr	Emission Rate TPY, Per Cent Control: 0	50.00	85.00
Ship to Storage										
Clamshell to Hold	672.00	0	1.00	0	0	0	1000.00	0	0	0
Clamshell to Hopper	672.00	0.0002479	1.00	0.167	0.083	0.025	1000.00	0.08	0.04	0.01
Hopper to Belt	672.00	0.0008656	1.00	0.582	0.291	0.087	1000.00	0.29	0.15	0.04
Belt Transfer	672.00	0.0017311	1.00	1.163	0.582	0.174	1000.00	0.58	0.29	0.09
To Storage Pile	672.00	0.0043278	0.03	0.087	0.087	0.087	1000.00	0.04	0.04	0.04
Pile Activity										
Pile Erosion		0	0.03	0	0	0	8000.00	0	0	0
Payloader Pickup	84.00	0	0.03	0	0	0	8000.00	0	0	0
Payloader Dump	84.00	0.0002903	0.03	0.001	0.001	0.001	8000.00	0.00	0.00	0.00
Vehicle Traffic	84.00	0.0909427	0.03	0.229	0.229	0.229	8000.00	0.92	0.92	0.92
Truck Loadout										
Belt Transfer	84.00	0.0024068	1.00	0.202	0.101	0.030	8000.00	0.81	0.40	0.12
Bin Dump	84.00	0.0034384	1.00	0.289	0.144	0.043	8000.00	1.15	0.58	0.17
Bin to Truck	84.00	0.0034384	1.00	0.289	0.144	0.043	8000.00	1.16	0.58	0.17
				3.009	1.663	0.721	TOTALS	5.04	3.00	1.57

JACOBS ENGINEERING GROUP, INC

Agrico 28-7443
October 2, 1984

EMISSION FACTORS

Batch Drop Operations AP 42

E = 0.0018k[(s/5)(U/5)(H/5)]/[(M/2)^2(Y/6)^.33]

	k	s	U	H	M	Y	E
Clamsh.-Hopper Pt 1	1.00	5.00	2.00	5.00	2.00	13.00	0.0005579
Clamsh.-Hopper Pt 1	1.00	5.00	2.00	5.00	3.00	13.00	0.0002479
Payloader- Belt Pt 5	1.00	5.00	2.00	6.00	2.00	14.00	0.0006533
Payloader- Belt Pt 5	1.00	5.00	2.00	6.00	3.00	14.00	0.0002903

Continuous Operations Lundgren Equation

E = kS[1+(u/10)^2](h/5)Fs/[((M+.3)/4)^2(Y/.33)^.33]

	k	S	u	h	M	Y	Fs	E
Hopper to Belt Pt 2	1.00	1.00	2.00	5.00	2.00	672.00	0.0070	0.0017819
Belt Transfer Pt 3	1.00	1.00	2.00	10.00	2.00	672.00	0.0070	0.0035637
to Storage Pile Pt 4	1.00	1.00	2.00	25.00	2.00	672.00	0.0070	0.0089093
Belt Transfer Pt 6	1.00	1.00	2.00	7.00	2.00	84.00	0.0070	0.0049547
Bin Dump Pt 8	1.00	1.00	2.00	10.00	2.00	84.00	0.0070	0.0070782
Bin to Truck Pt 9	1.00	1.00	2.00	10.00	2.00	84.00	0.0070	0.0070782
Hopper to Belt Pt 2	1.00	1.00	2.00	5.00	3.00	672.00	0.0070	0.0008656
Belt Transfer Pt 3	1.00	1.00	2.00	10.00	3.00	672.00	0.0070	0.0017311
to Storage Pile Pt 4	1.00	1.00	2.00	25.00	3.00	672.00	0.0070	0.0043278
Belt Transfer Pt 6	1.00	1.00	2.00	7.00	3.00	84.00	0.0070	0.0024068
Bin Dump Pt 8	1.00	1.00	2.00	10.00	3.00	84.00	0.0070	0.0034384
Bin to Truck Pt 9	1.00	1.00	2.00	10.00	3.00	84.00	0.0070	0.0034384

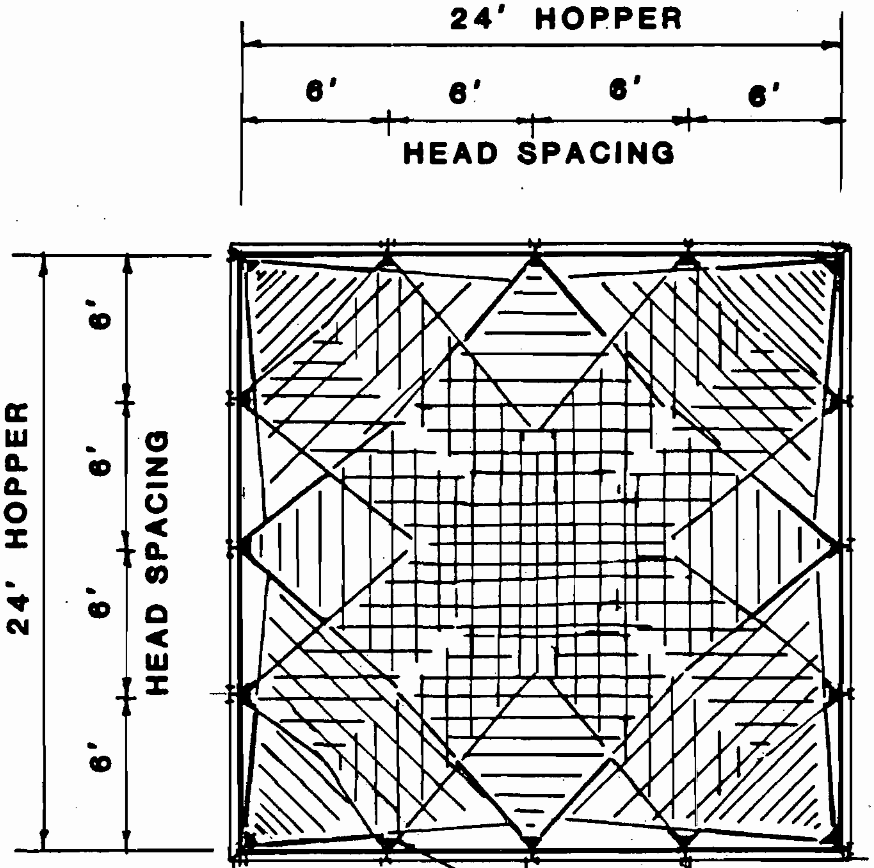
Vehicular Traffic AP 42

lb/VMT = 0.090kI(4/n)(s/10)(L/1000)(W/3)^0.7

	k	I	n	s	L	W	lb/VMT	E
Payloader Oper. Pt 5	1.00	1.00	2.00	8.00	23000.00	42.00	21.0078	0.0909427

with: 240 ft/round trip
8 trips/hr
84 TPH

then: E = (8)(240)/((5280)(84))xlb/VMT



16 - "BETE" FOG NOZZLE INC.
WL 3/4 80X .75 GPM at 40 psi
SPRAY NOZZLES WITH 80°
SPRAY ANGLE ON THE FLATS

SPRAY LAYOUT

SCALE: 1/8" : 1'-0"

AGRICO BIG BEND

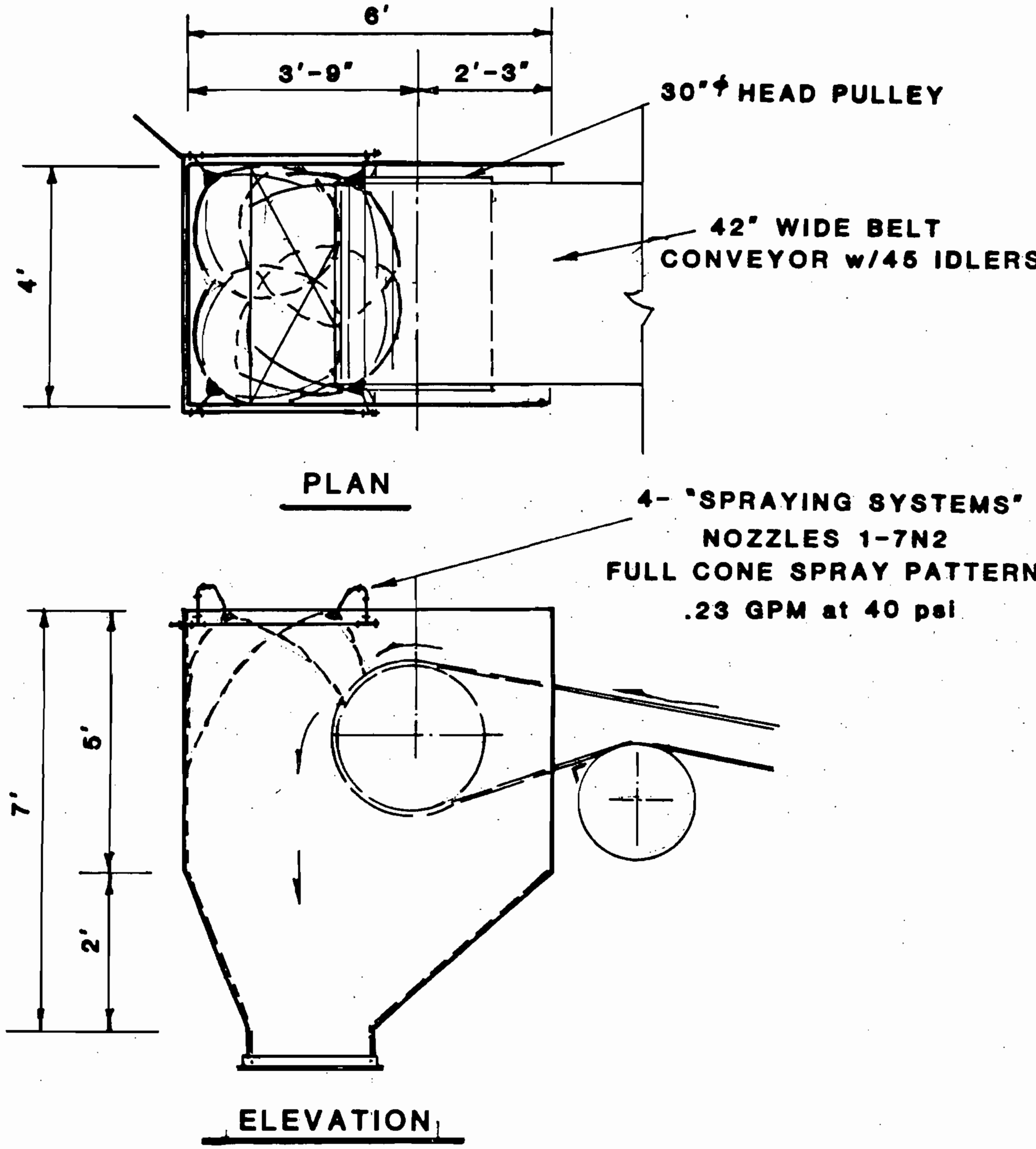
SULFUR TERMINAL

SHIP UNLOADER HOPPER

ATTACHMENT 19

JACOBS ENGINEERING GROUP

SEPTEMBER 11, 1984



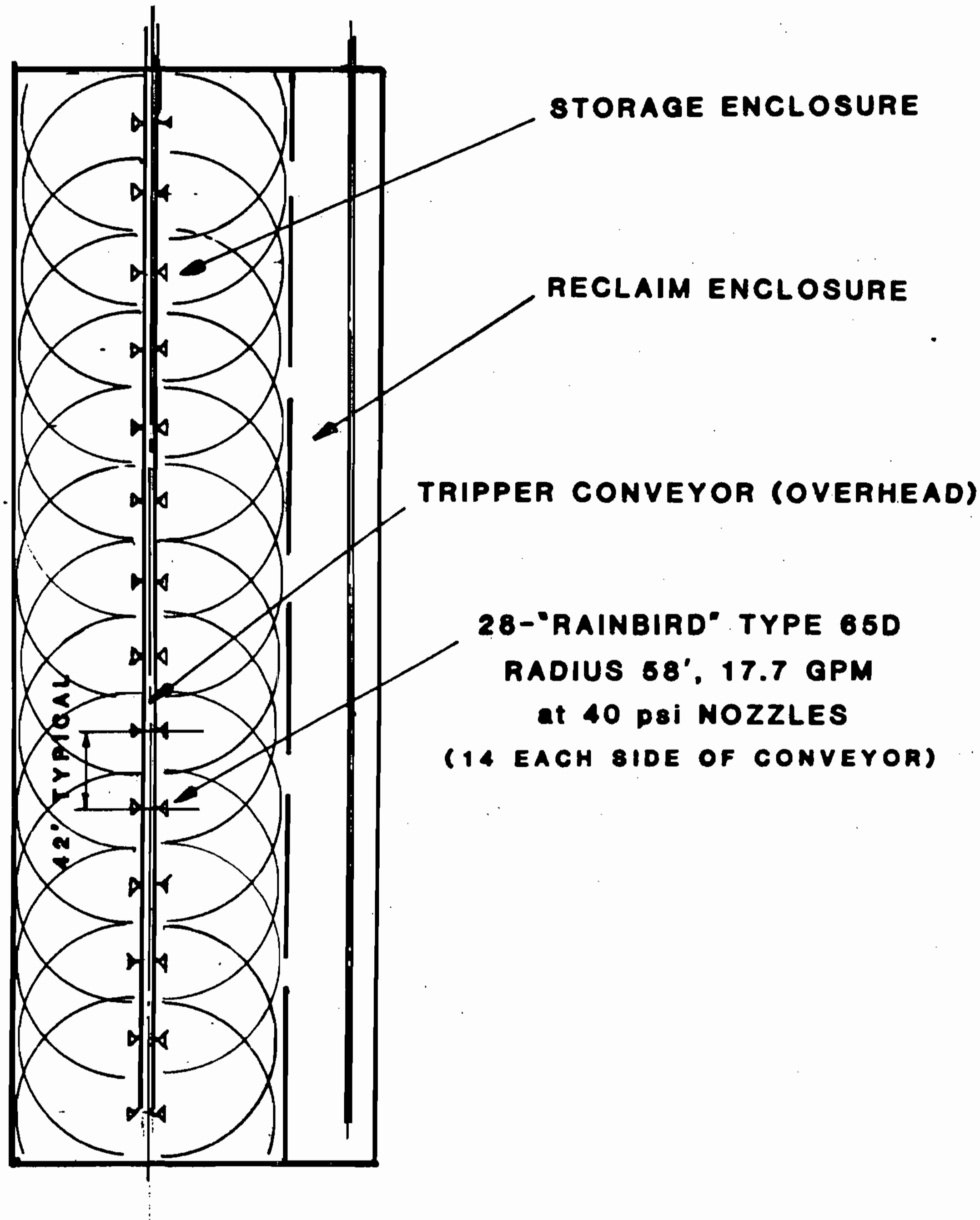
SPRAY LAYOUT

SCALE: 3/8" : 1'-0"

