

## APPENDIX B.1

### PARTICLE SIZE DISTRIBUTION DATA AND SIZED EMISSION FACTORS FOR SELECTED SOURCES



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## APPENDIX B.1

### PARTICLE SIZE DISTRIBUTION DATA AND SIZED EMISSION FACTORS FOR SELECTED SOURCES

#### Introduction

This appendix presents particle size distributions and emission factors for miscellaneous sources or processes for which documented emission data were available. Generally, the sources of data used to develop particle size distributions and emission factors for this appendix were:

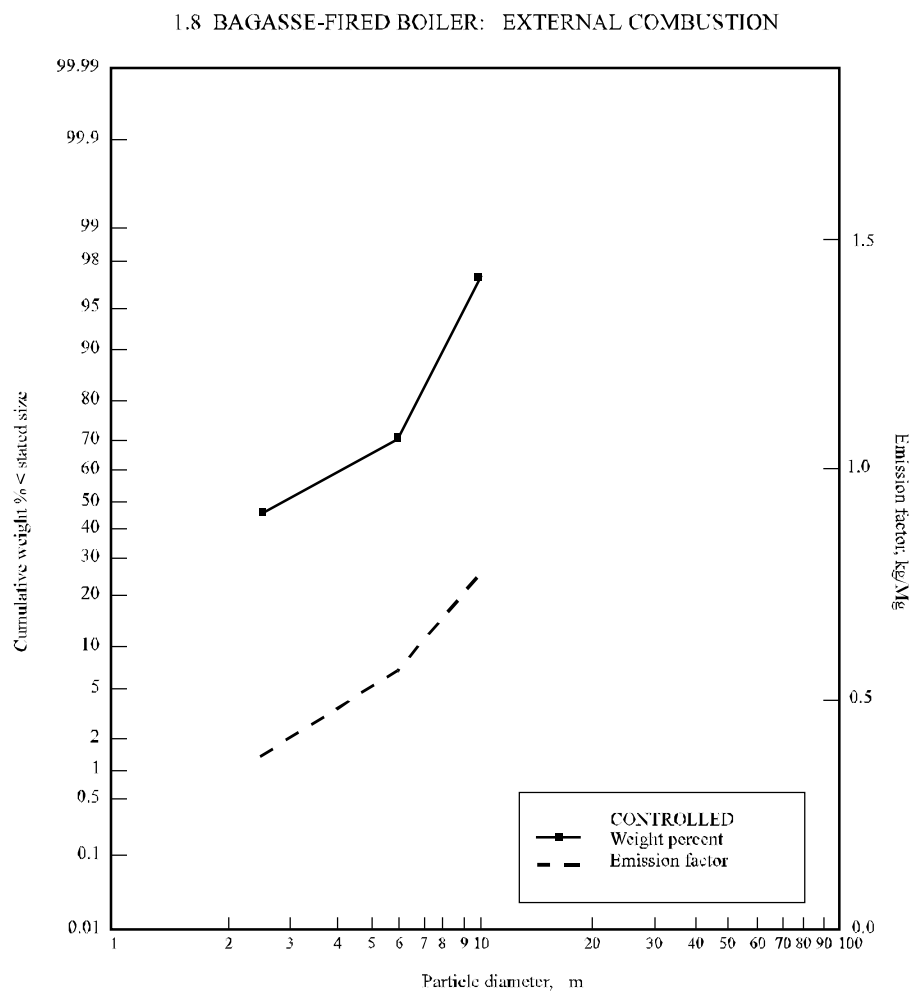
1. Source test reports in the files of the Emissions Monitoring, and Analysis Division of EPA's Office Of Air Quality Planning And Standards.
2. Source test reports in the Fine Particle Emission Information System (FPEIS), a computerized data base maintained by EPA's Air And Energy Engineering Research Laboratory, Office Of Research And Development.
3. A series of source tests titled *Fine Particle Emissions From Stationary And Miscellaneous Sources In The South Coast Air Basin*, by H. J. Taback.
4. Particle size distribution data reported in the literature by various individuals and companies.

Particle size data from FPEIS were mathematically normalized into more uniform and consistent data. Where EMB tests and Taback report data were filed in FPEIS, the normalized data were used in developing this appendix.

Information on each source category in Appendix B.1 is presented in a 2-page format: For a source category, a graph provided on the first page presents a particle size distribution expressed as the cumulative weight percent of particles less than a specified aerodynamic diameter (cut point), in micrometers. A sized emission factor can be derived from the mathematical product of a mass emission factor and the cumulative weight percent of particles smaller than a specific cut point in the graph. At the bottom of the page is a table of numerical values for particle size distributions and sized emission factors, in micrometers, at selected values of aerodynamic particle diameter. The second page gives some information on the data used to derive the particle size distributions.

Portions of the appendix denoted TBA in the table of contents refer to information that will be added at a later date.

## 1.8 BAGASSE-FIRED BOILER: EXTERNAL COMBUSTION



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg  |
|----------------------------------------|--------------------------------|-------------------------|
|                                        | Wet scrubber controlled        | Wet scrubber controlled |
| 2.5                                    | 46.3                           | 0.37                    |
| 6.0                                    | 70.5                           | 0.56                    |
| 10.0                                   | 97.1                           | 0.78                    |

## 1.8 BAGASSE-FIRED BOILER: EXTERNAL COMBUSTION

NUMBER OF TESTS: 2, conducted after wet scrubber control

|             |                                                  |      |      |      |
|-------------|--------------------------------------------------|------|------|------|
| STATISTICS: | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             | Mean (Cum. %):                                   | 46.3 | 70.5 | 97.1 |
|             | Standard deviation (Cum. %):                     | 0.9  | 0.9  | 1.9  |
|             | Min (Cum. %):                                    | 45.4 | 69.6 | 95.2 |
|             | Max (Cum. %):                                    | 47.2 | 71.4 | 99.0 |

TOTAL PARTICULATE EMISSION FACTOR: Approximately 0.8 kg particulate/Mg bagasse charged to boiler. This factor is derived from AP-42, Section 1.8, 4/77, which states that the particulate emission factor from an uncontrolled bagasse-fired boiler is 8 kg/Mg and that wet scrubbers typically provide 90% particulate control.

SOURCE OPERATION: Source is a Riley Stoker Corp. vibrating grate spreader stoker boiler rated at 120,000 lb/hr but operated during this testing at 121% of rating. Average steam temperature and pressure were 579°F and 199 psig, respectively. Bagasse feed rate could not be measured, but was estimated to be about 41 (wet) tons/hr.

SAMPLING TECHNIQUE: Andersen Cascade Impactor

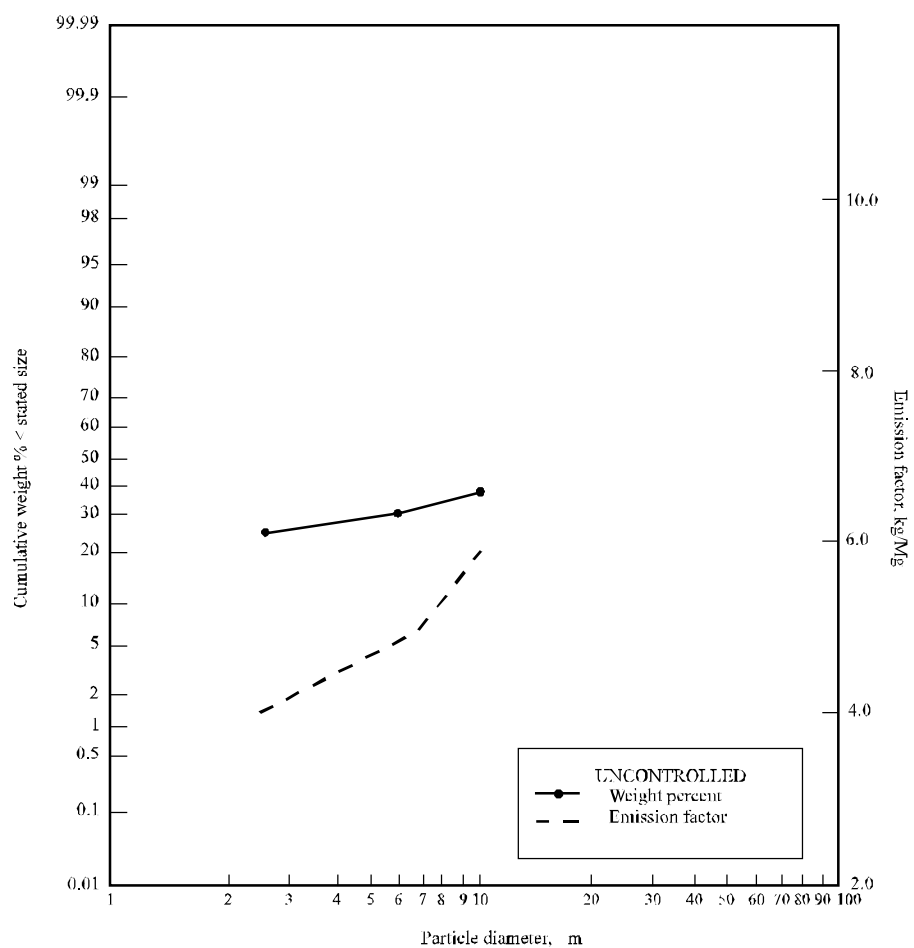
EMISSION FACTOR RATING: D

REFERENCE:

*Emission Test Report, U. S. Sugar Company, Bryant, FL, EMB-80-WFB-6, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.*

## 2.1 REFUSE INCINERATION: MUNICIPAL WASTE MASS BURN INCINERATOR

### 2.1 REFUSE INCINERATION: MUNICIPAL WASTE MASS BURN INCINERATOR



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 26.0                           | 3.9                    |
| 6.0                                    | 30.6                           | 4.6                    |
| 10.0                                   | 38.0                           | 5.7                    |

## 2.1 REFUSE INCINERATION: MUNICIPAL WASTE MASS BURN INCINERATOR

NUMBER OF TESTS: 7, conducted before control

|             |                                                  |      |      |      |
|-------------|--------------------------------------------------|------|------|------|
| STATISTICS: | Aerodynamic Particle Diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             | Mean (Cum. %):                                   | 26.0 | 30.6 | 38.0 |
|             | Standard deviation (Cum. %):                     | 9.5  | 13.0 | 14.0 |
|             | Min (Cum. %):                                    | 18   | 22   | 24   |
|             | Max (Cum. %):                                    | 40   | 49   | 54   |

TOTAL PARTICULATE EMISSION FACTOR: 15 kg of particulate/Mg of refuse charged. Emission factor from AP-42 Section 2.1.

SOURCE OPERATION: Municipal incinerators reflected in the data base include various mass burning facilities of typical design and operation.