AGRICO BIG BEND
SULFUR TERMINAL
DOCK CONVEYOR TRANSFER

JACOBS ENGINEERING GROUP

SEPTEMBER 11, 1984



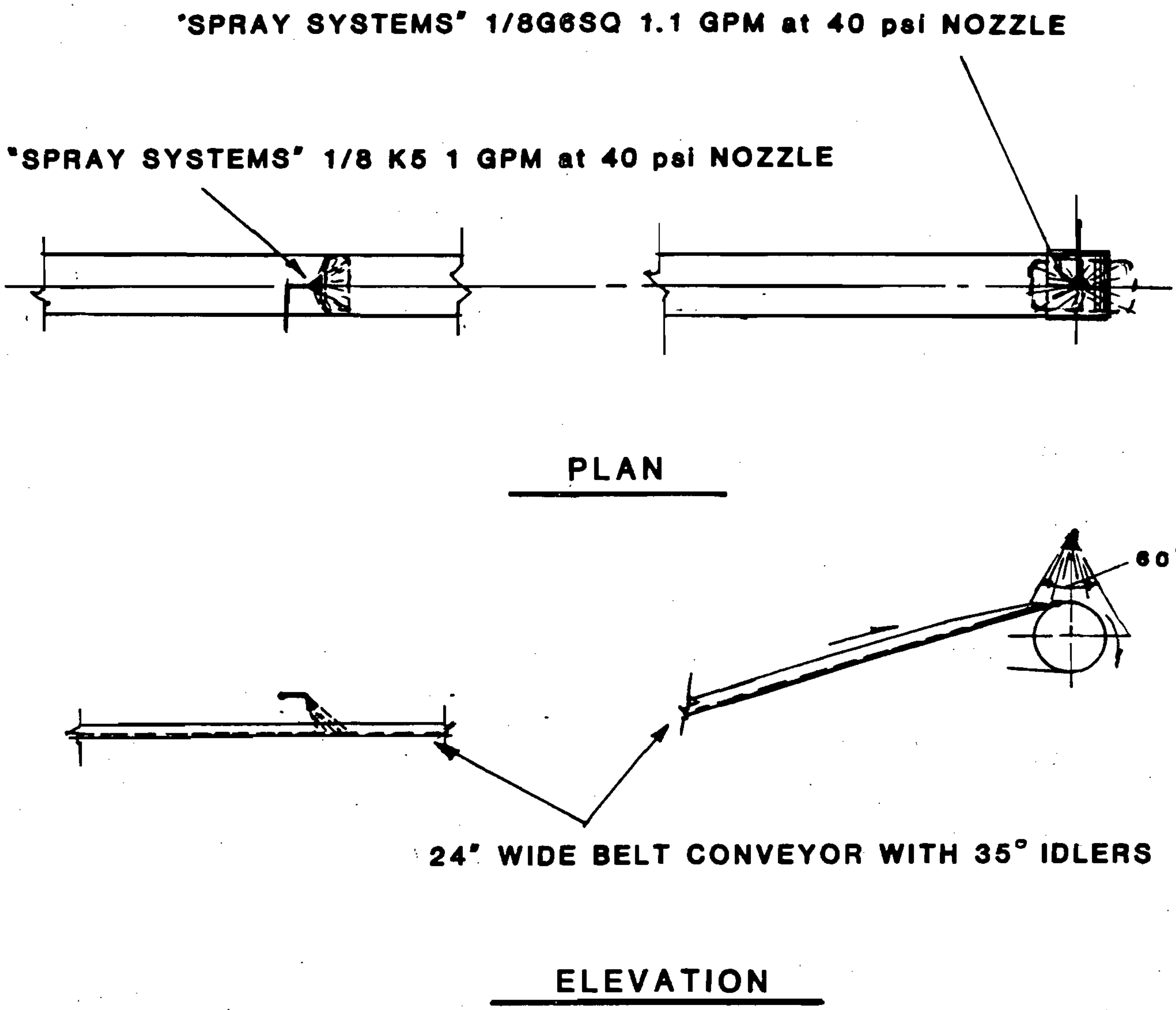
SPRAY LAYOUT

SCALE: 1":100'

AGRICO BIG BEND
SULFUR TERMINAL
STORAGE TRIPPER CONVEYOR

SEPTEMBER 11, 1984

JACOBS ENGINEERING GROUP



SPRAY LAYOUT

SCALE: 3/16" : 1'-0"

AGRICO BIG BEND
SULFUR TERMINAL
RECLAIM CONVEYOR

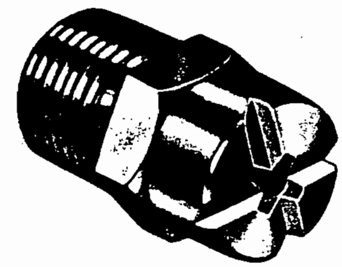
JACOBS ENGINEERING GROUP

SEPTEMBER 11, 1984

SQUARE

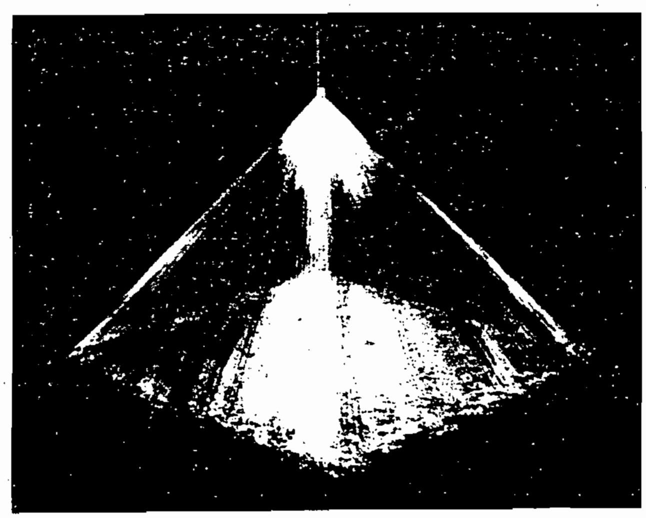
Best Available Copy

These square pattern nozzles deliver a squared off pattern with full coverage within the square. The spray angle is approximately 80° on the flats. Atomization, free passage and general performance are similar to the full cone nozzles.



The square pattern is recommended where a single nozzle must cover a square area or two or three nozzles must cover a rectangular area. For larger areas a group of full cone nozzles will give equally good coverage at less cost.

The WL nozzles are available in brass, stainless steel Type 303, Teflon and PVC plastic. Special materials frequently used are stainless steel Type 316, low carbon steel, monel and hard rubber.



80° square

Pipe Size	Female	Male	Hex Size	Length O.A.	Weight Ounces Metal	Weight Ounces Plastic	GALLONS PER MINUTE @ PSI 5	10	20	30	40	60	80	100	150	200	400
1/8	FWL¼80X	WL¼80X	7/16	7/8	1	1/4		.12	.18	.22	.25	.30	.35	.40	.48	.55	.80
	FWL½80X	WL½80X	7/16	7/8	1	1/4		.25	.35	.43	.50	.61	.71	.80	.95	1.10	1.60
	FWL¾80X	WL¾80X	7/16	7/8	1	1/4		.37	.52	.64	.75	.91	1.10	1.20	1.40	1.60	2.40
1/4	FWL180X	WL180X	9/16	1	1-1/2	3/8	.35	.50	.71	.86	1.00	1.20	1.40	1.60	1.90	2.20	3.20
	FWL1½80X	WL1½80X	9/16	1	1-1/2	3/8	.53	.75	1.10	1.30	1.50	1.80	2.10	2.40	2.90	3.40	4.70
3/8	FWL280X	WL280X	11/16	1-1/4	2	1/2	.71	1.00	1.40	1.70	2.00	2.50	2.80	3.20	3.90	4.50	6.30
	FWL380X	WL380X	11/16	1-1/4	2	1/2	1.10	1.50	2.10	2.60	3.00	3.70	4.20	4.70	5.80	6.70	9.50
	FWL480X	WL480X	11/16	1-1/4	2	1/2	1.40	2.00	2.80	3.50	4.00	4.90	5.70	6.30	7.70	9.00	12.60
1/2	FWL580X	WL580X	7/8	1-1/2	3	1	1.80	2.50	3.50	4.30	5.00	6.10	7.10	7.90	9.70	11.20	15.80
	FWL680X	WL680X	7/8	1-1/2	3	1	2.10	3.00	4.20	5.20	6.00	7.30	8.50	9.50	11.60	13.40	19.00
	FWL780X	WL780X	7/8	1-1/2	3	1	2.50	3.50	4.90	6.10	7.00	8.60	9.90	11.10	13.50	15.70	22.20
3/4	FWL880X	WL880X	1-1/8	2	6	1-1/2	2.80	4.00	5.70	6.90	8.00	9.80	11.30	12.60	15.40	17.90	25.20
	FWL1080X	WL1080X	1-1/8	2	6	1-1/2	3.50	5.00	7.10	8.60	10.00	12.20	14.10	15.80	19.40	22.30	31.60
	FWL1280X	WL1280X	1-1/8	2	6	1-1/2	4.20	6.00	8.50	10.40	12.00	14.70	17.00	19.00	23.20	26.80	37.90
1	FWL1580X	WL1580X	1-3/8	2-3/16	14	3-1/2	5.30	7.50	10.60	13.00	15.00	18.40	21.20	23.70	29.00	33.50	47.40
	FWL2080X	WL2080X	1-3/8	2-3/16	14	3-1/2	7.10	10.00	14.10	17.30	20.00	24.50	28.30	31.60	38.70	44.30	63.30

ATOMIZING
FINE SPRAY

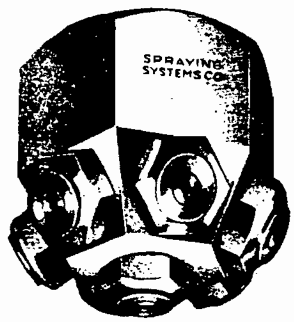
FogJet® NOZZLES Type 7N
Fine Atomizing Spray

Spray Characteristics—Fine particle spray forms an overall full cone type pattern.

Construction—Nozzle consists of body and seven removable spray caps, each cap with an internal core. Caps easily removed for cleaning or replacement.

Materials—Available from stock in brass with 303 stainless steel orifice inserts and core tips . . . or in 303 stainless steel throughout. See page 3 for list of other materials.

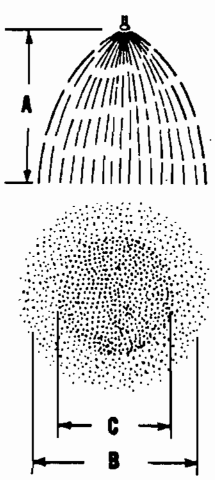
HOW TO ORDER: Specify Nozzle No., Material. Example: 1-7N16 303 Stainless Steel.



Type 7N
FogJet Nozzle
Pipe Connection—1" NPT (F)

See page 43 for Dimensions and Weights.