SAMPLING TECHNIQUE: Unknown

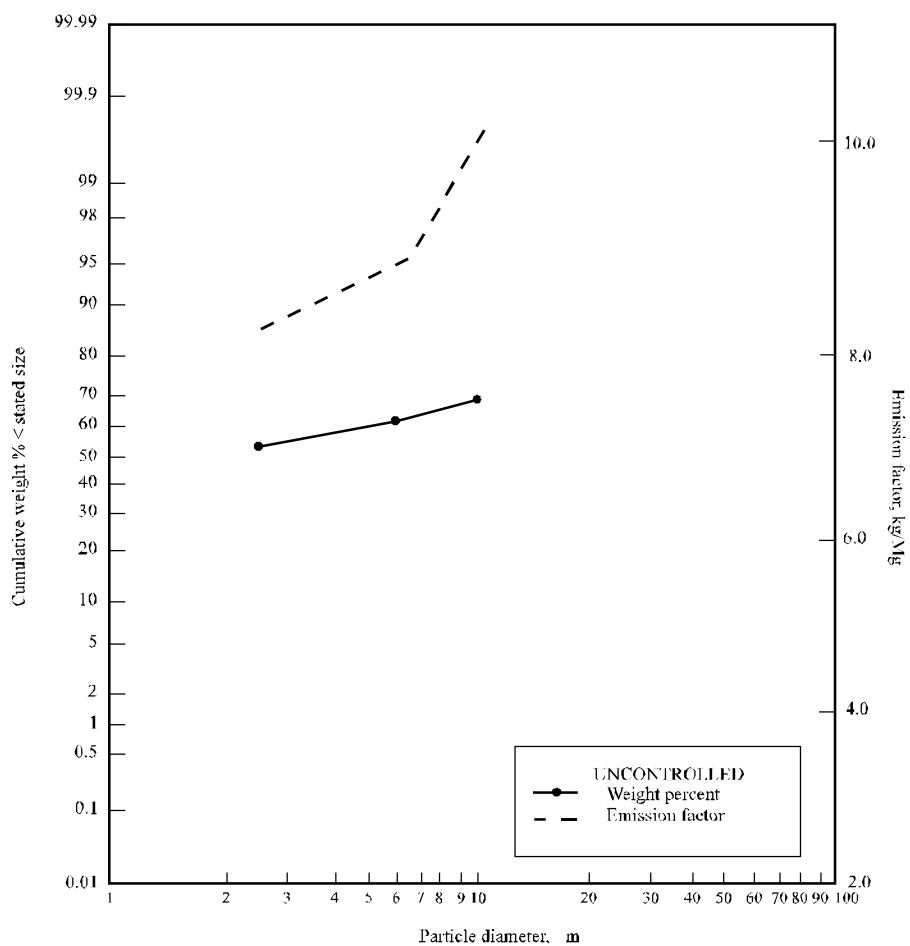
EMISSION FACTOR RATING: D

REFERENCE:

*Determination of Uncontrolled Emissions, Product 2B, Montgomery County, Maryland, Roy F. Weston, Inc., West Chester, PA, August 1984.*

## 2.1 REFUSE INCINERATION: MUNICIPAL WASTE MODULAR INCINERATOR

### 2.1 REFUSE INCINERATION: MUNICIPAL WASTE MODULAR INCINERATOR



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 54.0                           | 8.1                    |
| 6.0                                    | 60.1                           | 9.0                    |
| 10.0                                   | 67.1                           | 10.1                   |

## 2.1 REFUSE INCINERATION: MUNICIPAL WASTE MODULAR INCINERATOR

NUMBER OF TESTS: 3, conducted before control

|             |                                                  |      |      |      |
|-------------|--------------------------------------------------|------|------|------|
| STATISTICS: | Aerodynamic Particle Diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             | Mean (Cum. %):                                   | 54.0 | 60.1 | 67.1 |
|             | Standard deviation (Cum. %):                     | 19.0 | 20.8 | 23.2 |
|             | Min (Cum. %):                                    | 34.5 | 35.9 | 37.5 |
|             | Max (Cum. %):                                    | 79.9 | 86.6 | 94.2 |

TOTAL PARTICULATE EMISSION FACTOR: 15 kg of particulate/Mg of refuse charged. Emission factor from AP-42 Section 2.1.

SOURCE OPERATION: Modular incinerator (2-chambered) operation was at 75.9% of the design process rate (10,000 lb/hr) and 101.2% of normal steam production rate. Natural gas is required to start the incinerator each week. Average waste charge rate was 1.983T/hr. Net heating value of garbage 4200-4800 Btu/lb garbage charged.

SAMPLING TECHNIQUE: Andersen Impactor

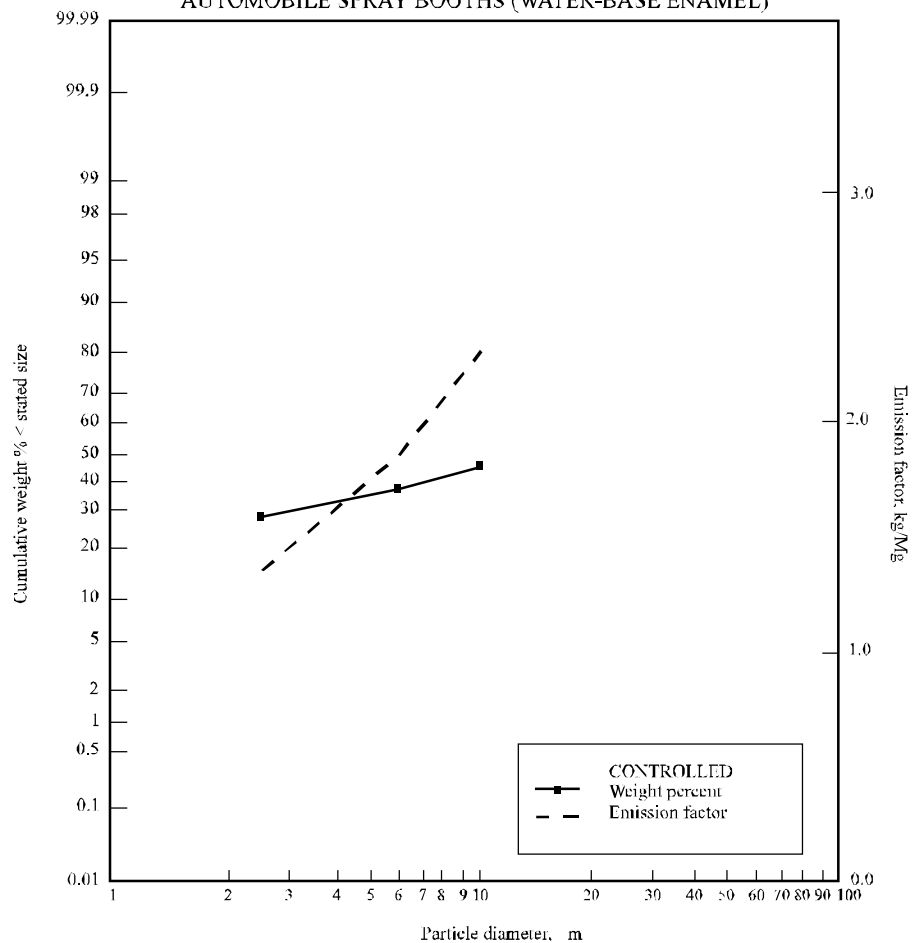
EMISSION FACTOR RATING: C

REFERENCE:

*Emission Test Report, City of Salem, Salem, Va, EMB-80-WFB-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1980.*

#### 4.2.2.8 AUTOMOBILE AND LIGHT-DUTY TRUCK SURFACE COATING OPERATIONS: AUTOMOBILE SPRAY BOOTHS (WATER-BASE ENAMEL)

4.2.2.8 AUTOMOBILE AND LIGHT-DUTY TRUCK SURFACE COATING OPERATIONS:  
AUTOMOBILE SPRAY BOOTHS (WATER-BASE ENAMEL)



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg   |
|----------------------------------------|--------------------------------|--------------------------|
|                                        | Water curtain controlled       | Water curtain controlled |
| 2.5                                    | 28.6                           | 1.39                     |
| 6.0                                    | 38.2                           | 1.85                     |
| 10.0                                   | 46.7                           | 2.26                     |

#### 4.2.2.8 AUTOMOBILE AND LIGHT-DUTY TRUCK SURFACE COATING OPERATIONS: AUTOMOBILE SPRAY BOOTHS (WATER-BASE ENAMEL)

NUMBER OF TESTS: 2, conducted after water curtain control

|             |                                                  |      |      |      |
|-------------|--------------------------------------------------|------|------|------|
| STATISTICS: | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             | Mean (Cum. %):                                   | 28.6 | 38.2 | 46.7 |
|             | Standard deviation (Cum. %):                     | 14.0 | 16.8 | 20.6 |
|             | Min (Cum. %):                                    | 15.0 | 21.4 | 26.1 |
|             | Max (Cum. %):                                    | 42.2 | 54.9 | 67.2 |

TOTAL PARTICULATE EMISSION FACTOR: 4.84 kg particulate/Mg of water-base enamel sprayed. From References a and b.

SOURCE OPERATION: Source is a water-base enamel spray booth in an automotive assembly plant. Enamel spray rate is 568 lb/hour, but spray gun type is not identified. The spray booth exhaust rate is 95,000 scfm. Water flow rate to the water curtain control device is 7181 gal/min. Source is operating at 84% of design rate.

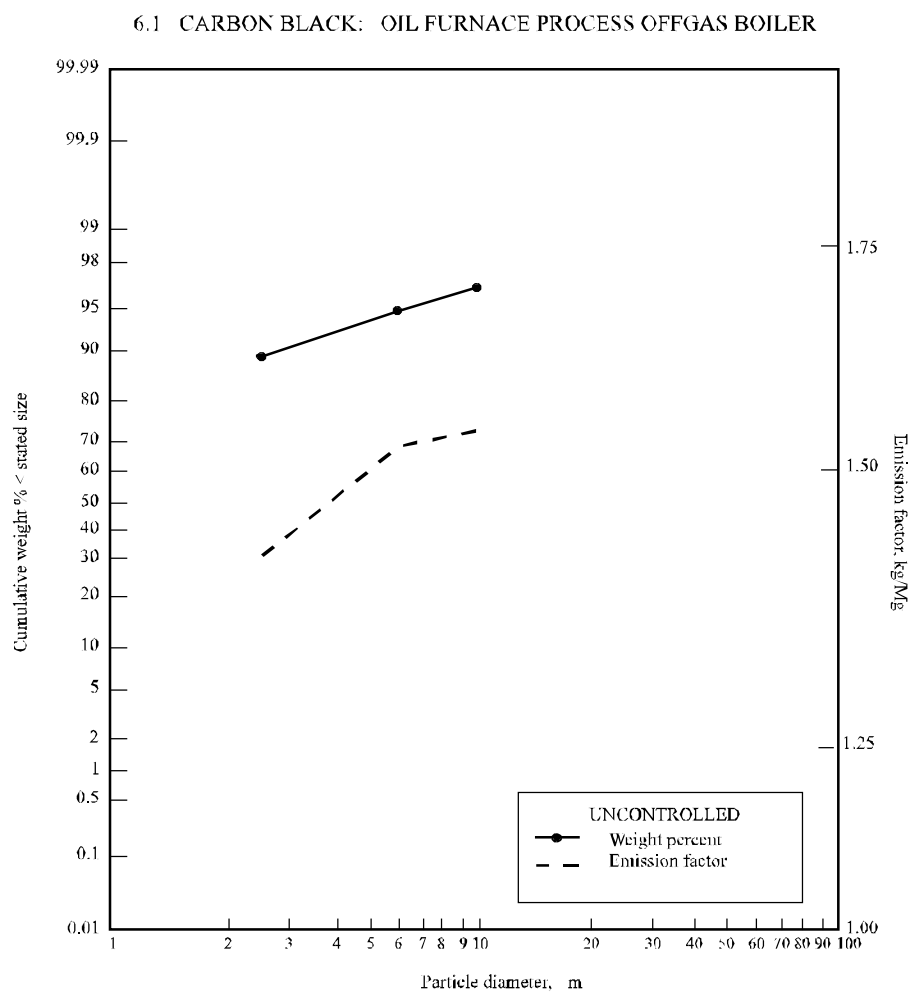
SAMPLING TECHNIQUE: SASS and Joy trains with cyclones

EMISSION FACTOR RATING: D

#### REFERENCES:

- a. H. J. Taback, *Fine Particle Emissions from Stationary and Miscellaneous Sources in the South Coast Air Basin*, PB 293 923/AS, National Technical Information Service, Springfield, VA, February 1979.
- b. Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 234, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 6.1 CARBON BLACK: OIL FURNACE PROCESS OFFGAS BOILER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 87.3                           | 1.40                   |
| 6.0                                    | 95.0                           | 1.52                   |
| 10.0                                   | 97.0                           | 1.55                   |

## 6.1 CARBON BLACK: OIL FURNACE PROCESS OFFGAS BOILER

NUMBER OF TESTS: 3, conducted at offgas boiler outlet

|             |                                     |      |      |      |
|-------------|-------------------------------------|------|------|------|
| STATISTICS: | Aerodynamic particle diameter (µm): | 2.5  | 6.0  | 10.0 |
|             | Mean (Cum. %):                      | 87.3 | 95.0 | 97.0 |
|             | Standard Deviation (Cum. %):        | 2.3  | 3.7  | 8.0  |
|             | Min (Cum. %):                       | 76.0 | 90.0 | 94.5 |
|             | Max (Cum. %):                       | 94.0 | 99   | 100  |

TOTAL PARTICULATE EMISSION FACTOR: 1.6 kg particulate/Mg carbon black produced, from reference.