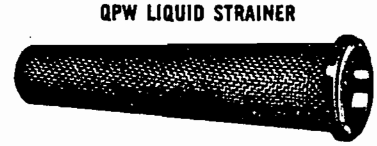
Nozzle No.	SPRAY PATTERN			CAPACITY GPM (gallons per minute) at p.s.i. (pounds per square inch)						
	A Feet	B Feet	C Feet	20 p.s.i.	40 p.s.i.	60 p.s.i.	80 p.s.i.	100 p.s.i.	125 p.s.i.	150 p.s.i.
1-7N.60	3 & Up	3½	1½					.11	.12	.14
1-7N1	3 & Up	4	2		.12	.14	.16	.18	.21	.23
1-7N1.5	3 & Up	4½	2½		.17	.21	.25	.28	.31	.34
1-7N2	3 & Up	4½	2½		.23	.29	.33	.37	.41	.45
1-7N3	3 & Up	5½	3½	.25	.35	.43	.50	.55	.62	.68
1-7N4	3 & Up	5½	3½	.33	.47	.57	.66	.74	.83	.90
1-7N6	3 & Up	6	4	.50	.70	.86	.98	1.1	1.2	1.4
1-7N8	3 & Up	6	4	.66	.93	1.1	1.3	1.5	1.7	1.8
1-7N10	3 & Up	7	4½	.83	1.2	1.4	1.7	1.8	2.1	2.3
1-7N12	3 & Up	8	4½	1.0	1.4	1.7	2.0	2.2	2.5	2.7
1-7N14	3	8	4½	1.2	1.6	2.0	2.3	2.6	2.9	3.2
1-7N16	3	8	5	1.3	1.9	2.3	2.6	3.0	3.3	3.6
	7 & Up	8½	5½							
1-7N18	3	8	5	1.5	2.1	2.6	3.0	3.3	3.7	4.1
	7 & Up	9	6							
1-7N22	3	9½	5½	1.8	2.6	3.2	3.6	4.1	4.5	5.0
	7 & Up	11	7							
1-7N26	3	10	6	2.1	3.0	3.7	4.3	4.8	5.4	5.9
	7 & Up	12	8							



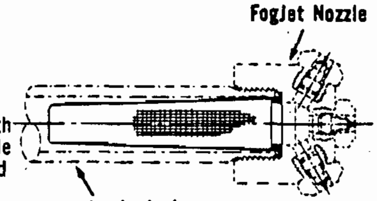
FULL CONE SPRAY PATTERN

Coverage in the "C" zone is about 65% of the total distribution density. The "B" zone represents the overall coverage pattern. About 35% of the total distribution occurs in the area outside of the "C" zone . . . with density gradually declining as the pattern perimeter is approached.

QPW LIQUID STRAINER



Available with 50 or 100 mesh screen. Specify ¾" or 1" size. (See Data Sheet 4915.)



QPW Liquid Strainer shown mounted with FogJet Nozzle and standard pipe.

TYPICAL APPLICATIONS

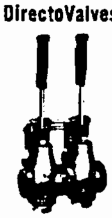
- GAS COOLING
- COOLING STORAGE TANKS
- DUST CONTROL
- WETTING

ACCESSORIES

Liquid Strainers

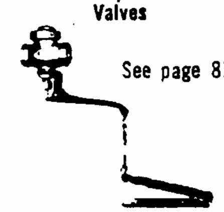
See pages 82-84

DirectoValves



See page 81

Foot Operated Valves

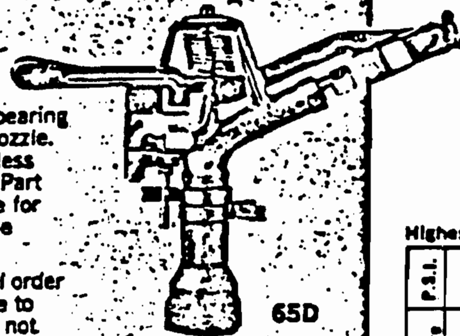


See page 81

RAIN BIRD

PART CIRCLE SPRINKLERS

65D SERIES



1" female Standard bearing only. Cast bronze body, arm, trips and bearing sleeve. Brass bearing nipple and straight bore range nozzle. Silicon bronze arm spring. Stainless steel trip spring and trip collars. Part circle sprinkler. Easily adjustable for full circle operation by sliding the slip pin up. No tools needed.

TNT bearings available on special order for use on all but DA models. Due to diffuser wire, the DA nozzle will not fit in 65D series sprinklers unless ordered from factory as DA models.

65D

Similar to the 65D above except has adjustable pin nozzle for control of stream break-up.

65D-ADJ

Similar to the 65D above except has Distance Control nozzle to allow adjustment of radius down to 30 feet.

65D-DA

Highest point of stream is 10' above nozzle.*

P.S.I.	Nozzle 7/32"		†Nozzle 1/4"		Nozzle 9/32"		Nozzle 5/16"		Nozzle 11/32"		Nozzle 3/8"	
Nozzle Pressure	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM
40	51	8.8	54	11.5	57	14.6	59	17.7	60	21.1	62	24.4
45	53	9.4	55	12.2	58	15.5	61	18.9	63	22.5	65	26.0
50	55	9.9	57	12.9	60	16.3	63	20.0	65	23.8	67	27.5
55	56	10.4	57	13.6	62	17.2	65	21.0	67	25.0	70	29.1
60	58	10.9	58	14.2	65	18.0	67	22.0	69	26.2	73	30.6
65	59	11.4	62	14.8	67	18.8	69	23.0	70	27.4	74	32.0
70	60	11.8	63	15.4	70	19.5	71	23.9	72	28.5	75	33.2
75	62	12.2	64	16.0	71	20.3	73	24.8	74	29.6	76	34.5
80	63	12.6	65	16.5	72	20.9	75	25.7	76	30.6	77	35.7

65PJ SERIES

65PJ

Similar to the 65D above except has a Precision-Jet arm. Arm is cast bronze with a brass tube. The Precision-Jet arm eliminates side splash.

65PJ-ADJ

Similar to the 65D-ADJ above except has a Precision-Jet arm.

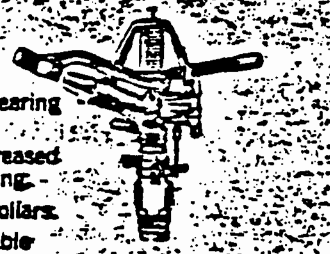
65PJ-DA

Similar to the 65D-DA above except has a Precision-Jet arm.

Highest point of stream is 10' above nozzle.*

P.S.I.	Nozzle 7/32"		†Nozzle 1/4"		Nozzle 9/32"		Nozzle 5/16"		Nozzle 11/32"		Nozzle 3/8"	
Nozzle Pressure	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM	Radius (Feet)	Discharge GPM
40	51	8.8	54	11.5	57	14.6	59	17.7	60	21.1	62	24.4
45	53	9.4	55	12.2	58	15.5	61	18.9	63	22.5	65	26.0
50	55	9.9	57	12.9	60	16.3	63	20.0	65	23.8	67	27.5
55	56	10.4	57	13.6	62	17.2	65	21.0	67	25.0	70	29.1
60	58	10.9	58	14.2	65	18.0	67	22.0	69	26.2	73	30.6
65	59	11.4	62	14.8	67	18.8	69	23.0	70	27.4	74	32.0
70	60	11.8	63	15.4	70	19.5	71	23.9	72	28.5	75	33.2
75	62	12.2	64	16.0	71	20.3	73	24.8	74	29.6	76	34.5
80	63	12.6	65	16.5	72	20.9	75	25.7	76	30.6	77	35.7

85E TNT



1¼" male TNT bearing only. Cast bronze body arm and trips. Brass bearing sleeve, nipple, and nozzles.

NEW non-clog plastic vane for increased diameters. Silicon bronze arm spring.

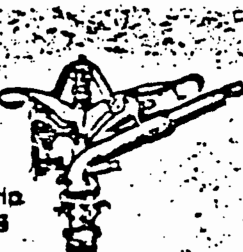
Stainless steel trip spring and trip collars.

Part circle sprinkler. Easily adjustable for full circle by sliding slip pin up. No tools needed.

P.S.I.	Nozzle 11/32" x 7/32"-20°		†Nozzle 3/8" x 7/32"-20°		Nozzle 13/32" x 7/32"-20°		Nozzle 7/16" x 7/32"-20°		Nozzle 15/32" x 7/32"-20°		Nozzle 1/2" x 1/4"		Nozzle 17/32" x 1/4"		Nozzle 9/16" x 1/4"		Nozzle 5/8" x 1/4"	
	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM
50	75	33.2	77	37.7	[illegible]	42.1	83	44.6	[illegible]	51.9	90	61.0	92	65.5	96	72.1	100	[illegible]
55	77	34.9	79	39.7	82	44.3	85	46.1	[illegible]	54.7	91	63.9	94	69.2	[illegible]	75.8	102	[illegible]
60	79	36.6	81	41.4	84	46.6	87	51.1	[illegible]	57.2	93	67.0	96	72.5	100	[illegible]	104	[illegible]
65	81	38.0	82	43.2	86	48.6	89	53.3	91	59.6	95	70.0	98	75.8	101	[illegible]	105	[illegible]
70	[illegible]	40.3	84	44.9	88	50.4	91	55.9	93	62.1	96	72.9	100	78.5	103	87.4	107	[illegible]
75	84	41.8	85	46.7	88	52.4	92	57.9	94	64.3	98	75.4	101	81.6	[illegible]	[illegible]	108	[illegible]
80	[illegible]	42.8	87	48.3	[illegible]	54.3	[illegible]	60.0	[illegible]	66.7	[illegible]	78.0	103	84.5	106	[illegible]	110	[illegible]
85	[illegible]	43.8	[illegible]	49.8	92	56.0	[illegible]	62.0	97	68.8	101	[illegible]	104	[illegible]	108	[illegible]	111	114.0
90	[illegible]	[illegible]	[illegible]	51.4	[illegible]	57.9	[illegible]	[illegible]	[illegible]	70.7	102	82.6	106	[illegible]	109	[illegible]	113	117.0
95	[illegible]	46.6	71	52.8	94	58.6	97	[illegible]	100	72.8	103	[illegible]	107	[illegible]	110	[illegible]	114	121.0
100	[illegible]	47.9	92	54.6	[illegible]	61.2	[illegible]	67.5	101	74.6	104	87.2	108	[illegible]	111	108.0	118	124.0

Also available as a 85EW-TNT, same as 85E-TNT except has brass plug instead of spreader nozzle for lower precipitation rates.

95 TNT



2" male TNT bearing only. Aluminum body and arm. Both have stainless steel striker plugs. Arm has a brass bushing and stainless steel trip striker plate. Anodized aluminum range tube with stainless steel vane. Cast bronze bearing sleeve, nipple, trips and trip collars. Stainless steel arm spring, bearing spring, and trip spring.

Brass straight bore range nozzle, drive nozzle and special spreader nozzle with a fixed stainless steel pin. Part circle sprinkler. Easily adjustable for full circle operation by sliding the slip pin up. No tools needed.

P.S.I.	Nozzle 1/2" x 5/16"x1/4"		Nozzle 9/16"x 5/16"x1/4"		†Nozzle 5/8"x 3/8"x5/16"		Nozzle 11/16"x 3/8"x5/16"		Nozzle 3/4"x 3/8"x11/32"	
	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM	Rad.	GPM
60	97	94.1	102	110.0	107	144.2	112	158.9	117	180.0
65	98	97.9	103	114.2	108	149.7	113	165.0	118	186.0
70	99	101.6	104	118.3	109	154.9	114	171.0	119	192.0
75	100	105.1	105	122.2	110	158.9	115	176.3	121	197.0
80	101	108.8	106	126.0	111	162.2	116	180.8	123	200.5
85	102	111.8	107	129.8	112	167.0	118	185.2	125	206.0
90	103	114.7	108	132.9	113	172.1	120	189.7	128	211.5
95	104	117.8	109	135.7	115	176.3	123	193.2	131	216.0
100	105	120.8	110	138.6	117	181.2	126	199.3	135	220.0

*Shown for standard nozzle at normal operating pressure.

†Indicates standard nozzle size.

Black face in chart indicates minimum recommended working pressures for best distribution.

SHADED AREAS IN CHARTS INDICATE ONLY AVAILABLE WITH TNT BEARING.

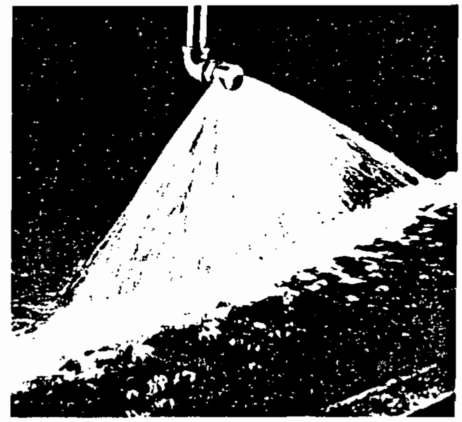
(105 Part Circle—see Rain Guns, Page 43.)

FloodJet. NOZZLES

Spray Characteristics—Very wide deflector type flat spray pattern and low impact. Suitable for liquid, air or steam. (See page 33 for air and steam performance data).

Construction—One-piece male connection nozzle. Round orifice minimizes clogging problems.

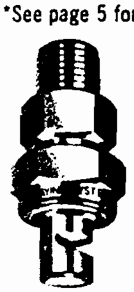
Materials—Available from stock in brass, type 303 or 316 stainless steel or PVC. See page 3 for list of other materials.