SOURCE OPERATION: Process operation: "normal" (production rate = 1900 kg/hr). Product is collected in fabric filter, but the offgas boiler outlet is uncontrolled.

SAMPLING TECHNIQUE: Brink Cascade Impactor

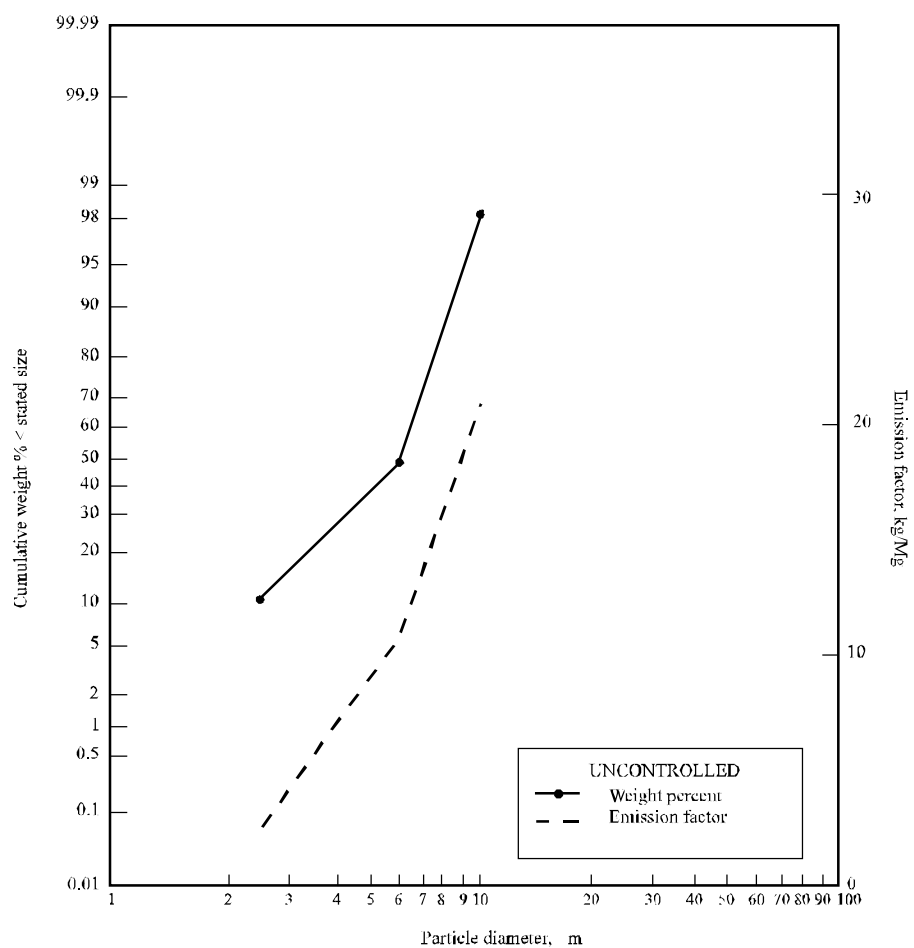
EMISSION FACTOR RATING: D

REFERENCE:

*Air Pollution Emission Test, Phillips Petroleum Company, Toledo, OH, EMB-73-CBK-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1974.*

## 8.4 AMMONIUM SULFATE FERTILIZER: ROTARY DRYER

8.4 AMMONIUM SULFATE FERTILIZER: ROTARY DRYER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------|--------------------------------|------------------------|
|                                  | Uncontrolled                   | Uncontrolled           |
| 2.5                              | 10.8                           | 2.5                    |
| 6.0                              | 49.1                           | 11.3                   |
| 10.0                             | 98.6                           | 22.7                   |

#### 8.4 AMMONIUM SULFATE FERTILIZER: ROTARY DRYER

NUMBER OF TESTS: 3, conducted before control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ):      2.5      6.0      10.0

Mean (Cum. %):      10.8      49.1      98.6

Standard Deviation (Cum. %):      5.1      21.5      1.8

Min (Cum. %):      4.5      20.3      96.0

Max (Cum. %):      17.0      72.0      100.0

TOTAL PARTICULATE EMISSION FACTOR: 23 kg particulate/Mg of ammonium sulfate produced. Factor from AP-42, Section 8.4.

SOURCE OPERATION: Testing was conducted at 3 ammonium sulfate plants operating rotary dryers within the following production parameters:

| Plant                    | A     | C    | D   |
|--------------------------|-------|------|-----|
| % of design process rate | 100.6 | 40.1 | 100 |
| production rate, Mg/hr   | 16.4  | 6.09 | 8.4 |

SAMPLING TECHNIQUE: Andersen Cascade Impactors

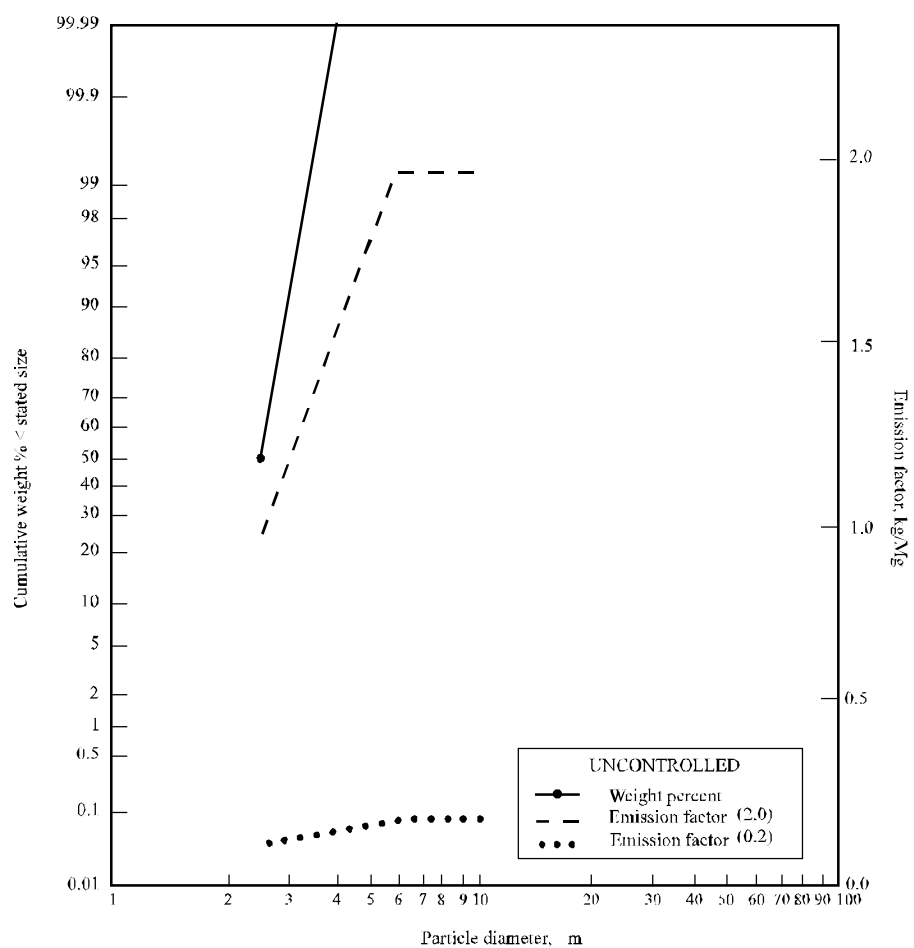
EMISSION FACTOR RATING: C

REFERENCE:

*Ammonium Sulfate Manufacture — Background Information For Proposed Emission Standards*, EPA-450/3-79-034a, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 1979.

## 8.10 SULFURIC ACID: ABSORBER (ACID ONLY)

8.10 SULFURIC ACID: ABSORBER (ACID ONLY)



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size |  | Emission factor, kg/Mg |       |
|----------------------------------------|--------------------------------|--|------------------------|-------|
|                                        | Uncontrolled                   |  | Uncontrolled           |       |
|                                        |                                |  | (0.2)                  | (2.0) |
| 2.5                                    | 51.2                           |  | 0.10                   | 1.0   |
| 6.0                                    | 100                            |  | 0.20                   | 2.0   |
| 10.0                                   | 100                            |  | 0.20                   | 2.0   |

## 8.10 SULFURIC ACID: ABSORBER (ACID ONLY)

NUMBER OF TESTS: Not available

|             |                                     |      |     |      |
|-------------|-------------------------------------|------|-----|------|
| STATISTICS: | Aerodynamic particle diameter (µm): | 2.5  | 6.0 | 10.0 |
|             | Mean (Cum. %):                      | 51.2 | 100 | 100  |
|             | Standard deviation (Cum. %):        |      |     |      |
|             | Min (Cum. %):                       |      |     |      |
|             | Max (Cum. %):                       |      |     |      |

TOTAL PARTICULATE EMISSION FACTOR: 0.2 to 2.0 kg acid mist/Mg sulfur charged, for uncontrolled 98% acid plants burning elemental sulfur. Emission factors are from AP-42 Section 8.10.

SOURCE OPERATION: Not available

SAMPLING TECHNIQUE: Brink Cascade Impactor

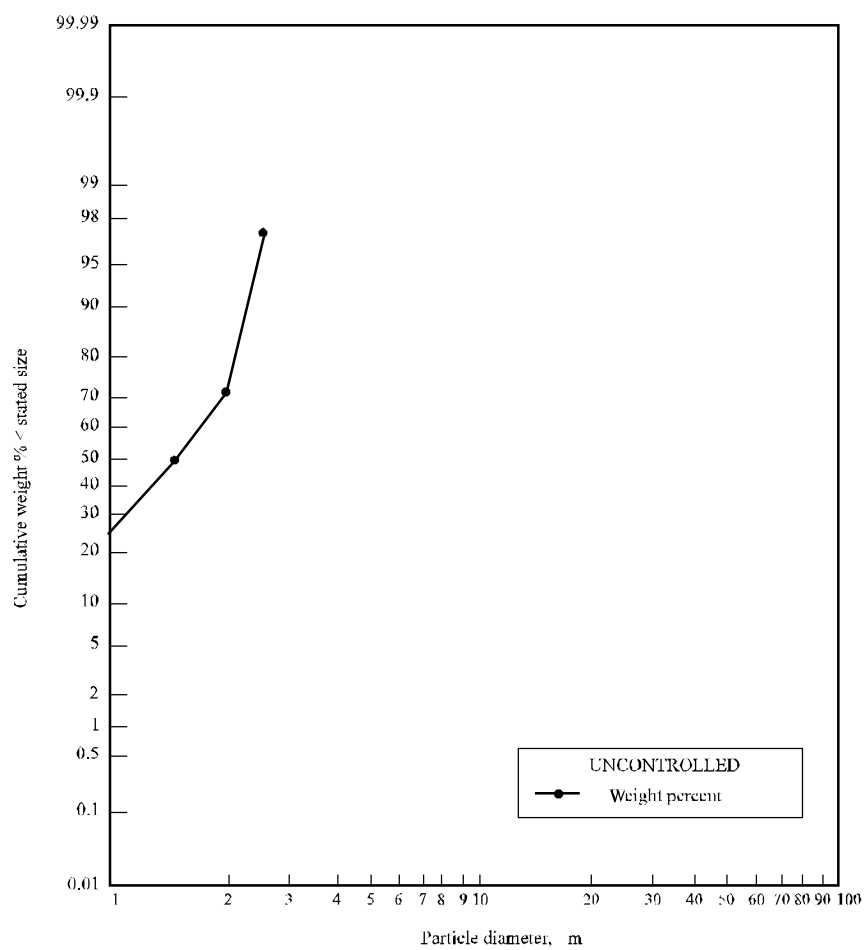
EMISSION FACTOR RATING: E

### REFERENCES:

- a. *Final Guideline Document: Control Of Sulfuric Acid Mist Emissions From Existing Sulfuric Acid Production Units*, EPA-450/2-77-019, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1977.
- b. R. W. Kurek, *Special Report On EPA Guidelines For State Emission Standards For Sulfuric Acid Plant Mist*, E. I. du Pont de Nemours and Company, Wilmington, DE, June 1974.
- c. J. A. Brink, Jr., "Cascade Impactor For Adiabatic Measurements", *Industrial and Engineering Chemistry*, 50:647, April 1958.

## 8.10 SULFURIC ACID: ABSORBER, 20% OLEUM

8.10 SULFURIC ACID: ABSORBER, 20% OLEUM



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 97.5                           | See Table 8.10-2       |
| 6.0                                    | 100                            |                        |
| 10.0                                   | 100                            |                        |

## 8.10 SULFURIC ACID: ABSORBER, 20% OLEUM

NUMBER OF TESTS: Not available

|             |                                                   |     |     |     |
|-------------|---------------------------------------------------|-----|-----|-----|
| STATISTICS: | Aerodynamic particle diameter ( $\mu\text{m}$ )*: | 1.0 | 1.5 | 2.0 |
|             | Mean (Cum. %):                                    | 26  | 50  | 73  |
|             | Standard deviation (Cum. %):                      |     |     |     |
|             | Min (Cum. %):                                     |     |     |     |
|             | Max (Cum. %):                                     |     |     |     |

TOTAL PARTICULATE EMISSION FACTOR: Acid mist emissions from sulfuric acid plants are a function of type of feed as well as oleum content of product. See AP-42, Section 8.10, Tables 8.10-2 and 8.10-3.

SOURCE OPERATION: Not available

SAMPLING TECHNIQUE: Brink Cascade Impactor

EMISSION FACTOR RATING: E

### REFERENCES:

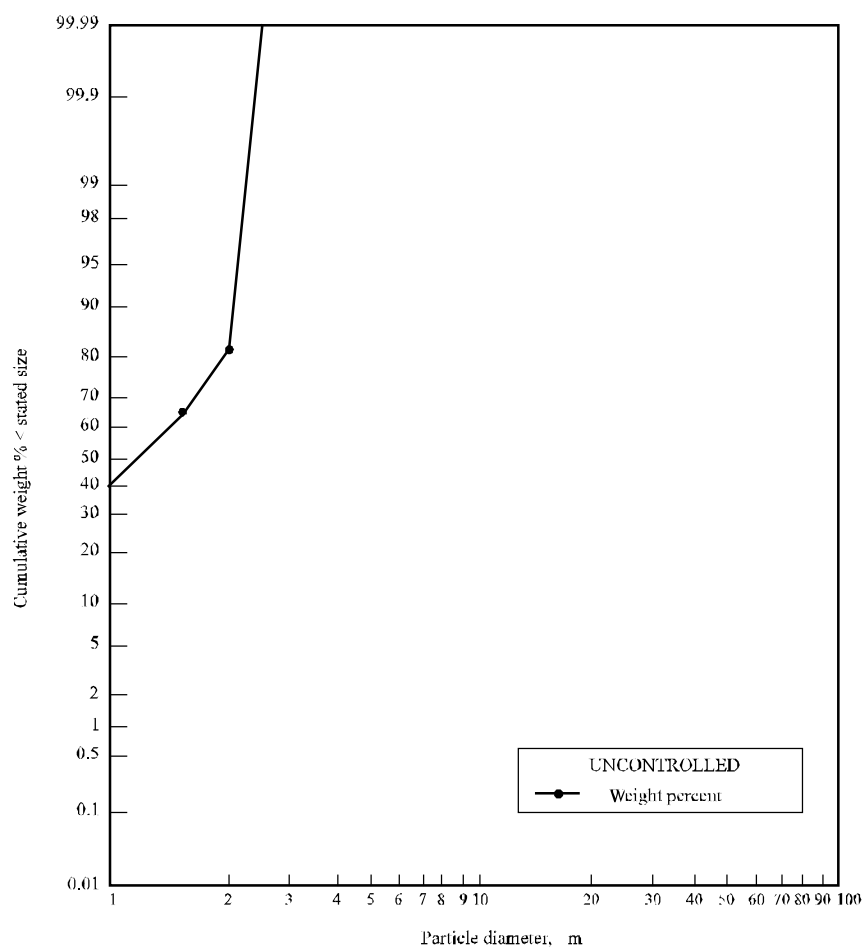
- Final Guideline Document: Control Of Sulfuric Acid Mist Emissions From Existing Sulfuric Acid Production Units*, EPA-450/2-77-019, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1977.
- R. W. Kurek, *Special Report On EPA Guidelines For State Emission Standards For Sulfuric Acid Plant Mist*, E. I. du Pont de Nemours and Company, Wilmington, DE, June 1974.
- J. A. Brink, Jr., "Cascade Impactor For Adiabatic Measurements", *Industrial and Engineering Chemistry*, 50:647, April 1958.

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\*100% of the particulate is less than 2.5  $\mu\text{m}$  in diameter.

## 8.10 SULFURIC ACID: ABSORBER, 32% OLEUM

8.10 SULFURIC ACID: ABSORBER, 32% OLEUM



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------|--------------------------------|------------------------|
|                                  | Uncontrolled                   | Uncontrolled           |
| 2.5                              | 100                            | See Table 8.10-2       |
| 6.0                              | 100                            |                        |
| 10.0                             | 100                            |                        |

## 8.10 SULFURIC ACID: ABSORBER, 32% OLEUM

NUMBER OF TESTS: Not available

|             |                                                   |     |     |     |
|-------------|---------------------------------------------------|-----|-----|-----|
| STATISTICS: | Aerodynamic particle diameter ( $\mu\text{m}$ )*: | 1.0 | 1.5 | 2.0 |
|             | Mean (Cum. %):                                    | 41  | 63  | 84  |
|             | Standard deviation (Cum. %):                      |     |     |     |
|             | Min (Cum. %):                                     |     |     |     |
|             | Max (Cum. %):                                     |     |     |     |

TOTAL PARTICULATE EMISSION FACTOR: Acid mist emissions from sulfuric acid plants are a function of type of feed as well as oleum content of product. See AP-42, Section 8.10, Table 8.10-2.

SOURCE OPERATION: Not available

SAMPLING TECHNIQUE: Brink Cascade Impactor

EMISSION FACTOR RATING: E

### REFERENCES:

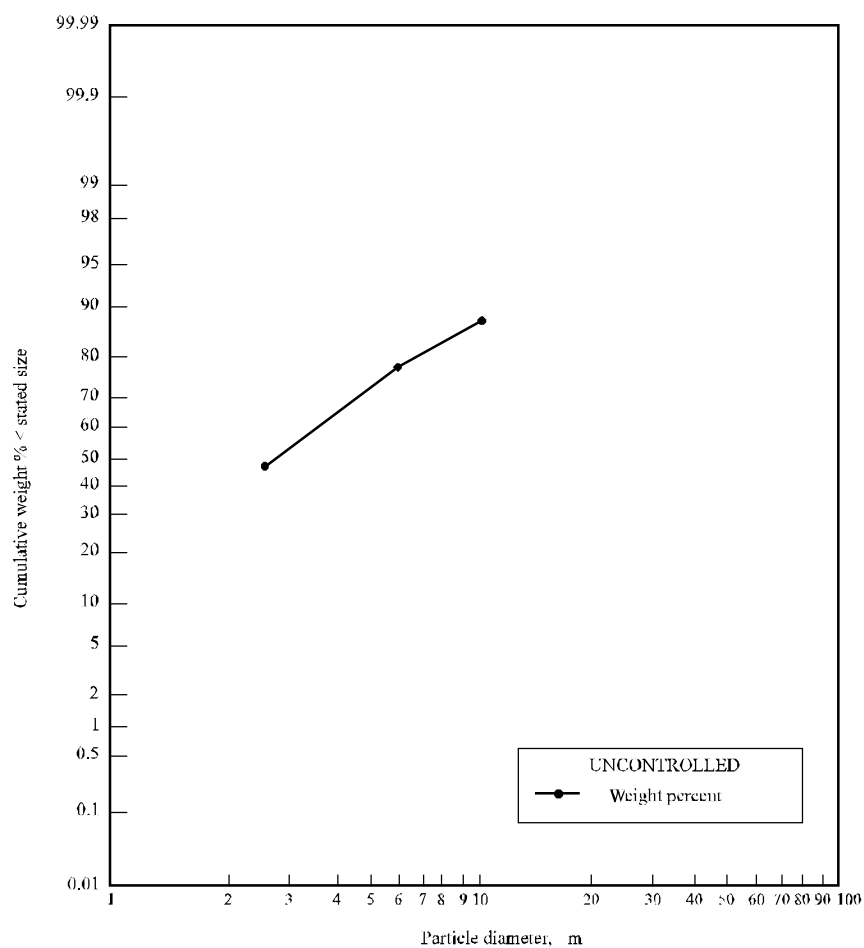
- Final Guideline Document: Control Of Sulfuric Acid Mist Emissions From Existing Sulfuric Acid Production Units*, EPA-450/2-77-019, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1977.
- R. W. Kurek, *Special Report On EPA Guidelines For State Emission Standards For Sulfuric Acid Plant Mist*, E. I. du Pont de Nemours and Company, Wilmington, DE, June 1974.
- J. A. Brink, Jr., "Cascade Impactor For Adiabatic Measurements", *Industrial and Engineering Chemistry*, 50:647, April 1958.

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\*100% of the particulate is less than 2.5  $\mu\text{m}$  in diameter.

## 8.10 SULFURIC ACID: SECONDARY ABSORBER

8.10 SULFURIC ACID: SECONDARY ABSORBER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 48                             | Not Available          |
| 6.0                                    | 78                             | Not Available          |
| 10.0                                   | 87                             | Not Available          |

## 8.10 SULFURIC ACID: SECONDARY ABSORBER

NUMBER OF TESTS: Not available

|             |                                                  |     |     |      |
|-------------|--------------------------------------------------|-----|-----|------|
| STATISTICS: | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5 | 6.0 | 10.0 |
|             | Mean (Cum. %):                                   | 48  | 78  | 87   |
|             | Standard Deviation (Cum. %):                     |     |     |      |
|             | Min (Cum. %):                                    |     |     |      |
|             | Max (Cum. %):                                    |     |     |      |

TOTAL PARTICULATE EMISSION FACTOR: Acid mist emission factors vary widely according to type of sulfur feedstock. See AP-42 Section 8.10 for guidance.