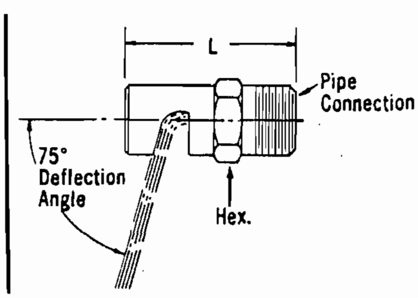
HOW TO ORDER: Specify Nozzle No., Material. Example: ¼K2 316 Stainless Steel.

Nozzle No.	Male Pipe Conn. NPT	Orifice Diam. Nom. Inches	Net Weight	DIMENSIONS		MATERIALS √=IN STOCK				CAPACITY GPM (gallons per minute) at p.s.i. (pounds per square inch)									SPRAY ANGLE*		
				Hex. Inches	L Inches	Brass	303 SS	316 SS	PVC	3 p.s.i.	5 p.s.i.	7 p.s.i.	10 p.s.i.	15 p.s.i.	20 p.s.i.	30 p.s.i.	40 p.s.i.	60 p.s.i.	7 p.s.i.	20 p.s.i.	60 p.s.i.
⅛K.25		.016	½ oz.	7/16	15/16	√	√	√						.03	.035	.04	.05	.06		83°	117°
• ⅛K.50		.024	½ oz.	7/16	15/16	√	√	√	√					.06	.07	.08	.10	.12		89°	122°
• ⅛K.75		.028	½ oz.	7/16	15/16	√	√	√	√				.075	.09	.11	.13	.15	.18		106°	125°
• ⅛K1		.033	½ oz.	7/16	15/16	√	√	√	√				.10	.12	.14	.17	.20	.24		109°	128°
• ⅛K1.5		.041	½ oz.	7/16	15/16	√	√	√	√			.12	.15	.18	.21	.26	.30	.37	73°	108°	125°
• ⅛K2		.046	½ oz.	7/16	1	√	√	√	√			.17	.20	.24	.28	.35	.40	.49	83°	113°	129°
• ⅛K2.5		.052	½ oz.	7/16	1	√	√	√	√		.18	.21	.25	.31	.35	.43	.50	.61	98°	122°	133°
• ⅛K3	⅛	.057	½ oz.	7/16	1	√	√	√	√		.21	.25	.30	.37	.42	.52	.60	.73	86°	112°	126°
• ⅛K4		.065	½ oz.	7/16	1	√	√	√	√		.28	.33	.40	.49	.57	.69	.80	.98	97°	123°	132°
• ⅛K5		.073	½ oz.	7/16	1	√	√	√	√	.27	.35	.42	.50	.61	.71	.87	1.0	1.2	114°	128°	142°
• ⅛K7.5		.091	½ oz.	7/16	1	√	√	√	√	.41	.53	.63	.75	.92	1.1	1.3	1.5	1.8	101°	119°	134°
• ⅛K10		.104	½ oz.	7/16	1	√	√	√	√	.55	.71	.84	1.0	1.2	1.4	1.7	2.0	2.5	115°	133°	145°
⅛K12		.116	½ oz.	7/16	1	√	√	√	√	.66	.85	1.0	1.2	1.5	1.7	2.1	2.4	2.9	128°	139°	153°
• ⅛K15		.129	1 oz.	9/16	1 7/32	√	√	√	√	.82	1.1	1.3	1.5	1.8	2.1	2.6	3.0	3.7	98°	113°	123°
⅛K18		.141	1 oz.	9/16	1 7/32	√	√	√	√	.99	1.3	1.5	1.8	2.2	2.5	3.1	3.6	4.4	106°	120°	131°
• ⅛K20		.148	1 oz.	9/16	1 7/32	√	√	√		1.1	1.4	1.7	2.0	2.4	2.8	3.5	4.0	4.9	110°	122°	133°
¼K2		.046	1 oz.	9/16	1 7/32	√	√	√	√			.17	.20	.24	.28	.35	.40	.49	82°	111°	128°
¼K2.5		.052	1 oz.	9/16	1 7/32	√	√	√	√		.18	.21	.25	.31	.35	.43	.50	.61	98°	122°	133°
¼K3		.057	1 oz.	9/16	1 7/32	√	√	√	√		.21	.25	.30	.37	.42	.52	.60	.73	86°	112°	126°
¼K5		.073	1 oz.	9/16	1 7/32	√	√	√	√	.27	.35	.42	.50	.61	.71	.87	1.0	1.2	114°	128°	142°
¼K7.5		.091	1 oz.	9/16	1 7/32	√	√	√	√	.41	.53	.63	.75	.92	1.1	1.3	1.5	1.8	101°	119°	134°
¼K10		.104	1 oz.	9/16	1 7/32	√	√	√	√	.55	.71	.84	1.0	1.2	1.4	1.7	2.0	2.5	115°	133°	145°
¼K15	¼	.129	1 oz.	9/16	1 11/32	√	√	√	√	.82	1.1	1.3	1.5	1.8	2.1	2.6	3.0	3.7	98°	113°	123°
¼K18		.141	1 oz.	9/16	1 11/32	√	√	√	√	.99	1.3	1.5	1.8	2.2	2.5	3.1	3.6	4.4	106°	120°	131°
¼K20		.148	1 oz.	9/16	1 11/32	√	√	√	√	1.1	1.4	1.7	2.0	2.4	2.8	3.5	4.0	4.9	110°	122°	133°
¼K22		.156	1 oz.	9/16	1 11/32	√	√	√		1.2	1.6	1.8	2.2	2.7	3.1	3.8	4.4	5.4	113°	125°	136°
¼K24		.161	1 oz.	9/16	1 11/32	√	√	√	√	1.3	1.7	2.0	2.4	2.9	3.4	4.2	4.8	5.9	115°	131°	144°
¼K27		.173	1 oz.	9/16	1 11/32	√	√	√	√	1.5	1.9	2.3	2.7	3.3	3.8	4.7	5.4	6.6	119°	135°	148°
• ⅜K30		.180	2 oz.	11/16	1¾	√	√	√	√	1.6	2.1	2.5	3.0	3.7	4.2	5.1	6.0	7.3	100°	110°	121°
⅜K35	⅜	.196	2 oz.	11/16	1¾	√	√	√	√	1.9	2.5	2.9	3.5	4.3	5.0	6.1	7.0	8.6	105°	118°	128°
⅜K40		.209	2 oz.	11/16	1¾	√	√	√	√	2.2	2.8	3.3	4.0	4.9	5.7	6.9	8.0	9.8	111°	126°	136°
⅜K45		.221	2 oz.	11/16	1¾	√	√	√		2.5	3.2	3.8	4.5	5.5	6.4	7.8	9.0	11.0	115°	130°	140°
½K40		.209	4 oz.	⅞	2	√	√	√	√	2.2	2.8	3.3	4.0	4.9	5.7	6.9	8.0	9.8	111°	126°	136°
½K50		.238	4 oz.	⅞	2	√	√			2.7	3.5	4.2	5.0	6.1	7.0	8.7	10.0	12.3	117°	131°	140°
½K60	½	.256	4 oz.	⅞	2	√	√	√	√	3.3	4.2	5.0	6.0	7.3	8.5	10.4	12.0	14.7	120°	134°	142°
½K70		.281	4 oz.	⅞	2	√	√			3.8	5.0	5.9	7.0	8.6	9.9	12.1	14.0	17.2	123°	137°	146°
½K80		.297	4 oz.	⅞	2	√	√	√	√	4.4	5.6	6.7	8.0	9.8	11.3	13.8	16.0	19.6	127°	138°	149°
½K120		.368	4 oz.	⅞	2	√	√	√	√	6.6	8.5	10.0	12.0	14.7	17.0	21	24	29	129°	143°	150°
¾K90		.316	7 oz.	1⅛	2 3/16	√	√	√		4.9	6.4	7.5	9.0	11.0	12.7	15.6	18.0	20	120°	133°	140°
¾K100		.332	7 oz.	1⅛	2 3/16	√	√	√		5.5	7.1	8.4	10.0	12.3	14.1	17.3	20	24	123°	136°	145°
¾K110		.348	7 oz.	1⅛	2 3/16	√	√			6.0	7.8	9.2	11.0	13.5	15.6	19.0	22	27	125°	138°	148°
¾K120	¾	.368	7 oz.	1⅛	2 3/16	√	√	√	√	6.6	8.5	10.0	12.0	14.7	17.0	21	24	29	128°	143°	153°
¾K140		.406	14 oz.	1½	2 9/16	√	√			7.7	9.9	11.7	14.0	17.1	19.8	24	28	34	118°	127°	135°
¾K160		.437	14 oz.	1½	2 9/16	√	√			8.8	11.3	13.4	16.0	19.6	23	28	32	39	121°	130°	137°
¾K180		.453	14 oz.	1½	2 9/16	√	√	√		10.0	12.7	15.1	18.0	22	25	31	36	44	124°	133°	139°
¾K210		.484	14 oz.	1½	2 9/16	√	√	√	√	11.5	14.8	17.5	21.0	26	30	36	42	51	128°	139°	145°
1K300	1	.578	1¼ lbs.	1¾	3 7/16	√	√	√	√	16.5	21	25	30	37	43	52	60	74	110°	128°	135°
1K450		.703	2 lbs.	1⅞	3⅝	√	√	√		25	32	38	45	55	64	78	90	111	118°	132°	138°

*See page 5 for spray coverage information.



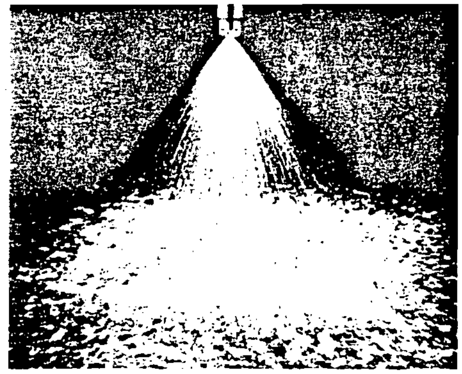
• These orifice sizes are also available in type TK or TTK UniJet Nozzles shown on page 33. Use above table for liquid performance.



TYPICAL APPLICATIONS

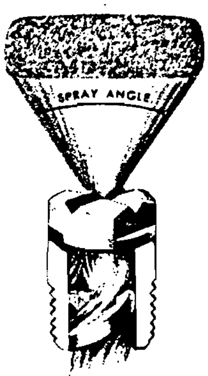
- Spraying Eliminator Plates
- Cooling Conveyor Belts
- Film Washing
- Water Curtain
- Fire Protection

FullJet® NOZZLES square spray



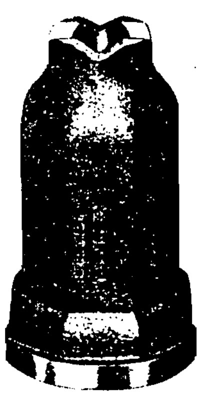
Spray Characteristics—Square spray pattern with uniform distribution throughout square pattern.
Construction—Nozzle made with internal, removable vane design. Types G and GG have removable caps. Sizes 1¼" and larger are cast type nozzles.
Materials—Bar stock sizes available from stock in brass, mild steel, type 303 stainless steel or PVC. Type HH also available in 316 stainless steel. Cast type available in brass, iron or 316 stainless steel. See page 3 for list of other materials.
NOTE: The sides of the square spray pattern are offset approximately 25° from the groove positions of the nozzles, depending upon spraying pressure and spray distance. Write for details.

SQUARE SPRAY PATTERN



Type HH-SQ male connection

Type GG-SQ with removable cap male connection



Type H-SQ cast type female connection

Patent Nos. 3,104,829, 3,146,674 and Foreign Patents.

HOW TO ORDER: Specify Nozzle No., Material. Example: ¼HH10SQ Mild Steel.