SOURCE OPERATION: Source is the second absorbing tower in a double absorption sulfuric acid plant. Acid mist loading is 175 - 350 mg/m<sup>3</sup>.

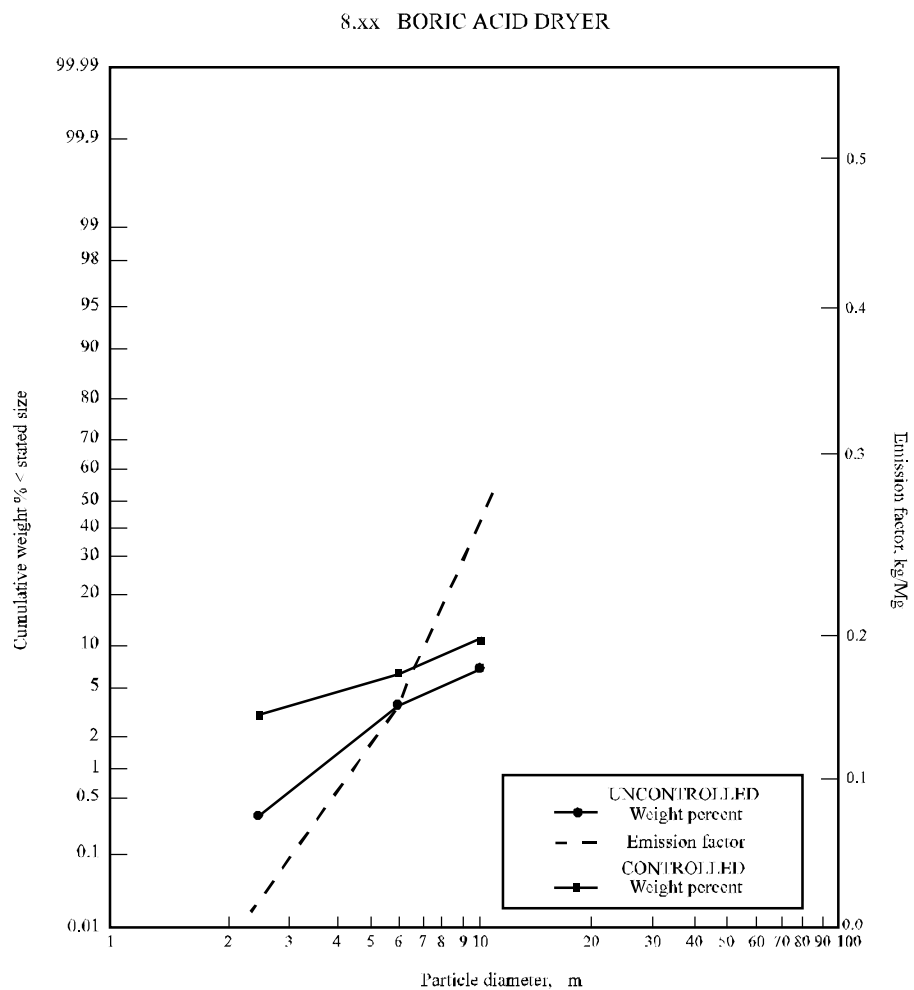
SAMPLING TECHNIQUE: Andersen Impactor

EMISSION FACTOR RATING: E

REFERENCE:

G. E. Harris and L. A. Rohlack, "Particulate Emissions From Non-fired Sources In Petroleum Refineries: A Review Of Existing Data", Publication No. 4363, American Petroleum Institute, Washington, DC, December 1982.

## 8.xx BORIC ACID DRYER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |               | Emission factor, kg/Mg |                          |
|----------------------------------|--------------------------------|---------------|------------------------|--------------------------|
|                                  | Uncontrolled                   | Fabric filter | Uncontrolled           | Fabric filter controlled |
| 2.5                              | 0.3                            | 3.3           | 0.01                   | 0.004                    |
| 6.0                              | 3.3                            | 6.7           | 0.14                   | 0.007                    |
| 10.0                             | 6.9                            | 10.6          | 0.29                   | 0.011                    |

## 8.xx BORIC ACID DRYER

NUMBER OF TESTS: (a) 1, conducted before controls  
(b) 1, conducted after fabric filter control

|                                                                  |     |     |      |
|------------------------------------------------------------------|-----|-----|------|
| STATISTICS: (a) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                                                   | 0.3 | 3.3 | 6.9  |
| Standard Deviation (Cum. %):                                     |     |     |      |
| Min (Cum. %):                                                    |     |     |      |
| Max (Cum. %):                                                    |     |     |      |

|                                                      |     |     |      |
|------------------------------------------------------|-----|-----|------|
| (b) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                                       | 3.3 | 6.7 | 10.6 |
| Standard Deviation (Cum. %):                         |     |     |      |
| Min (Cum. %):                                        |     |     |      |
| Max (Cum. %):                                        |     |     |      |

TOTAL PARTICULATE EMISSION FACTOR: Before control, 4.15 kg particulate/Mg boric acid dried. After fabric filter control, 0.11 kg particulate/Mg boric acid dried. Emission factors from Reference a.

SOURCE OPERATION: 100% of design process rate.

SAMPLING TECHNIQUE: (a) Joy train with cyclones  
(b) SASS train with cyclones

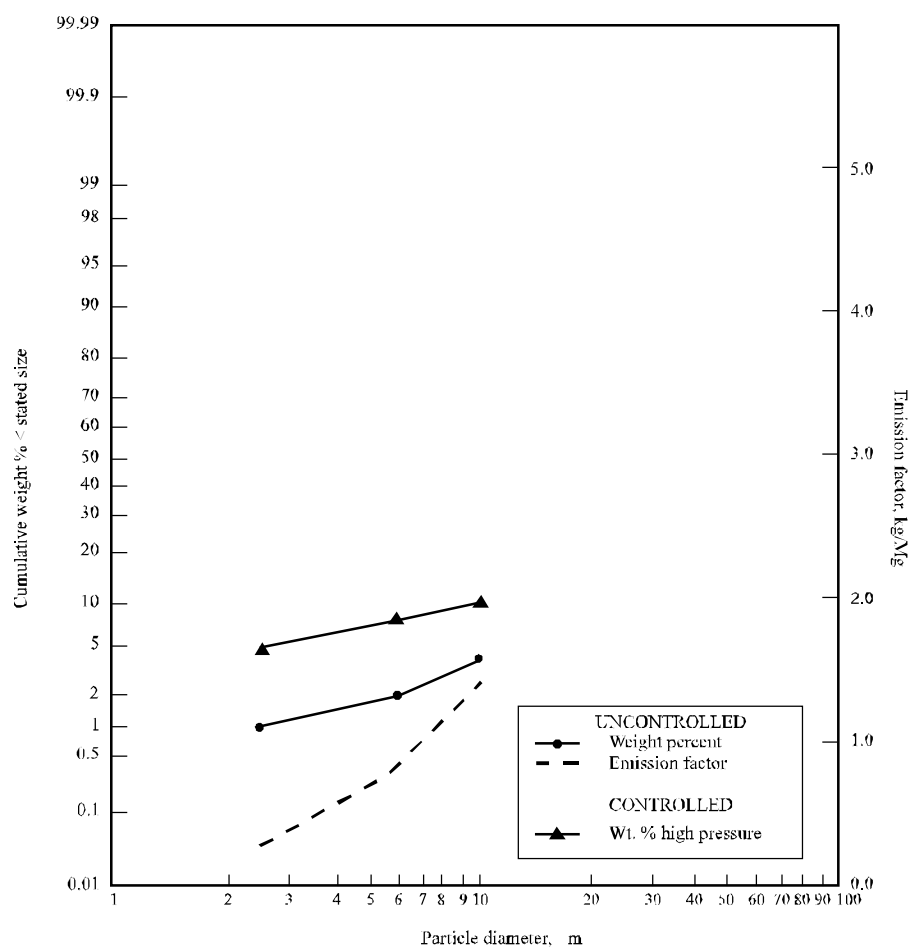
EMISSION FACTOR RATING: E

### REFERENCES:

- a. H. J. Taback, *Fine Particle Emissions From Stationary And Miscellaneous Sources In The South Coast Air Basin*, PB 293 923/AS, National Technical Information Service, Springfield, VA, February 1979.
- b. Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 236, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 8.xx POTASH (POTASSIUM CHLORIDE) DRYER

8.xx POTASH (POTASSIUM CHLORIDE) DRYER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                                     | Emission factor, kg/Mg |
|----------------------------------|--------------------------------|-------------------------------------|------------------------|
|                                  | Uncontrolled                   | High pressure drop venturi scrubber | Uncontrolled           |
| 2.5                              | 0.95                           | 5.0                                 | 0.31                   |
| 6.0                              | 2.46                           | 7.5                                 | 0.81                   |
| 10.0                             | 4.07                           | 9.0                                 | 1.34                   |

## 8.xx POTASH (POTASSIUM CHLORIDE) DRYER

NUMBER OF TESTS: (a) 7, before control  
(b) 1, after cyclone and high pressure drop venturi scrubber control

|             |                                                  |      |      |       |
|-------------|--------------------------------------------------|------|------|-------|
| STATISTICS: | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0  |
|             | Mean (Cum. %):                                   | 0.95 | 2.46 | 4.07  |
|             | Standard deviation (Cum. %):                     | 0.68 | 2.37 | 4.34  |
|             | Min (Cum. %):                                    | 0.22 | 0.65 | 1.20  |
|             | Max (Cum. %):                                    | 2.20 | 7.50 | 13.50 |

|     |                                                  |     |     |      |
|-----|--------------------------------------------------|-----|-----|------|
| (b) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5 | 6.0 | 10.0 |
|     | Mean (Cum. %):                                   | 5.0 | 7.5 | 9.0  |
|     | Standard deviation (Cum. %):                     |     |     |      |
|     | Min (Cum. %):                                    |     |     |      |
|     | Max (Cum. %):                                    |     |     |      |

TOTAL PARTICULATE EMISSION FACTOR: Uncontrolled emissions of 33 kg particulate/Mg of potassium chloride product from dryer, from AP-42. It is assumed that particulate emissions from rotary gas-fired dryers for potassium chloride are similar to particulate emissions from rotary steam tube dryers for sodium carbonate.

SOURCE OPERATION: Potassium chloride is dried in a rotary gas-fired dryer.