Nozzle No.		Pipe Conn. NPT	Orifice Diam. Nom. Inches	Max. Free Passage Diam.* Inches	CAPACITY GPM (gallons per minute) at p.s.i. (pounds per square inch)										SPRAY ANGLE**		
Female Pipe Conn.	Male Pipe Conn.				5 p.s.i.	7 p.s.i.	10 p.s.i.	20 p.s.i.	30 p.s.i.	40 p.s.i.	60 p.s.i.	80 p.s.i.	100 p.s.i.	150 p.s.i.	7 p.s.i.	20 p.s.i.	80 p.s.i.
⅛G3.6SQ	⅛GG3.6SQ	⅛	1/16	.050	.26	.31	.36	.50	.60	.69	.83	.95	1.1	1.3	40°	52°	47°
⅛G6SQ	⅛GG6SQ	⅛	3/32	.050	.43	.51	.60	.83	1.0	1.1	1.4	1.6	1.8	2.1	60°	66°	60°
¼G10SQ	¼GG10SQ	¼	7/64	1/16	.72	.85	1.0	1.4	1.7	1.9	2.3	2.6	2.9	3.5	62°	67°	61°
¼G12SQ	¼GG12SQ	¼	⅛	1/16	.86	1.0	1.2	1.7	2.0	2.3	2.8	3.2	3.5	4.3	70°	75°	68°
⅜G18SQ	⅜GG18SQ	⅜	5/32	3/32	1.3	1.5	1.8	2.5	3.0	3.4	4.1	4.7	5.3	6.4	71°	75°	68°
½G29SQ	½GG29SQ	½	7/32	⅛	2.1	2.5	2.9	4.0	4.8	5.5	6.7	7.6	8.5	10.0	71°	75°	68°
	⅛HH3.6SQ	⅛	1/16	.050	.26	.31	.36	.50	.60	.69	.83	.95	1.1	1.3	40°	52°	47°
	⅛HH4.8SQ	⅛	5/64	.050	.34	.40	.48	.66	.80	.91	1.1	1.3	1.4	1.7	48°	63°	57°
	⅛HH6SQ	⅛	3/32	.050	.43	.51	.60	.83	1.0	1.1	1.4	1.6	1.8	2.1	62°	71°	65°
	¼HH10SQ	¼	7/64	1/16	.72	.85	1.0	1.4	1.7	1.9	2.3	2.6	2.9	3.5	62°	67°	61°
	¼HH12SQ	¼	⅛	1/16	.86	1.0	1.2	1.7	2.0	2.3	2.8	3.2	3.5	4.3	70°	75°	68°
	¼HH14.5SQ	¼	.154	1/16	1.1	1.2	1.45	2.0	2.4	2.8	3.3	3.8	4.2	5.1	78°	82°	75°
	⅜HH18SQ	⅜	5/32	3/32	1.3	1.5	1.8	2.5	3.0	3.4	4.1	4.7	5.3	6.4	71°	75°	68°
	½HH29SQ	½	7/32	⅛	2.1	2.5	2.9	4.0	4.8	5.5	6.7	7.6	8.5	10.0	71°	75°	68°
	½HH36SQ	½	¼	⅛	2.6	3.1	3.6	5.0	6.0	6.9	8.3	9.5	10.5	13.0	78°	82°	75°
	¾HH50SQ	¾	11/64	11/64	3.7	4.3	5.0	7.0	8.4	9.6	11.5	13.2	14.6	17.6	71°	75°	68°
1H106SQ		1	25/64	7/32	7.6	8.9	10.6	14.5	17.5	20	24	28	31	37	78°	80°	73°
1¼H177SQ		1¼	½	¼	12.8	15.0	17.7	25	30	34	41	47	52	63	78°	80°	73°
1½H230SQ		1½	9/16	11/32	16.6	19.5	23	32	38	44	53	61	67	80	73°	77°	70°
2H290SQ		2	39/64	7/16	21	25	29	40	48	55	67	76	85	100	66°	70°	64°
2H360SQ		2	11/16	7/16	26	31	36	50	60	69	83	95	105	130	70°	74°	67°
2H480SQ		2	53/64	7/16	34	40	48	66	80	91	110	125	138	166	79°	82°	74°
2½H490SQ		2½	25/32	9/16	35	41	49	67	81	92	113	128	142	170	62°	67°	61°
2½H590SQ		2½	⅞	9/16	43	50	59	81	99	113	136	155	173	208	75°	78°	71°
2½H950SQ		2½	1⅛	11/16	69	80	95	132	160	183	220	253	280	339	81°	84°	76°
5H2980SQ		5	1⅞	1⅛	213	250	298	408	490	561	678	775	860	1040	89°	91°	83°
6H5690SQ		6	3 7/32	1¾	412	480	569	780	940	1080	1310	1490	1670	2040	102°	105°	95°

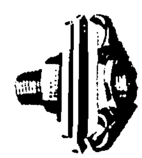
*Foreign matter with maximum diameter as listed can pass through nozzle without clogging.
**See page 5 for spray coverage information and page 25 for DIMENSIONS AND WEIGHTS.

TYPICAL APPLICATIONS

- COOLING AND QUENCHING
- PRODUCT WASHING
- AIR AND GAS WASHERS
- SCRUBBERS
- LIQUOR WASHERS
- DUST CONTROL
- FIRE PROTECTION

ACCESSORIES

Adjustable Ball Fittings



See page 73

Liquid Strainers

See pages 82-84

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Dec 1980

ATTACHMENT 20

PB81-174393

Fourth Symposium on Fugitive Emissions Measurement and Control Held at New Orleans, LA., on May 28-30, 1980

TRC Environmental Consultants, Inc.
Wethersfield, CT

Prepared for

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Research Triangle Park, NC

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FUGITIVE EMISSIONS CONCERNS FOR COAL STORAGE AND HANDLING AT UTILITY OPERATING STATIONS

Presented at the Fourth Symposium on Fugitive Emissions:
Measurement and Control
May 28-30, 1980
Monteleone Hotel, New Orleans, Louisiana

Peter W. Kalika and Pietro Catizone
TRC Environmental Consultants

ABSTRACT

This paper discusses the potential impact on utility operations of fugitive particulate matter emissions from coal storage and handling. It is based primarily on a study completed by TRC for a large utility.

Utilities seeking to convert to coal firing or preparing to reactivate older coal systems will be faced with a number of concerns, including:

- What are the probable magnitudes of the fugitive emission?
- What type of fugitive emission control systems are available?
- What modeling techniques are available to assess the impact on air quality of fugitive emissions?
- What are the design characteristics of various types of coal handling components with respect to fugitive emission potential?
- What are the ramifications of fugitive emissions control with respect to BACT and LAER under the Clean Air Act?

In developing a fugitive emissions inventory and applying the findings to decisions regarding the feasibility of resuming coal firing, the utility and TRC found it necessary to formulate answers to the foregoing questions. The paper presents discussions related to each of these concerns, with the objective of providing a general guideline to the utility managers who must address these problems.

1.0 FUGITIVE EMISSIONS CONCERNS FOR COAL STORAGE AND HANDLING AT UTILITY GENERATING STATIONS

1.1 Introduction

The U.S. dependence on imported oil for utility power generation has continued to grow in the years since the 1973 oil embargo. Coupled with the Three Mile Island incident, this has given major impetus to the early assessment of opportunities for increased power generation by coal combustion. However, the increased utilization of coal has been cited as carrying an inherently greater air pollution potential than any other form of power generation. Among the potentially serious sources of air pollution from coal-fired power generation are fugitive emissions of particulate matter from coal storage and handling operations.

Utilities considering the switch to coal firing, or preparing to reactivate older coal systems, must be concerned with fugitive emissions from the delivery, loading/unloading, transport, storage and processing of coal. TRC has recently completed a study for a large utility which inventoried the fugitive emissions for a projected resumption of coal firing at selected generating stations. The major technical problem of the study was the meaningful quantification of the particulate matter fugitive emissions. Direct measurement of such emissions from individual sources is an exceedingly expensive process, with costs at least an order of magnitude greater and accuracy inherently lower than for conventional stack testing. Thus estimation of emissions by emission inventory/emissions factor techniques, although not nearly as well defined as for point source emissions, was selected. Similarly, the nature and performance of emissions control systems for coal operations fugitive emissions are not well established, and there is a serious lack of information on the degree to which fugitive emissions can be designed out of the available options in coal handling equipment.

Given this framework, a stringent schedule, and a limited budget, TRC sought to predict fugitive emissions quantities and control performance from information available in the open literature, and by the application of judicious engineering judgment. The calculated emissions were then to be used as input to a mathematical model which would predict the air quality impact of the emissions and allow individual source contributions to be isolated.

This paper reviews the findings of the study, with the objective of providing general guidelines to the utility managers who must address coal fugitive emissions problems. The discussion will be directed to the following questions:

- What are the probable magnitudes of the particulate matter fugitive emissions and how are they distributed among the coal system components?

- What types of fugitive emissions control systems are available for each coal system component, and what are their probable efficiencies? What is considered BACT?

- What are the design characteristics of various types of coal handling components with respect to fugitive emission potential? To what degree are these quantifiable?

- What are the ramifications of coal handling fugitive emissons control, with respect to BACT and LAER under the Clean Air Act?

- What modeling techniques are available to assess the impact on air quality of particulate fugitive emissions, and how well can they isolate the contributions of the major sources within the coal system complex?

2.0 EMISSION FACTORS

The answers to the first three questions raised in the Introduction were sought through a comprehensive literature survey. The objective of this survey was to determine the range of fugitive particulate matter emission factors applicable to coal storage and handling, and the range of control efficiencies to be expected from appropriate control techniques. The literature review encompassed the recent studies by PEDCO and Midwest Research Institute, and the information generated by TRC's ongoing studies for EPA. In all cases, the literature sources were critically reviewed in terms of the means used to arrive at the emissions factors given, the type of operation for which they were developed, and their applicability to existing or visualized coal handling operations. A literature pool of 12 references resulted from this review, and formed the basis for the emission factors used in the study. These are given in the reference section of this paper.

The fugitive emission factors from the literature were classified as follows:

- o coal delivery: rail car
  barge
- o coal transfer: belt conveyors
  transfer operations
- o coal storage: active storage
  inactive storage

Table I summarizes the emission factors which were selected from the literature for these classifications, and also shows further refinement of the factors, based on a critical assessment of currently installed and expected equipment at the generating stations in question. It is this step which requires the application of engineering judgment based on experience. The "refined" factors which appear in Table I therefore should be viewed as somewhat site-specific. and would probably differ for other installations.

In applying the refined factors, the use of the ranges is recommended, as opposed to so-called "best estimate" single values. The carrying of a range of calculated emissions throughout the process will serve to remind all concerned that the emission values being developed incorporate a considerable degree of uncertainty.

The form of the emission factors for storage and transfer operations raises questions as to their physical validity. For example, the literature did not provide a specific factor which reflected the influence of the length of a conveyor, which seems the logical way of assessing the emissions from this type of source (emissions per unit length). Thus the factors expressed on the basis of through-put of coal conveyed or transferred were used, despite their obvious shortcoming in excluding the length factor.

In the case of inactive storage, one would expect the emissions to be related to windspeed and frequency of rainfall. While there are empirical emission factor equations available which take these into account, most of the literature emission factors were given in terms of the quantity placed in storage (annual basis) and this convention was adopted despite the lack of accounting for other physical aspects of the situation.

In the case of the active stockpile, it is recognized that there are several specific emission-generating processes which take place; i.e. load-in, load-out, vehicular traffic around the storage pile, and wind pickup. Each process would be expected to have a specific emission factor. Many literature sources did, in fact, attempt to distinguish among these individual sources. The typical active storage operations are usually located relatively close together, and the processes do not occur occur simultaneously. Thus, a single emission factor was judged to be most appropriate. Fortunately, such a factor was available in the literature (Ref. 4) and was adopted for use in the study. The single value given (0.22 kg/metric ton) was assigned a range of 0.11 to 0.33, in recognition of the likelihood that, even if obtained in a well-run experiment, such a factor would be determined from data scatter exhibiting at least a ±50% range.

TABLE 1

SUMMARY OF UNCONTROLLED PARTICULATE MATTER FUGITIVE EMISSION FACTORS FOR COAL OPERATIONS AT UTILITY POWER PLANTS

Operations	Uncontrolled Emission Factor (kg/metric ton) From Literature	Refined Uncontrolled Emission Factor[1]	Reliability Ratings Found In Literature[2]
Coal Delivery:			
(1) Railcar	0.0001 - 0.2	0.025 - 0.2	B, C, D, E
(2) Barge	0.0001 - 0.2	0.01 - 0.1	C, E
Coal Storage:			
(1) Inactive Storage Piles	0.055[3]	0.03 - 0.08[4]	B
(2) Active Storage Piles	0.22[3]	0.11 - 0.33[4]	B
Coal Transfer:			
(1) Belt Conveyor	0.02 - 0.5	0.02 - 0.2	D, E
(2) Transfer Operations	0.075[5]	0.04 - 0.12[4]	N/A (E)[5]

3.0 EFFICIENCY OF CONTROLS

Information on availability and expected effectiveness of control systems for fugitive particulate emissions from coal operations was also gleaned from the literature. Again, application of engineering judgment led to the refining of the literature values to provide efficiencies which could be applied to the existing or anticipated installations under study. In the case of control efficiency, a single "refined" value was selected from the literature range. This specificity could seem unwarranted in view of prior discussion regarding the uncertainties of the whole emission calculation process. However, it was felt that "engineering judgment" is more consistent with a single efficiency value than a single-valued emission factor, and there seemed to be insufficient justification for further widening of the range of uncertainty by assigning a control efficiency range.

Table 2 summarizes the control efficiency values which were selected from the literature for the same coal operation classifications used in Table 1. The "refined" efficiency value is given along with the nature of the control technique which could be expected to provide that efficiency. The "remarks" column gives information as to the probable maximum control efficiency available if cost of control were not a factor. The "refined" efficiency value and associated control type could also be viewed as providing a "practical" level of control, at least as far as the operations which were the subject of the TRC study are concerned.

TABLE 2
SUMMARY OF CONTROL EFFICIENCIES FOR PARTICULATE MATTER FUGITIVE EMISSIONS FOR COAL OPERATIONS AT UTILITY POWER PLANTS

Operations	Control Efficiency Range From Literature	Refined Control Efficiency & Nature of Control	Remarks
Coal Delivery			
(1) Rail Car Unloading	90 - 99%	95% Ventilation of Enclosure to Baghouse	Complete Enclosure is Difficult With Unit Train Dumping Systems
(2) Barge			
(a) Unloading	70 - 90%	75% Unventilated Enclosure	
(b) Loading	50 - 90%	75% Telescopic Unloading Chute & Local Ventilation and Control	95% Feasible With Enclosure, Ventilation and Control, But Very High CFM
Coal Storage			
(1) Inactive Storage Piles	50 - 100%	50% Wetting and Chemical Stabilization	Virtually 100% if Fully Enclosed, But Not Usually Practical With 30, 60 or 90 Day Piles at Large Stations
2) Active Storage Piles	50 - 75%	75% Wetting & Chemical Stabilization Plus Local Ventilation and Baghouse	95% Feasible With Enclosure, Ventilation and Control, But Very High CFM
Coal Transfer			
(1) Belt Conveyor	95 - 99%	97% Conveyors Enclosed But Not Ventilated	99% If Conveyors Properly Enclosed & Ventilated to Control, But Very Sensitive to Leaks
(2) Transfer Operations	90 - 99%	98% Enclosed; Ventilated to Baghouse	Usually Enclosed to Start With

4.0 BEST AVAILABLE CONTROL TECHNOLOGY (BACT)

The requirements of the Clean Air Act Amendments of 1977 specify that new or modified sources in certain process categories, whose emissions could impact criteria pollutant air quality attainment areas, be required to install Best Available Control Technology, (BACT). BACT is determined on a case by case review basis, and only limited information, as shown on Table 3, is presently available on BACT for coal handling fugitive emissions. Table 3 shows that the required efficiency of BACT for coal handling and storage and similar operations could conceivably range from an unspecified "do the best you can" to complete enclosure with ventilation and baghouse control and 99.7% efficiency. The control efficiencies obtained from the literature and "refined" by TRC as shown on Table 2, are generally consistent with the BACT values given. Only the 90% efficiency of the raw coal storage pile dedusting agent for the Region V Coal Cleaning Plant seems inconsistent. Lacking more detailed information, an efficiency of 50% would be more in keeping with the information encountered in the TRC study. At best, we could visualize no more than 75% control if the dedusting agent were used in conjunction with carefully placed windscreens/barriers at the active sites of the storage piles. 90% control is expected to require a substantial degree of enclosure or covering of the pile, in conjunction with a dedusting agent.

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TABLE 3
SUMMARY OF BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATIONS[1]
FOR PARTICULATE MATTER FUGITIVE EMISSIONS
FOR COAL HANDLING AND STORAGE OPERATION

Process/Operation	EPA Region	BACT Strategy Description	Control Efficiency Specified	Remarks
Petrochemical	VI			
Coal Crusher		Baghouse Filters	99.7%	Controlled efficiency to include capture ventilation system (Totally Enclosed)
Coal Bunker		Baghouse Filters	99.7%	
Coal Handling		Shrouded Conveyors: Water Spray at Crusher: Dust Collection at Transfer Points	Not Given	
Coal Cleaning Plant	7			
Truck Dump		Capture & Fabric Filter Fabric Filter	80% 99%	
Rotary Breaker		Capture Plus Fabric Filter	80%	
Raw Coal Transfer Belts		Dedusting Agent	90%	
Raw Coal Sampling Building		Dust Collector	90%	
Preparation Plant Duct Belt		Dust Collector	99%	
Coal Cleaning Plant	IV			
Truck Dump		Enclosed Wet Suppression	90%	
Screen's Transfer Points		Enclosed Wet Suppression	90%	
Crusher		Enclosed Wet Suppression	90%	Assumed that no ventilation used in conjunction with these
Surge Bins		Not Given	90%	
Stock Piles		Enclosed Wet Suppression	90%	
Loading		Wet Suppression	90%	
Electrical Generating Station	IX			
Coal Handling		Spray Application And Dust Collectors	Not Given	Detailed Control Strategy Info is Given in Permit
Coal Classification Plant	IX			
Aggregate Coal Storage		Water Sprays	Not Given	
Loading Areas				
Oil Shale Project	VIII			
Roads, Parking Areas, Drill Pads and Shale Deposit Areas		Water Sprays & Chemical Controls	"To Greatest Extent Possible"	

NOTES:

1. SOURCE: "Compilation of BACT/LAER Determinations": EPA

5.0 MAGNITUDE OF EMISSIONS

The significance of particulate fugitive emissions may best be judged by the application of the foregoing emission factors and control efficiencies to a typical coal handling and storage situation. The calculations are summarized on Table 4. These are abstracted from the TRC study, with appropriate simplification of the system and modification of throughput values.

The "typical" plant is assumed to burn 5000 metric tons of coal per 24 hours, which provides approximately 5500 X 106 BTU/hr heat input and is about equivalent to a 600 MW plant.

The total fugitive particulate emissions estimated for this typical plant are significant, even after application of controls which could certainly be considered BACT. At the high end of the range of annual emissions, over 100 TPY would be emitted. The active stockpile is seen to be the largest contributor (40% of the total), which is not suprising, since this operation involves actively disturbing and working the coal in the open. Significant additional control could only be achieved by completely enclosing the operation, and by ventilating to a baghouse or other control device. The maximum contribution of the conveyors (30 metric tons, or 21%) seems intuitively too high. Although the selected upper value for the uncontrolled emission factor of 0.2 kg/metric ton is well supported by the literature, its application to each conveyor section may be suspect. The available information did not clearly state whether the conveyor uncontrolled factors should be applied to the entire conveyor system, or to each section. In the TRC study, we adopted the latter, more conservative approach, and this is reflected in Table 4.

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TABLE 4
CALCULATION OF PARTICULATE FUGITIVE EMISSIONS
FROM COAL HANDLING AND STORAGE OPERATIONS
FOR A TYPICAL COAL FIRED GENERATING PLANT

Emission Source And A Throughput	Uncontrolled Emission Factor	Control Type And Efficiency	Emissions Estimate 24 Hr	Emissions Estimate Annual
Unit Train Rotary Car Dumper 5,000 Metric Tons/24 Hr 1×10^6 Metric Tons/Yr	0.025 - 0.20	Enclosure; Ventilation; Baghouse; 95%	7-50 kg	1.3 metric -10 tons
Conveyors 5,000 Metric Tons/24 Hr 1×10^6 Metric Tons/Yr	0.020 - 0.20 Per Conveyor Section Assume 5 Sections	Enclosed; Well Sealed; 97%	15 - 150 kg	3 - 30 metric tons
Transfers 5,000 Metric Tons/24 Hr 1×10^6 Metric Tons/Yr	0.06 - 0.12 Per Transfer Point Assume 4 Transfers	Enclosed; Ventilation; Baghouse; 98%	16 - 48 kg	3.2 - 9.6 metric tons
Active Stockpile 2,000 Metric Tons/24 Hr 0.5×10^6 Metric Tons/Yr	0.11 - 0.33	Wetting; Chemical Stabilization; Local Ventilation to Baghouse; 75%	55 - 165 kg	13.8 - 41.3 metric tons
Inactive Stockpile 90 Day Storage (450,000 Metric tons in storage)	0.03 - 0.08	Wetting; Chemical Stabilization; 50%	19 - 50 kg (annual emissions divided by 365)	6.8 - 18 metric tons
TOTAL EMISSIONS			112 - 463 kg (246-1019 lb)	28.1-108.9 metric tons (30.9-120 short tons)

6.0 COAL HANDLING COMPONENTS

The design of the coal handling system components can significantly influence the magnitude of uncontrolled fugitive emissions. That is, the degree to which the design minimizes the mechanical agitation of the coal, will be reflected in reduced emissions. The operations which are most involved with such mechanical manipulation of the coal, and which contribute significantly to the total fugitive emissions are:

- o coal unloading
  - from trains
  - from barges
- o coal loading
  - to barges
  - to trains
- o active stockpiles
  - coal delivery to the piles
  - coal reclamation from the piles

The emission factor literature rarely distinguishes among various available equipment arrays for accomplishing these functions. Ideally, one would assume that the uncontrolled emission factor would range from the high extreme to the low extreme as the equipment's inherent capability to disturb the coal is decreased. Unfortunately, there is no specific information to support this speculation and one can only surmise in a general way as to which method (e.g., of delivering coal to a storage pile), generates the least fugitive emissions.

Figure 1 illustrates this, schematically showing two ways of accomplishing several of the functions in the order of (probably) decreasing emissions.

For barge unloading, the continuous unloader, which is a shrouded and articulated bucket conveyor, would be expected to generate substantially less fugitive emissions than the grapple bucket unloading method. The continuous unloader also offers the opportunity to apply reasonably effective local ventilation.

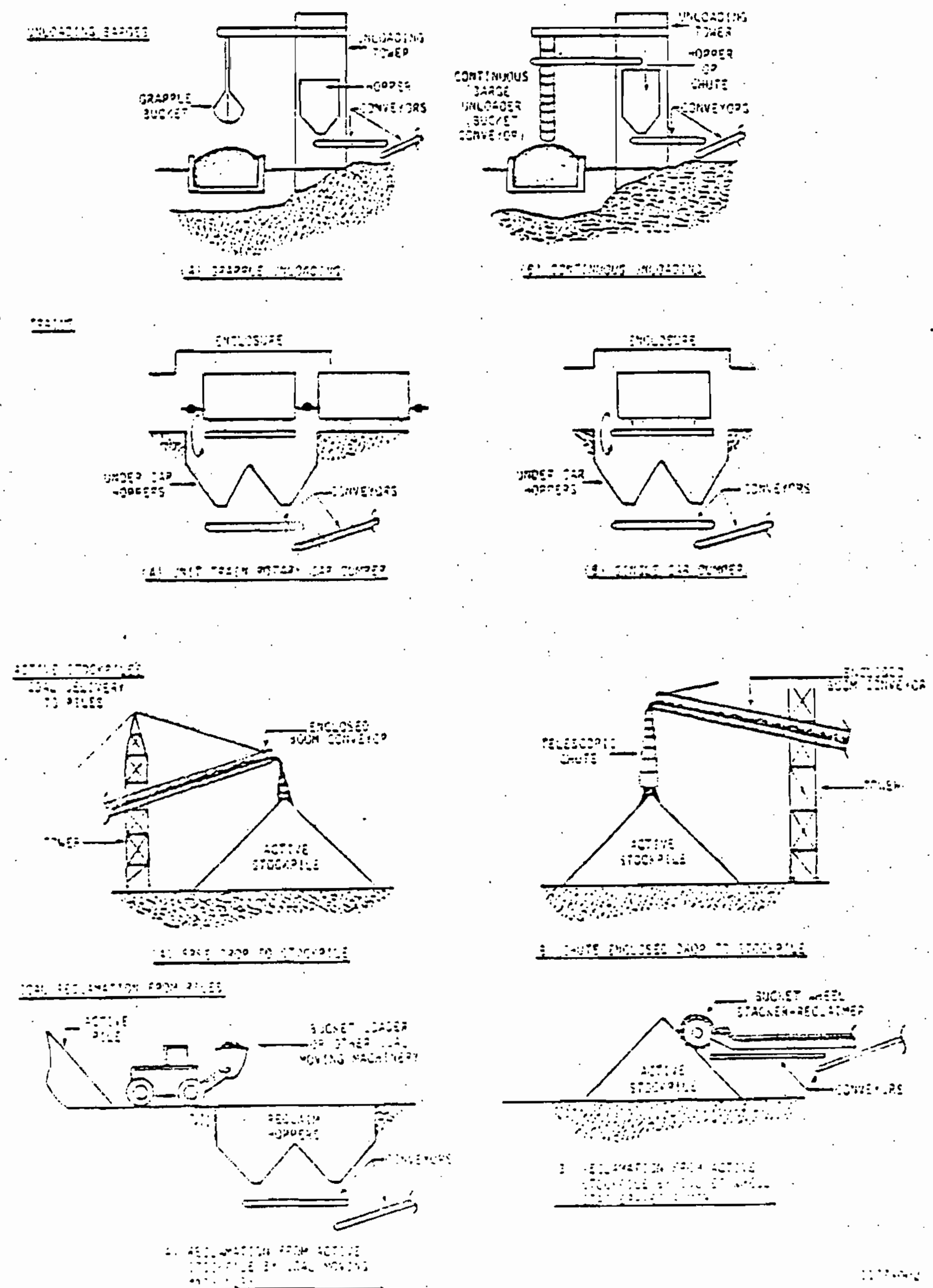
In the case of trains, it is not apparent that a rotary car dumper designed to invert coal rail cars while they remain coupled, could generate more fugitive emissions than a single car dumper, except to the extent that a single car is more readily enclosed. The unit train system would operate more rapidly and thereby generate more emissions in a given time period, given equal control effectiveness. In either case, the train unloading system can be expected to be enclosed, ventilated and controlled, so in this case, the degree to which one version can generate more fugitive emissions than the other may be a moot point.

Active stockpile coal delivery is shown in two versions. One entails a free drop to the stockpile, while the second incorporates a telescoping chute to essentially enclose the coal stream during the drop. It is apparent that the latter method will generate less fugitive emissions.