SAMPLING TECHNIQUE: (a) Andersen Impactor  
(b) Andersen Impactor

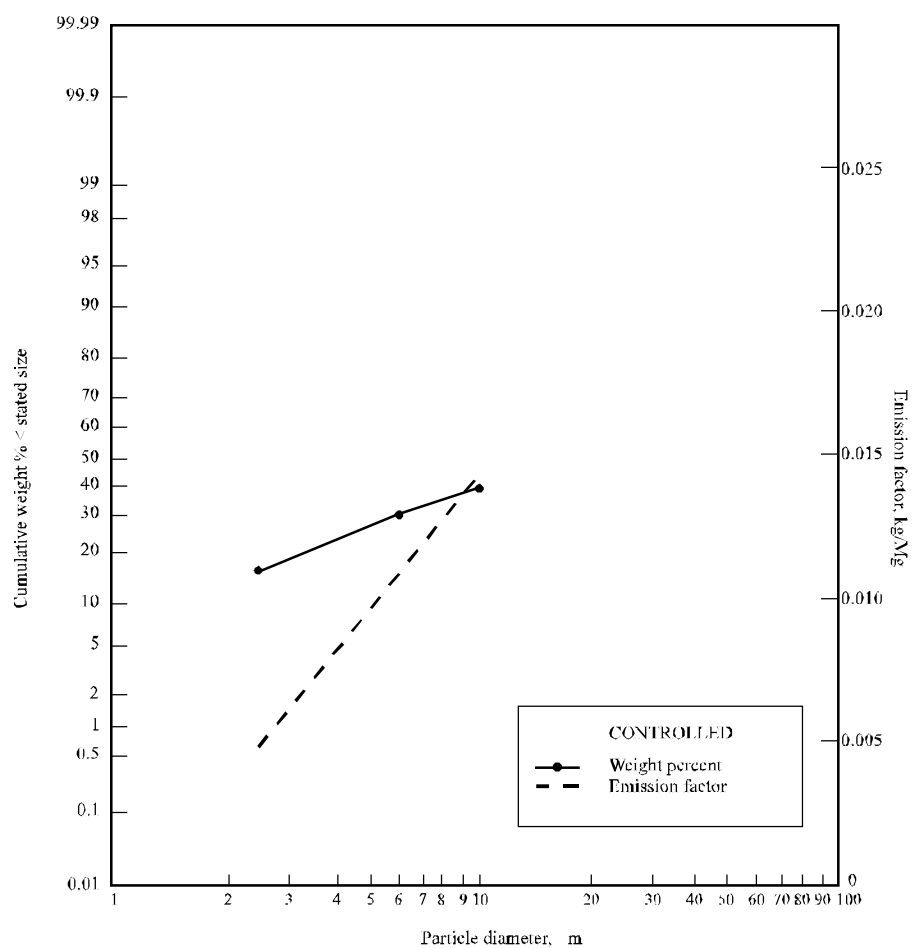
EMISSION FACTOR RATING: C

### REFERENCES:

- a. *Emission Test Report, Kerr-Magee, Trona, CA, EMB-79-POT-4*, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1979.
- b. *Emission Test Report, Kerr-Magee, Trona, CA, EMB-79-POT-5*, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1979.

## 8.xx POTASH (POTASSIUM SULFATE) DRYER

8.xx POTASH (POTASSIUM SULFATE) DRYER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg        |
|----------------------------------------|--------------------------------|-------------------------------|
|                                        | Controlled with fabric filter  | Controlled with fabric filter |
| 2.5                                    | 18.0                           | 0.006                         |
| 6.0                                    | 32.0                           | 0.011                         |
| 10.0                                   | 43.0                           | 0.014                         |

## 8.xx POTASH (POTASSIUM SULFATE) DRYER

NUMBER OF TESTS: 2, conducted after fabric filter

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 18.0 | 32.0 | 43.0 |
|----------------|------|------|------|

|                              |     |      |      |
|------------------------------|-----|------|------|
| Standard deviation (Cum. %): | 7.5 | 11.5 | 14.0 |
|------------------------------|-----|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Min (Cum. %): | 10.5 | 21.0 | 29.0 |
|---------------|------|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 24.5 | 44.0 | 14.0 |
|---------------|------|------|------|

**TOTAL PARTICULATE EMISSION FACTOR:** After fabric filter control, 0.033 kg of particulate per Mg of potassium sulfate product from the dryer. Calculated from an uncontrolled emission factor of 33 kg/Mg and control efficiency of 99.9%. From Reference a and AP-42, Section 8.12. It is assumed that particulate emissions from rotary gas-fired dryers are similar to those from rotary steam tube dryers.

**SOURCE OPERATION:** Potassium sulfate is dried in a rotary gas-fired dryer.

**SAMPLING TECHNIQUE:** Andersen Impactor

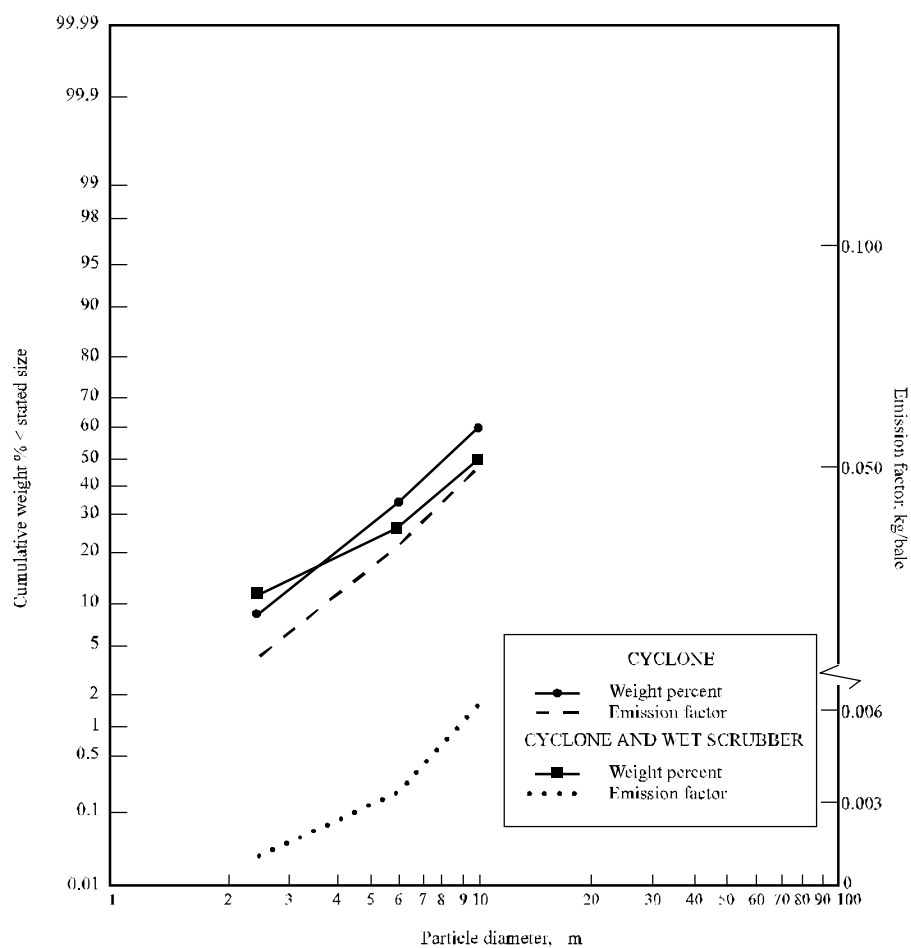
EMISSION FACTOR RATING: E

REFERENCES:

- a. *Emission Test Report, Kerr-McGee, Trona, CA, EMB-79-POT-4, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1979.*
- b. *Emission Test Report, Kerr-McGee, Trona, CA, EMB-79-POT-5, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1979.*

## 9.7 COTTON GINNING: BATTERY CONDENSER

9.7 COTTON GINNING: BATTERY CONDENSER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                             | Emission factor, kg/bale |                             |
|----------------------------------|--------------------------------|-----------------------------|--------------------------|-----------------------------|
|                                  | With cyclone                   | With cyclone & wet scrubber | With cyclone             | With cyclone & wet scrubber |
| 2.5                              | 8                              | 11                          | 0.007                    | 0.001                       |
| 6.0                              | 33                             | 26                          | 0.028                    | 0.003                       |
| 10.0                             | 62                             | 52                          | 0.053                    | 0.006                       |

### 9.7 COTTON GINNING: BATTERY CONDENSER

NUMBER OF TESTS: (a) 2, after cyclone  
(b) 3, after wet scrubber

|             |                                         |     |     |      |
|-------------|-----------------------------------------|-----|-----|------|
| STATISTICS: | (a) Aerodynamic particle diameter (µm): | 2.5 | 6.0 | 10.0 |
|             | Mean (Cum. %):                          | 8   | 33  | 62   |
|             | Standard deviation (Cum. %):            |     |     |      |
|             | Min (Cum. %):                           |     |     |      |
|             | Max (Cum. %):                           |     |     |      |

| (b) Aerodynamic particle diameter (µm) |    |    |    |
|----------------------------------------|----|----|----|
| Mean (Cum. %.):                        | 11 | 26 | 52 |
| Standard deviation (Cum. %):           |    |    |    |
| Min (Cum. %):                          |    |    |    |
| Max (Cum. %):                          |    |    |    |

**TOTAL PARTICULATE EMISSION FACTOR:** Particulate emission factor for battery condensers with typical controls is 0.09 kg (0.19 lb)/bale of cotton. Factor is from AP-42, Section 9.7. Factor with wet scrubber after cyclone is 0.012 kg (0.026 lb)/bale. Scrubber efficiency is 86%. From Reference b.

**SOURCE OPERATION:** During tests, source was operating at 100% of design capacity. No other information on source is available.

SAMPLING TECHNIQUE: UW Mark 3 Impactor

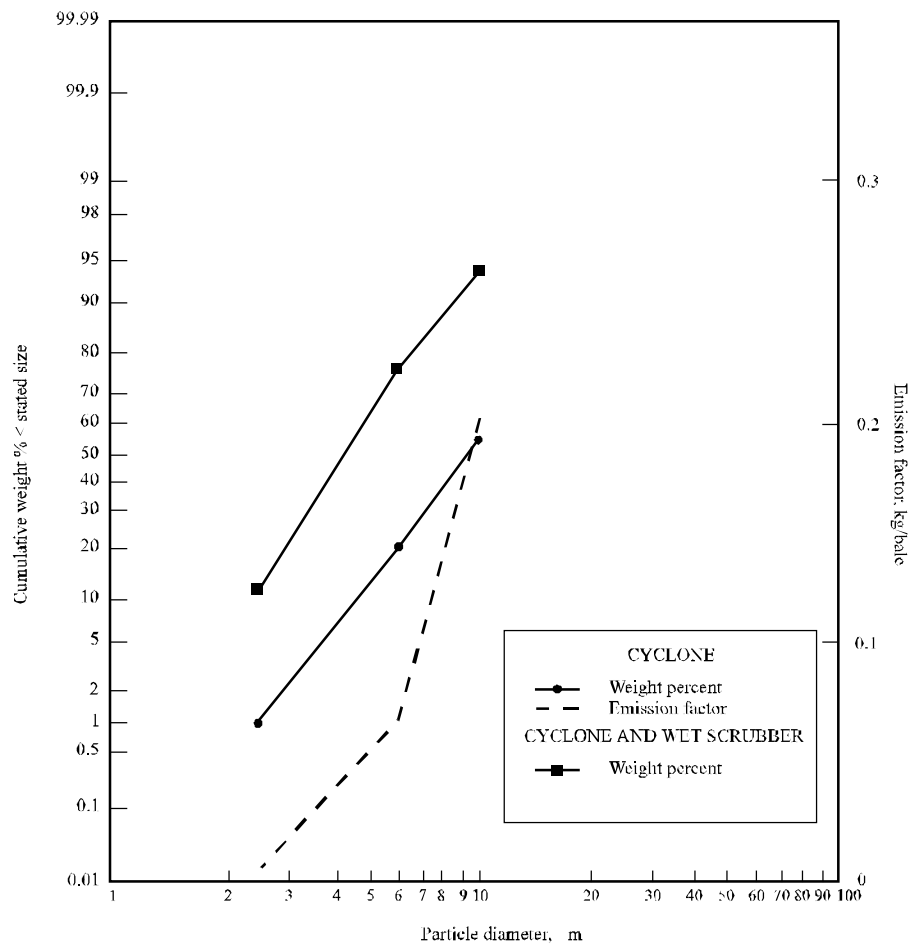
EMISSION FACTOR RATING: E

REFERENCES:

- a. Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System (FPEIS), Series Report No. 27, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.
- b. Robert E. Lee, Jr., *et al.*, "Concentration And Size Of Trace Metal Emissions From A Power Plant, A Steel Plant, And A Cotton Gin", *Environmental Science And Technology*, 9(7)643-7, July 1975.