Coal pile reclamation is shown in two systems which could be construed as "manual" vs. "automatic". The use of earth moving equipment around the pile, such as bucketloaders, bulldozers or graders which carry or push the coal to underground hopper/conveyor systems, can be expected to generate substantially greater fugitive emissions than an articulated bucket wheel stacker/reclaimer with associated conveyors. The latter would be shrouded and can be subjected to local ventilation and control.

In summary, the design features of coal handling component and systems can be a positive factor in minimizing fugitive emissions from the operation. Quantification of emission characteristics for various designs is beyond the present state of knowledge, and only educated estimates can be used to recognize that one component array may generate less emissions than another.

FIGURE 1: THE EFFECT OF COAL HANDLING COMPONENTS ON FUGITIVE EMISSIONS



7.0 MODELING OF FUGITIVE PARTICULATE MATTER EMISSIONS

The foregoing sections have described concerns and methodology related to the quantificaton of fugitive particulate matter emissions, and the means available for their control. Determination of the impact of these emissions on ambient air quality and their specific contribution to ambient concentrations requires the use of sophisticated mathematical modeling techniques. These techniques also are needed to assess tradeoffs in the application of controls to individual fugitive emissions sources, and to nearby point sources.

The immediate need for such refined analytical techniques has been acknowledged and met by EPA with the recent development of advanced dispersion models. The Industrial Source Complex (ISC) Dispersion Model developed by the H.E. Cramer Co. Inc., and the CDMDEP Model, a modified version of the Climatological Dispersion Model (CDM), developed by TRC Environmenal Consultants are two such models prepared for the EPA.

The ISC Dispersion Model combines and enhances various EPA dispersion model algorithms into a set of two computer programs that can be used to assess the air quality impact of emissions from a wide variety of sources, associated with an industrial source complex such as a Power Generating Station.

The ISC and CDMDEP models have been designed to account for mechanisms which influence the dispersion and quantification of particulate plumes. These mechanisms include:

- o dry deposition
- o gravitational settling
- o washout
- o building wake effects
- o vertical wind profile variations
- o plume rise

Stack, Area and Volume sources can be simulated by the ISC Model programs. Long-term concentrations of total suspended particulate matter due to emissions from point and area sources can be estimated by CDMDEP.

Short term or long-term source-receptor relationships can be derived using the ISC Dispersion Model. The ISC Short Term Model (ISCST) is designed to calculate concentrations or deposition values for time periods of 1, 2, 3, 4, 6, 8, 12 and 24 hours. The ISC Long Term Model (ISCLT) uses STAR Meteorological Summaries to calculate seasonal and/or annual ground level concentrations or deposition values.

The input data required to run either ISC or CDMDEP consists of four categories:

- o Meteorological Data
- o Source Data
- o Receptor Data
- o Program Control Parameters

The details of the input data are given in references 13 & 14. The output from these mathematical models provides a quantitative estimate of the spatial distribution of air quality, averaged over the time period considered. Contributions from major sources within the industrial complex can be identified and appropriate controls prescribed. It should be noted that these advanced, complicated models are intended to be used by Air Quality Engineers and/or Meteorologists familiar with effluent dispersion characteristics and computer techniques. The models, with proper fundamental knowledge, can be applied to other types of studies such as:

- o Stack design
- o PSD analyses
- o Source Permit Applications
- o Monitoring Network Design
- o Regulatory Variance Evaluation
- o Control Strategy Evaluations
- o Fuel Conversion Studies
- o New Source Reviews
- o Analyses of Emission Offsets

8.0 CONCLUSIONS

This paper has reviewed a methodology for estimating the quantities and degree of control for fugitive particulate matter emissions from coal handling operations. Available information in the form of emission factors and estimates of control efficiencies was found to be relatively sparse and to vary widely. Information on BACT controls is also limited at present. Considerable judgment must be incorporated in the application of information. The estimation of well-controlled fugitive particulate emissions from a typical coal-fired plant results in significant residual emissions, of which a large proportion is due to actively working the stored coal in the open. More information on the relationship between coal handling equipment design characteristics and fugitive emissions is needed.

Mathematical Models are available which will discriminate among various fugitive emission sources and elevated point sources to isolate their individual impacts on ambient concentrations of suspended particulate matter. Application of these models completes the assessment of fugitive emissions and leads to the formulation of cost-effective control strategies.

There is at present enough information to only generally guide those managers who must address coal fugitive emission problems at utility stations. Each site will have its specific problems and constraints. The manager is urged to approach the problems utilizing a broad team of experts. Air pollution control engineers, power generation specialists, diffusion meteorologists, coal systems designers, environmental consultants, and environmental attorneys can all provide important inputs to the problem solutions. The success and cost effectiveness of the solutions will depend on how well the efforts of the team are orchestrated.

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ATTACHMENT 21

ncasi technical bulletin

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC., 260 MADISON AVENUE, NEW YORK, N.Y. 10016

FUGITIVE DUST EMISSION FACTORS AND CONTROL METHODS IMPORTANT TO FOREST PRODUCTS INDUSTRY MANUFACTURING OPERATIONS

TECHNICAL BULLETIN NO. 424
MARCH 1984

TABLE 16 FUGITIVE EMISSION CONTROL MEASURES AND EFFICIENCIES (27,28)

SOURCE	CONTROL METHOD	REPORTED EFFICIENCIES, PERCENT
Storage Pile Wind Erosion	Enclosure	95-99
	Wind Screen	low-30
	Chemical Wetting	85,90
	Water Spray	50,80
	Chemical Stabilization	50,99
Load-In	Enclosure	70-90
	Wetting Agents	80-90
	Foam	80-90
	Telescoping Chutes	75
	Wind Guard	50
	Water Spray	50
Load-Out	Water Spray	50
	Under Pile Conveyor	80
	Stacker-Reclaimer	40,80
Vehicle Traffic	Watering	50
	Stacker-Reclaimer	25-50
	Chemical Spray	85-90
Conveyor Transfer	Total Enclosure	90-97
	Water Spray-Feed Points	35,50
	Foam	73
	Chemical Spray	85

ATTACHMENT 22

79-11.4

Fugitive Emission from Coal-Fired Power Plants

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For Presentation at the 72nd Annual Meeting of the
Air Pollution Control Association
Cincinnati, Ohio June 24-29, 1979

Introduction

In the routine course of coal-fired power plant operation, "fugitive" discharges to the environment may occur. Sources of these emissions may include coal unloading, coal stockpiles, coal handling and transfer facilities, ash handling and disposal, and associated vehicular traffic. Emissions from such sources are often referred to as "fugitive" because they are not emitted from a definable point source and because their quantification and control can frequently be elusive. In this paper, fugitive emissions are defined as pollutants which escape from an industrial process due to leakage, materials charging/handling, inadequate operational control, transfer, or storage. Controlled fugitive emissions are defined as those fugitive emissions to which mechanical, chemical, or physical constraints have been applied to reduce environmental contamination.

Until recently, control of fugitive emissions has often been overlooked, especially with regard to ambient particulate concentration levels. The stimulus for much of the recent interest in fugitive emissions has been the increasingly successful control of non-fugitive emissions (i.e., point sources), wherein a proportional improvement in air quality near the source has not been noted. This suggests that fugitive emissions may have a greater impact on air quality levels than had been hitherto suspected

This paper is a report of a study made to assess, through a literature search, airborne fugitive emissions from a coal-fired power plant.

Approach

Possible sources of fugitive emissions at a coal-fired power plant were identified. The identification of these emission-prone processes was accomplished by analyzing power plant operations and assessing their potential for releasing fugitive materials. Next, a comprehensive literature.search was conducted to locate published information on power plant fugitive emissions. When possible, the information was classified as to location, process type, equipment capacity, coal source, control method and cost, and validity. Many of these items were often not provided within the literature. The costs are all reported as 1978 costs.

In order to classify the quality of the data, a validity rating system similar to that used by the EPA[1] was adopted. The ratings are A - Excellent B - Above Average, C- Average, D - Below Average, and E - Poor (or no supporting data). One aspect of the "E" validity rating deserves clarification. Many reports in the literature refer to earlier works as justification for emission estimates but do not present data with which to judge their validity. In accordance with the rating system, those information sources were given a validity rating of "E". Because of this, an "E" rating may indicate a non-primary data source rather than a poor estimat

Results

Data related to airborne fugitive emissions are usually given as emission factors, emission rates, or ambient concentration levels. The emission factor, an estimate of the rate at which a pollutant is released to the atmosphere divided by the level of activity, is the most convenient form. Emission factors are shown in tabular format when possible. However, sometimes emission factors are not reported as a single value. Instead, some investigators have developed formulas to calculate emission factors. These formulas are generally related to meteorological and industrial variables. If an equation appeared in the literature, a typical calculated emission factor is shown in the table and the reader is referred to the reference for more information.

Coal Delivery

Coal is delivered to power plants by railcar, barge/ship, truck, or slurry pipeline. The delivery process includes loading, transporting, and unloading. Unloading is the primary concern at the power plant. Fugitive emission data for which the specific delivery process was not given are included along with railcar delivery data since this is the most common method of coal delivery.

Railcar Delivery. No fugitive emissions data were found in the literature which were derived directly from railcar unloading. However, several reports have applied emission factors to this activity as shown in Table I. This table shows a range of 0.0001 to 0.2 kilogram of fugitive emissions per ton of coal unloaded. As shown by the table, the factor most often given is 0.2 kg/t. This is judged to be the most appropriate emission factor even though the origin of this factor could not be located. Other emission factors given in Table I with higher validity ratings have been used to estimate emissions from railcar unloading; however, the equipment for which these factors were derived was either not specified or inappropriate for railcar unloading.

Barge Delivery. Most barges today are of the open-hopper type with capacities ranging from 900 to 1800 t (2). Ten to thirty-six barges may constitute a single tow to the power plant, depending on river capacity and lock size. An average barge shipment consists of about 18,000 t of coal. Emission factors are given in Table II. Unloading at the plant is oftentimes accomplished by belt conveyors which are fed from hoppers in the barge's holds. The hoppers are in turn fed by retractable bucket type elevators or by clamshell buckets which are usually open at the top and poorly sealed at the bottom. One source (6) relates wind speed, silt content, surface moisture content, and dumping device capacity to the amount of dust released per ton of material unloaded. When this formula is applied to clam shell bucket unloading of coal (a common method of barge unloading), a calculated emission factor of 0.0001 kg/t is obtained (6). Although this factor is much smaller than the emission factor for railcar unloading, it appears to be the most appropriate emission factor for barge unloading, and it also carries a higher validity rating than does the recommended emission factor for railcar unloading.

Slurry Pipeline Delivery. Coal in slurry form can also be transported from mine to power plant by slurry pipeline. Only one coal slurry pipeline is operating in the United States at the present time. This pipeline runs 440 km (273 miles) from Peabody Coal Company's Kayenta mine in

Table I

Coal Delivery - Railcar Unloading

Ref. No.	Uncontrolled Fugitive Emissions (kg/t)	Equipment	Validity	Control: Method	Cost (M$)	Efficiency
1	0.2		E			
2	0.2	unit train	E	dustproofing		
3	0.2	hopper car	E	chute		
4	0.025	loader	B			
5	0.2	unit train bottom gates	E	hood w/filter		99
6	0.0001	loader, clam shell buckets	C	a. enclosure w/filter	108[a]	99
				b. spray system	32[a]	80
8	0.005		D			
9	0.025		E			

[a]Cost - capacity relationship not provided by source

Table II

Coal Delivery - Barge Unloading

Ref. No.	Uncontrolled Fugitive Emissions (kg/t)	Validity	Control: Method	Cost (M$)	Efficiency
2	0.2	E	a. sprays b. wind guards c. negative bin pressure		
3	0.2	E	a. canopy & exhaust b. enclosure of clam shell buckets c. enclose hopper & exhaust to filter		~100
6	0.0001 (equation)	C	a. enclose w/filter b. spray system	108[a] 32[a]	99 80
10	0.2	E			

[a]Cost - capacity relationship not provided by source

Arizona to the Mohave Power Plant. The 46 cm pipeline has a capacity of 5 million tons of coal per year. No air emissions are directly attributable to the transfer of coal by slurry pipeline; however, emissions may occur at the power plant during and after drying because of the fines produced as a result of slurry processing.(5) No information pertaining to coal processing or airborne fugitive emissions related to the slurry process at the Mohave Power Plant was found in the literature.

Other Methods of Coal Delivery. Information on transport of coal by railcar is given in references (2), (5), and (7). Fugitive emissions related to barge transport are given in reference (2) and (6), and coal truck transport emissions are given in reference (2).

Coal Storage

The storage of coal is one of the most obvious sources of fugitive wind-blown particulate emissions associated with a coal-fired power plant. In addition to wind erosion, storage pile activities such as loading into piles, vehicular traffic, and load-out from piles, may generate fugitive emissions. The major parameters that are known to affect fugitive emissions from coal piles are pile geometry, coal erodibility, wind speed, humidity, precipitation, and temperature.