## 9.7 COTTON GINNING: LINT CLEANER AIR EXHAUST

9.7 COTTON GINNING: LINT CLEANER AIR EXHAUST



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                              | Emission factor, kg/bale      |
|----------------------------------|--------------------------------|------------------------------|-------------------------------|
|                                  | After cyclone                  | After cyclone & wet scrubber | Controlled with fabric filter |
| 2.5                              | 1                              | 11                           | 0.004                         |
| 6.0                              | 20                             | 74                           | 0.07                          |
| 10.0                             | 54                             | 92                           | 0.20                          |

## 9.7 COTTON GINNING: LINT CLEANER AIR EXHAUST

NUMBER OF TESTS: (a) 4, after cyclone  
(b) 4, after cyclone and wet scrubber

|                                                                  |     |     |      |
|------------------------------------------------------------------|-----|-----|------|
| STATISTICS: (a) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                                                   | 1   | 20  | 54   |
| Standard deviation (Cum. %):                                     |     |     |      |
| Min (Cum. %):                                                    |     |     |      |
| Max (Cum. %):                                                    |     |     |      |
| (b) Aerodynamic particle diameter ( $\mu\text{m}$ ):             | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                                                   | 11  | 74  | 92   |
| Standard deviation (Cum. %):                                     |     |     |      |
| Min (Cum. %):                                                    |     |     |      |
| Max (Cum. %):                                                    |     |     |      |

TOTAL PARTICULATE EMISSION FACTOR: 0.37 kg particulate/bale of cotton processed, with typical controls. Factor is from AP-42, Section 9.7.

SOURCE OPERATION: Testing was conducted while processing both machine-picked and ground-harvested upland cotton, at a production rate of about 6.8 bales/hr.

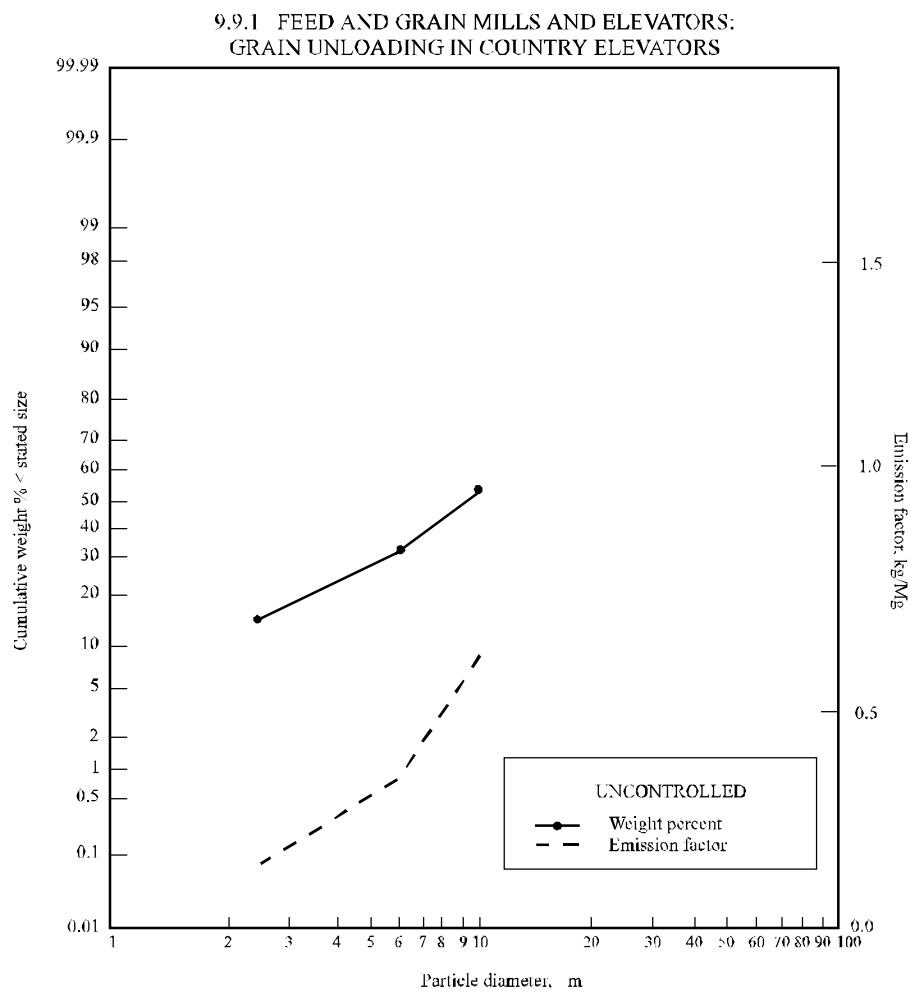
SAMPLING TECHNIQUE: Coulter counter

EMISSION FACTOR RATING: E

### REFERENCE:

S. E. Hughs, *et al.*, "Collecting Particles From Gin Lint Cleaner Air Exhausts", presented at the 1981 Winter Meeting of the American Society Of Agricultural Engineers, Chicago, IL, December 1981.

## 9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: GRAIN UNLOADING IN COUNTRY ELEVATORS



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 13.8                           | 0.13                   |
| 6.0                                    | 30.5                           | 0.33                   |
| 10.0                                   | 49.0                           | 0.56                   |

9.9.1 FEED AND GRAIN MILLS AND ELEVATORS:  
GRAIN UNLOADING IN COUNTRY ELEVATORS

NUMBER OF TESTS: 2, conducted before control

|                                                 |      |      |      |
|-------------------------------------------------|------|------|------|
| STATISTICS: Aerodynamic particle diameter (µm): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                  | 13.8 | 30.5 | 49.0 |
| Standard deviation (Cum. %):                    | 3.3  | 2.5  | —    |
| Min (Cum. %):                                   | 10.5 | 28.0 | 49.0 |
| Max (Cum. %):                                   | 17.0 | 33.0 | 49.0 |

TOTAL PARTICULATE EMISSION FACTOR: 0.3 kg particulate/Mg of grain unloaded, without control. Emission factor from AP-42, Section 9.9.1.

SOURCE OPERATION: During testing, the facility was continuously receiving wheat of low dockage. The elevator is equipped with a dust collection system that serves the dump pit boot and leg.

SAMPLING TECHNIQUE: Nelson Cascade Impactor

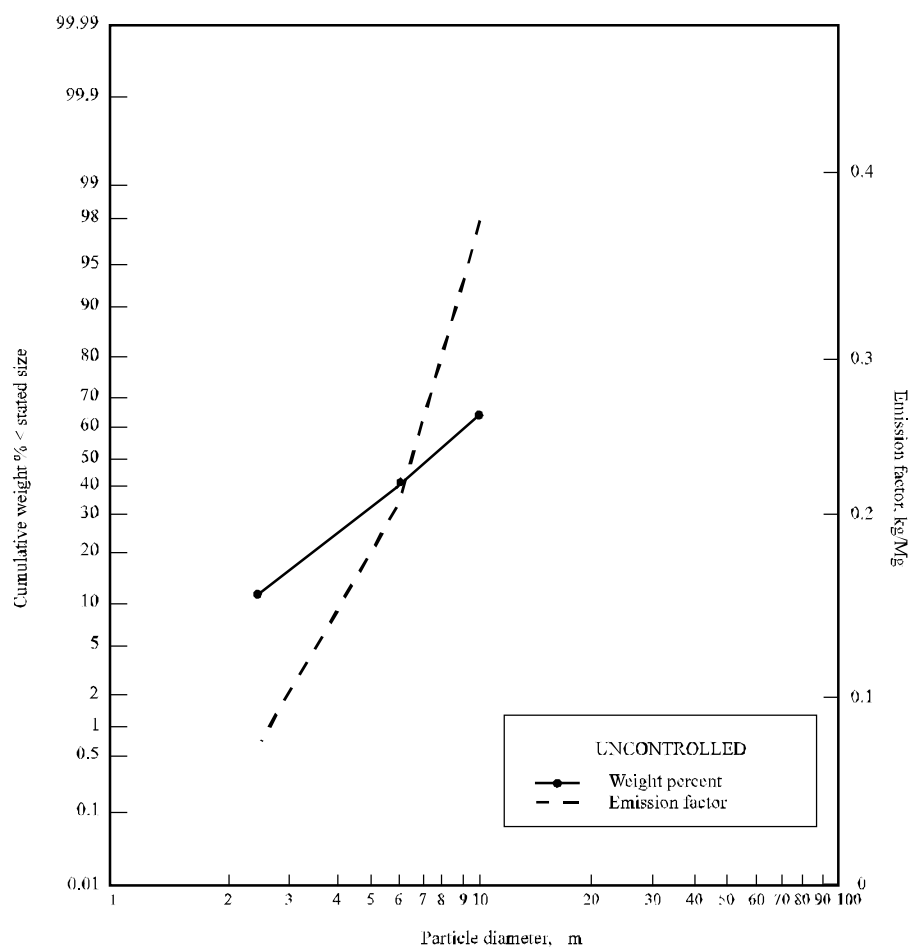
EMISSION FACTOR RATING: D

REFERENCES:

- a. Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System (FPEIS), Series Report No. 154, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.
- b. *Emission Test Report, Uniontown Co-op, Elevator No. 2, Uniontown, WA*, Report No. 75-34, Washington State Department Of Ecology, Olympia, WA, October 1975.

## 9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: CONVEYING

9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: CONVEYING



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 16.8                           | 0.08                   |
| 6.0                                    | 41.3                           | 0.21                   |
| 10.0                                   | 69.4                           | 0.35                   |

### 9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: CONVEYING

NUMBER OF TESTS: 2, conducted before control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 16.8 | 41.3 | 69.4 |
|----------------|------|------|------|

|                              |     |      |      |
|------------------------------|-----|------|------|
| Standard deviation (Cum. %): | 6.9 | 16.3 | 27.3 |
|------------------------------|-----|------|------|

|               |     |      |      |
|---------------|-----|------|------|
| Min (Cum. %): | 9.9 | 25.0 | 42.1 |
|---------------|-----|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 23.7 | 57.7 | 96.6 |
|---------------|------|------|------|

TOTAL PARTICULATE EMISSION FACTOR: 0.5 kg particulate/Mg of grain processed, without control. Emission factor from AP-42, Section 9.9.1.

**SOURCE OPERATION:** Grain is unloaded from barges by "marine leg" buckets lifting the grain from the barges and discharging it onto an enclosed belt conveyer, which transfers the grain to the elevator. These tests measured the combined emissions from the "marine leg" bucket unloader and the conveyer transfer points. Emission rates averaged 1956 lb particulate/hour (0.67 kg/Mg grain unloaded). Grains are corn and soy beans.