Various estimates of wind erosion from coal storage piles and numerous control methods are given in Table III. All emission factors given in the table are in units of kilograms per ton, but sometimes emission factors are associated with time as well as storage pile mass or area. This can create a certain amount of confusion in application. Since time is generally not considered with emission factors, it is omitted in Table III and assumed to enter emission estimates via annual materials storage. Inspection of Table III will show that emission estimates vary over several orders of magnitude. The emission factor with the highest validity comes from reference (4), although this factor has been applied to coal piles, it was originally derived for sand and gravel piles. Therefore, a better estimate of coal-related emissions may be obtained from one of the coal-specific emission factors listed in the table. Emission factors from references (3) and (6) were calculated from equations which are designed for universal application (i.e., equation parameters account for variations due to location and material). The resulting calculated emission factors for coal storage appear somewhat high in comparison to emission factors derived from actual coal pile data, such as that obtained by Blackwood (12). However, the emission factor equation given by reference (6) is considered to be more applicable in that it can account for variations due to location and length of storage. Certain assumptions have been utilized in Table III to provide uniformity for comparison.

Besides wind erosion, fugitive emissions may also be associated with storage pile activities, as mentioned previously. These activities include load-in, load-out, and vehicular traffic around the storage pile. Fugitive emission factors and control data for load-in are displayed in Table IV. Judging from this table, the best emission factor for stacker load-in is about 0.0005 kg/t. (6). Other methods of load-in may produce more significant emissions. Data available for load-out, a similar process, indicate that much higher emissions are produced. Table V summarizes information in the literature related to load-out from open storage piles. In contrast to other processes, there appears to be good agreement from reference-to-reference in regard to the magnitude of the proper emission factor. The best emission factor for load-out is 0.025 kg/t (4).

Table III

Coal Storage - Wind Erosion From Coal Storage Piles

Ref. No.	Uncontrolled Fugitive Emissions (kg/t)	Validity	Control Method	Cost($)	Efficiency(%)
2	0.027	E	a. cap piles w/large coals		
			b. pack and seal		
			c. earthen impoundment		
3	0.270	E	a. enclosure	72-172 per ton	95-99
			b. wind screens		very low
			c. chemical wetting	0.01-0.12 per ton[a]	90
			d. screening		
			e. water spray		50
4	0.055	B			
6	0.01-0.33	C	a. surface stabilization	0.01 per ton[a]	up to 99
			b. watering	17,000[b]	80
			c. enclosure	95 per ton	100
			d. wind breaks	55-550 ea	30
			e. low piles		30
8	0.006	D			
9	0.009	E	a. watering		50
			b. chemical spray		85
10	0.183	E			
12	0.027	C			
13	0.006	C	a. coat coal w/tar		
			b. wind barriers		
14	4-21	E	watering		
16		D	chemical spray		0-100
17	0.82 (equation)	C			
18	0.72 (equation)	C			

[a]Operating costs

[b]Relationship to capacity not provided by source

Table IV

Coal Storage - Load-In

Ref. No.	Uncontrolled Fugitive Emissions[a] (kg/t)	Validity	Control: Method	Control: Cost($)	Control: Efficiency(%)
3	0.06.0.22 (stacker)	E	a. enclosure	72-172 per ton	70-90
			b. wetting agents	0.01-0.05 per ton[b]	80-90
			c. foam	0.02-0.12 per ton[b]	80-90
			d. chutes	5.2-8.3 per t/hr	75
6	0.00015-0.00050 (stacker)	B	a. reduce fall w/ special stacker	1200-1433 per t/hr	25
			b. chutes	7500[c]	75
			c. stone ladder	21,500[c]	80
			d. wind guards	32,000[c]	50
			e. spray system	64,500[c]	75
9	0.020 (equation)	E	a. water spray		50
			b. chemical spray		85
10	0.07 (equation)	E			

[a]Equipment type in ( ) when known

[b]Operating costs

[c]Relationship to capacity not provided by source

Vehicle traffic around storage piles can be a significant source of airborne fugitive emissions. This activity may account for as much as 40 percent of the total emissions associated with open coal storage (3). Table VI shows several emission factors that appear in the literature for vehicular traffic in the storage area. Best emission estimates are apparently given by reference (6) Using typical values for equation parameters, a calculated range of 0.01 to 0.12 kg/t is obtained.

Information on gaseous concentrations upwind and near coal storage piles is found in reference (13). Fugitive emissions data related to enclosed coal storage are given in references (2), (3) and (6).

Coal Conveyor Transfer

Table VII shows information related to fugitive dust emissions from belt conveyor operations. This table offers a range of emission factors of 0.02 to 0.5 kg/t for coal conveying. None of these emission factors are supported by data and, as a result, they are not highly rated. The most specific, but unsupported, quantitative information is given by the State of Colorado (9). The Colorado Department of Health has proposed emission factors of 0.025 kg/t per section and 0.075 kg/t per transfer point.

Table V

Coal Storage - Load-Out

Ref. No.	Uncontrolled Fugitive Emissions[a] (kg/t)	Validity	Control: Method	Control: Cost ($)	Control: Efficiency (%)
3	0.08-0.28 (reclaimer)	E	a. water spray		50
			b. under-pile conveyor		80
			c. stacker/reclaimer		40
4	0.025 (loader)	B			
6	0.005-0.025 (loader)	C	a. gravity feed system	38-65 per ton	85
			b. stacker/ reclaimer	2760 per t/hr	80
9	0.025	E			
10	0.08	E			

[a]equipment type in ( ) when known

Table VI

Coal Storage - Vehicular Traffic Around Storage Piles

Ref. No.	Uncontrolled Fugitive Emissions (kg/t)	Validity	Control: Method	Control: Cost ($)	Control: Efficiency (%)
3	0.13-0.48 (equation)	E	a. watering		50
			b. stacker/reclaimer		25-50
6	0.01-0.12 (equation)	8	a. watering	11,000 per truck + 21,500 per year	50
			b. chemical dust suppressants	0.11 per m^2	≥ 90
9	0.02	E	a. watering		50
			b. chemical spray		85
10.	0.22	E			

Table VII

Coal Transfer - Belt Conveyor
Airborne Fugitive Emissions and Controls

Ref. No.	Uncontrolled Fugitive Emissions (kg/t)	Valid-ity	Control: Method	Cost ($)	Efficiency(%)
2	0.1-0.2	E	a. enclose transfer stations		90
			b. hoods w/vents at transfer stations		
3	0.02-0.48	E	a. cover top		marginal
			b. cover sides		good
			c. enclose		excellent
			d. spray water at feed points	78,000[a]	35
			e. foam	0.02/ton[b]	73
			f. scrapers		
			g. wet belt		15
			h. belt turnovers		
			i. hoods w/filters at transfer stations		
6	0.02-0.5	E	a. cover conveyor	125-250 per meter	70-99
			b. enclose transfer station	3200-19,500[c]	70-99
			c. spray system	16,000 per station	70-95
9	0.025/section	E	a. water spray		50
	0.075/transfer point	E	b. chemical spray		85
10	negligible to 0.2	D			

[a]900 ton per hour capacity

[b]Operating costs

[c]Capacity relationship not provided by source

Coal Preparation

Information on fugitive emissions for coal sizing is given in references (5), (9), and (10); for coal cleaning in references (1), (5), and (19); and on emissions from burning refuse piles in reference (5).

Flue Gas Desulfurization

A wide variety of flue gas desulfurization (FGD) systems are in development or operation at the present time. Currently, the most commonly used FGD systems are non-recovery calcium-based lime and limestone processes. These two processes are quite similar except for the material used as the absorbent. Airborne fugitive emissions associated with FGD can be separated into two general sub-systems: chemical feed systems and sludge disposal systems.

Chemical Feed. For ship/rail unloading of limestone, an uncontrolled emission factor of 0.1 kg/t is given by reference (3). This factor has an "E" validity rating. In addition to unloading emissions, fugitive limestone emissions may also be associated with open storage operations: load-in, wind erosion, vehicle traffic and load-out. Fugitive emission information related to limestone load-in is given in Table VIII. The data given by reference (6) are preferred due to the higher validity rating. Note that load-in emission factors shown in Table VIII (0.0002-0.02 kg/t) are significantly less than the above unloading emission factor (0.1 kg/t).

Table VIII

Flue Gas Desulfurization - Limestone Load-In
Airborne Fugutive Emissions

Ref. No.	Uncontrolled Fugitive Emissions[a] (kg/t)	Valid-ity	Control: Method	Cost ($)	Effici-ency (%)
1	0.02	E	a. watering		40
			b. chemical treatment		up to 90
3	0.02	E	a. enclosure	43-102 per ton	70-90
			b. wetting agents	0.01-0.05 per ton[b]	80-90
			c. foam	0.02-0.12 per ton[b]	80-90
			d. chutes	5.2-8.3 per t/hr	75
6	0.0002(stacker) 0.012 (loader)	C	a. reduce fall w/ spec. stacker	1200-1433 per t/hr	25
			b. chutes	7500[c]	75
			c. stone ladder	21,500[c]	80
			d. wind guards	32,500[c]	50
			e. spray system	64,500[c]	75

[a]Equipment type in ( ) when known

[b]Operating Costs

[c]Relationship to capacity not given by source

Uncontrolled fugitive emission factors for wind erosion of limestone storage piles are given as 0.05 kg/t (1), 0.055 kg/t (3), and 0.045 kg/t (6). Uncontrolled fugitive emission factors for vehicle traffic around limestone storage piles are given as 0.06 kg/t (1), 0.065 kg/t (3), and 0.02-0.32 kg/t (6). Controls may be applied to all the above items.

Table IX shows data given in the literature for limestone load-out. The best emission factor is 0.025 kg/t (4). However, this factor may vary from location to location.

Table IX

Flue Gas Desulfurization - Limestone Load-Out
Airborne Fugitive Emissions

Ref. No.	Uncontrolled Fugitive Emissions[a] (kg/t)	Validity	Control: Method	Cost ($)	Efficiency (%)
1	0.02	E	a. watering		40
			b. chemical treatment		≤ 90
3	0.025	E	a. water spray		50
			b. under pile conveyor		80
			c. stacker/reclaimer		40
4	0.025 (loader)	B			
6	0.0003-0.02 (loader)	C	a. enclosed unloading station w/filter	107,000[b]	99
			b. spray system	32,000[b]	80

[a]Equipment type in ( ) when known

[b]Cost-capacity relationship not provided by source

Sludge Disposal. Sludge from the FGD process may be disposed of in a storage pond or may be dewatered and stabilized and hauled away to a landfill site. Pond disposal generally consists of pumping the wet sludge to a nearby pond. The opportunity for airborne fugitive emissions during this operation is very remote. After the sludge has reached the pond, it may be stored in a wet condition or allowed to dry, depending on geographic location. No data directly related to wind-blown dust from dried sludge ponds were found in the literature, but one source of information pertaining to wind erosion of exposed areas, given in Table X, may provide an estimate of dried pond dust emissions.

Table X

FLUE GAS DESULFURIZATION - SLUDGE DISPOSAL
WIND EROSION OF EXPOSED AREAS

Ref. No.	Uncontrolled Fugitive Emissions (t/ha/yr)	Validity	Control: Method	Cost ($/hectare)	Efficiency(%)
6	1.4	C	a. watering	2000	50
			b. chemical stabilizers	2000+	70
			c. windbreaks	55-550	30
			d. vegetative cover		70

Fly Ash Handling and Disposal

Fugitive emissions resulting from fly ash handling may amount to as much as 50 kg/t[3,20]. Few data appear in the literature to quantify emissions at the disposal site. In the absence of satisfactory data, emission factors related to construction activities and to wind erosion of exposed areas may provide the best estimate of fugitive emissions at landfills and dry storage ponds. Reference (4) gives an emission factor of 32.4 $t \cdot ha^{-1} \cdot yr^{-1}$ for heavy construction operations and reference (6) gives an emission factor of 1.4 $t \cdot ha^{-1} \cdot yr^{-1}$ for wind erosion of exposed areas.

Surface Dusts

Significant sources of fugitive dust may originate from activities other than those directly related to the generation of electricity. These sources include plant traffic, plant grounds and construction activities.

Fugitive dust from unpaved roads may amount to 1.0 - 2.4 kg per vehicle kilometer of travel (VKT).[1,3,4,6] Fugitive dust from paved roads may amount to 3.8 - 850 or more grams per VKT.[3,6]

Fugitive dust emission factors for exposed plant grounds and construction activities were given previously in connection with fly ash disposal.

Conclusions

Power plant designs typically comprise a large variety of process schemes and mechanical systems. These differences in power plants are generally required in response to local site variables, fuel sources and other needs. The estimation of fugitive emissions will vary from plant to plant, depending on the different systems (particularly with regard to waste disposal) used. From the results of this study, the following conclusions are drawn.

1. Control methods are available to eliminate or significantly reduce fugitive power plant emissions. The costs of controls vary widely, depending on the process application and the degree of control.

2. Much of the fugitive emission information found in the literature are not of convincing validity. For this reason, the annual fugitive emission rates resulting from applying this information must be regarded as approximate.

3. The largest sources of uncontrolled fugitive emissions from coal-fired power plants may be attributed to solid waste handling and disposal.

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