**SAMPLING TECHNIQUE:** Brink Model B Cascade Impactor

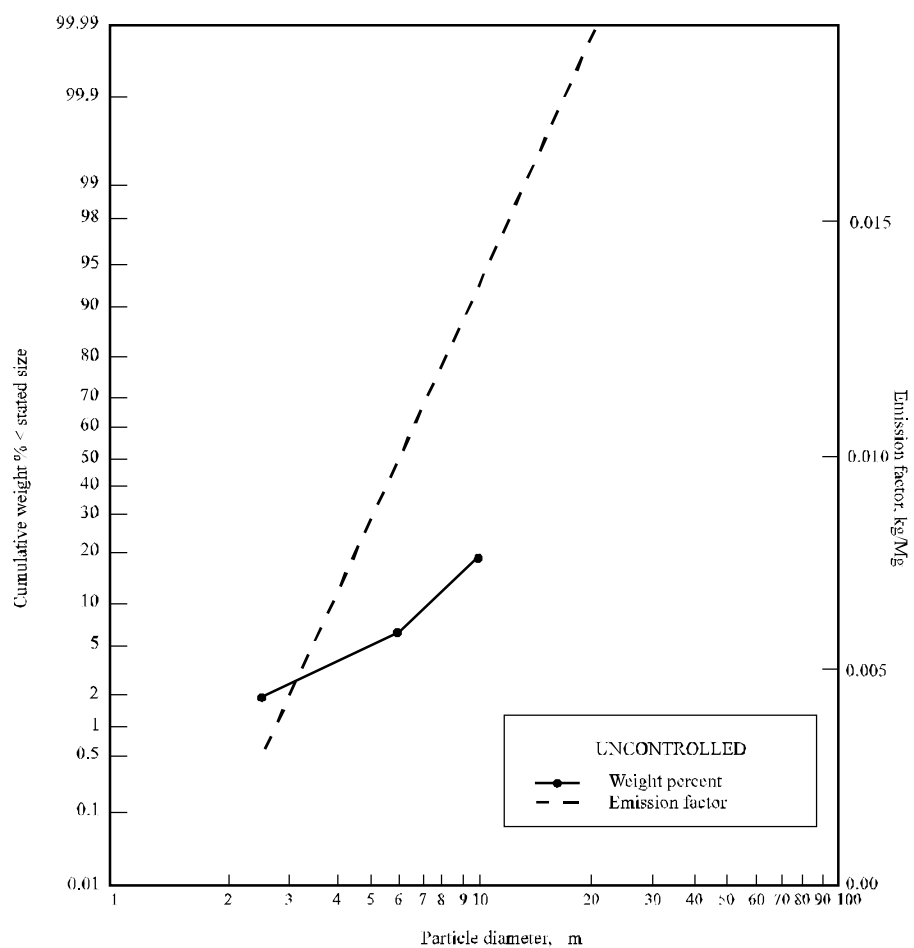
EMISSION FACTOR RATING: D

REFERENCE:

*Air Pollution Emission Test, Bunge Corporation, Destrehan, LA, EMB-74-GRN-7, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1974.*

## 9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: RICE DRYER

9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: RICE DRYER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 2.0                            | 0.003                  |
| 6.0                                    | 8.0                            | 0.01                   |
| 10.0                                   | 19.5                           | 0.029                  |

### 9.9.1 FEED AND GRAIN MILLS AND ELEVATORS: RICE DRYER

NUMBER OF TESTS: 2, conducted on uncontrolled source.

|                                                 |     |     |      |
|-------------------------------------------------|-----|-----|------|
| STATISTICS: Aerodynamic Particle Diameter (µm): | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                                  | 2.0 | 8.0 | 19.5 |
| Standard Deviation (Cum. %):                    | —   | 3.3 | 9.4  |
| Min (Cum. %):                                   | 2.0 | 3.1 | 10.1 |
| Max (Cum. %):                                   | 2.0 | 9.7 | 28.9 |

TOTAL PARTICULATE EMISSION FACTOR: 0.15 kg particulate/Mg of rice dried. Factor from AP-42, Section 9.9.1. Table 9.9.1-1, footnote b for column dryer.

SOURCE OPERATION: Source operated at 100% of rated capacity, drying 90.8 Mg rice/hr. The dryer is heated by 4 9.5-kw/hr burners.

SAMPLING TECHNIQUE: SASS train with cyclones

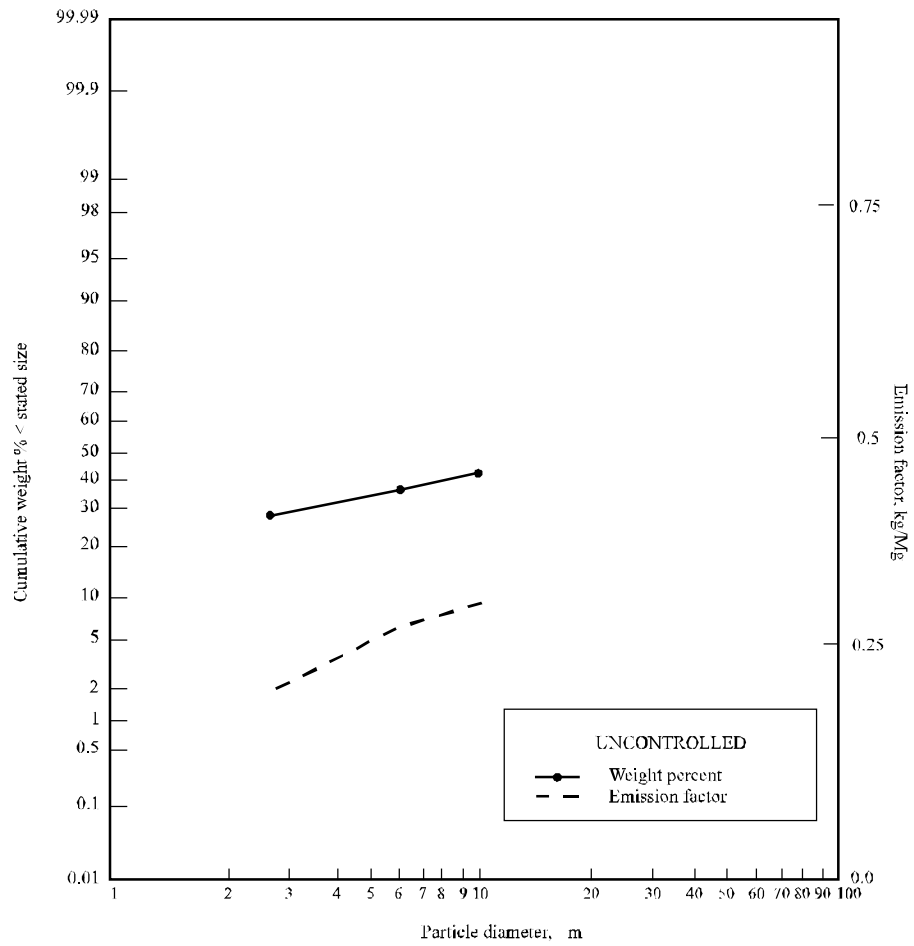
EMISSION FACTOR RATING: D

#### REFERENCES:

- a. H. J. Taback, *Fine Particle Emissions From Stationary And Miscellaneous Sources In The South Coast Air Basin*, PB 293 923/AS, National Technical Information Service, Springfield, VA, February 1979.
- b. Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 228, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 9.9.2 FEED AND GRAIN MILLS AND ELEVATORS: CEREAL DRYER

9.9.2 FEED AND GRAIN MILLS AND ELEVATORS: CEREAL DRYER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 27                             | 0.20                   |
| 6.0                                    | 37                             | 0.28                   |
| 10.0                                   | 44                             | 0.33                   |

### 9.9.2 FEED AND GRAIN MILLS AND ELEVATORS: CEREAL DRYER

NUMBER OF TESTS: 6, conducted before controls

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |    |    |    |
|----------------|----|----|----|
| Mean (Cum. %): | 27 | 37 | 44 |
|----------------|----|----|----|

|                              |    |    |    |
|------------------------------|----|----|----|
| Standard deviation (Cum. %): | 17 | 18 | 20 |
|------------------------------|----|----|----|

|               |    |    |    |
|---------------|----|----|----|
| Min (Cum. %): | 13 | 20 | 22 |
|---------------|----|----|----|

|               |    |    |    |
|---------------|----|----|----|
| Max (Cum. %): | 47 | 56 | 58 |
|---------------|----|----|----|

TOTAL PARTICULATE EMISSION FACTOR: 0.75 kg particulate/Mg cereal dried. Factor taken from AP-42, Section 9.9.2.

SOURCE OPERATION: Confidential

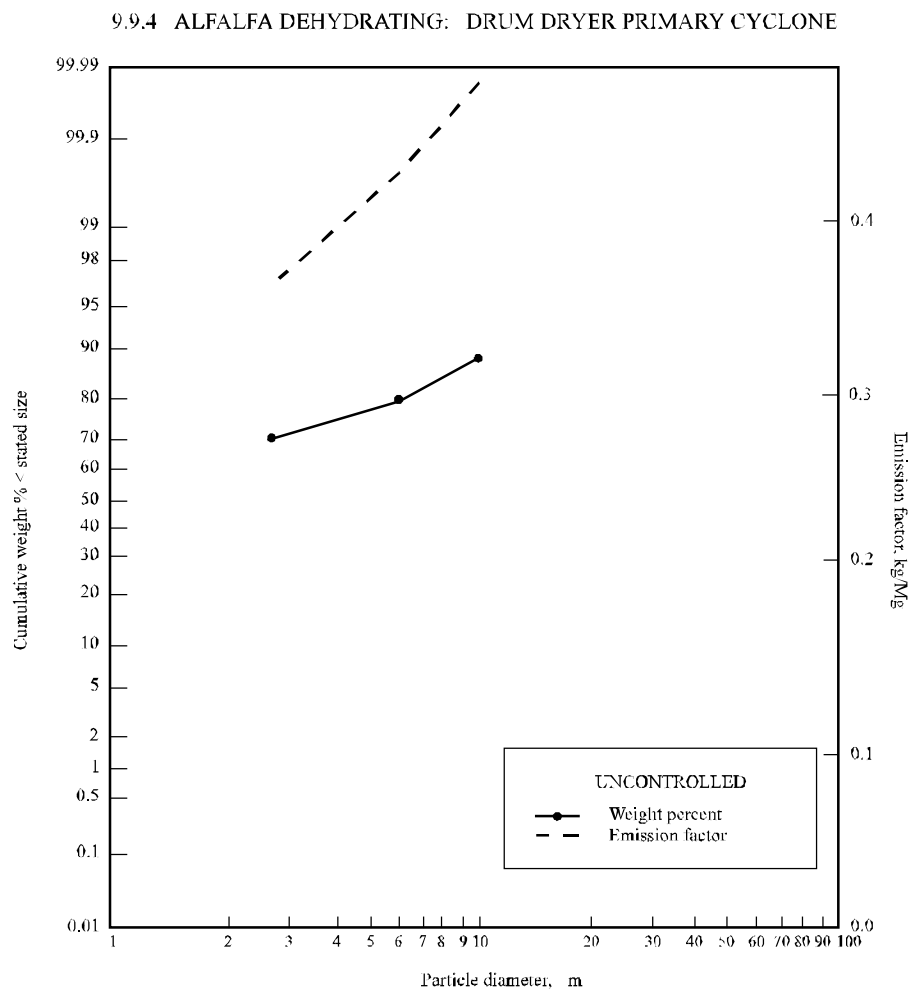
SAMPLING TECHNIQUE: Andersen Mark III Impactor

EMISSION FACTOR RATING: C

REFERENCE:

Confidential test data from a major grain processor, PEI Associates, Inc., Golden, CO, January 1985.

## 9.9.4 ALFALFA DEHYDRATING: DRUM DRYER PRIMARY CYCLONE



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 70.6                           | 0.35                   |
| 6.0                                    | 82.7                           | 0.41                   |
| 10.0                                   | 90.0                           | 0.45                   |

#### 9.9.4 ALFALFA DEHYDRATING: DRUM DRYER PRIMARY CYCLONE

NUMBER OF TESTS: 1, conducted before control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 70.6 | 82.7 | 90.0 |
|----------------|------|------|------|

Standard deviation (Cum. %)

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 5.0 kg particulate/Mg alfalfa pellets before control.  
Factor from AP-42, Section 9.9.4.

SOURCE OPERATION: During this test, source dried 10 tons of alfalfa/hour in a direct-fired rotary dryer.

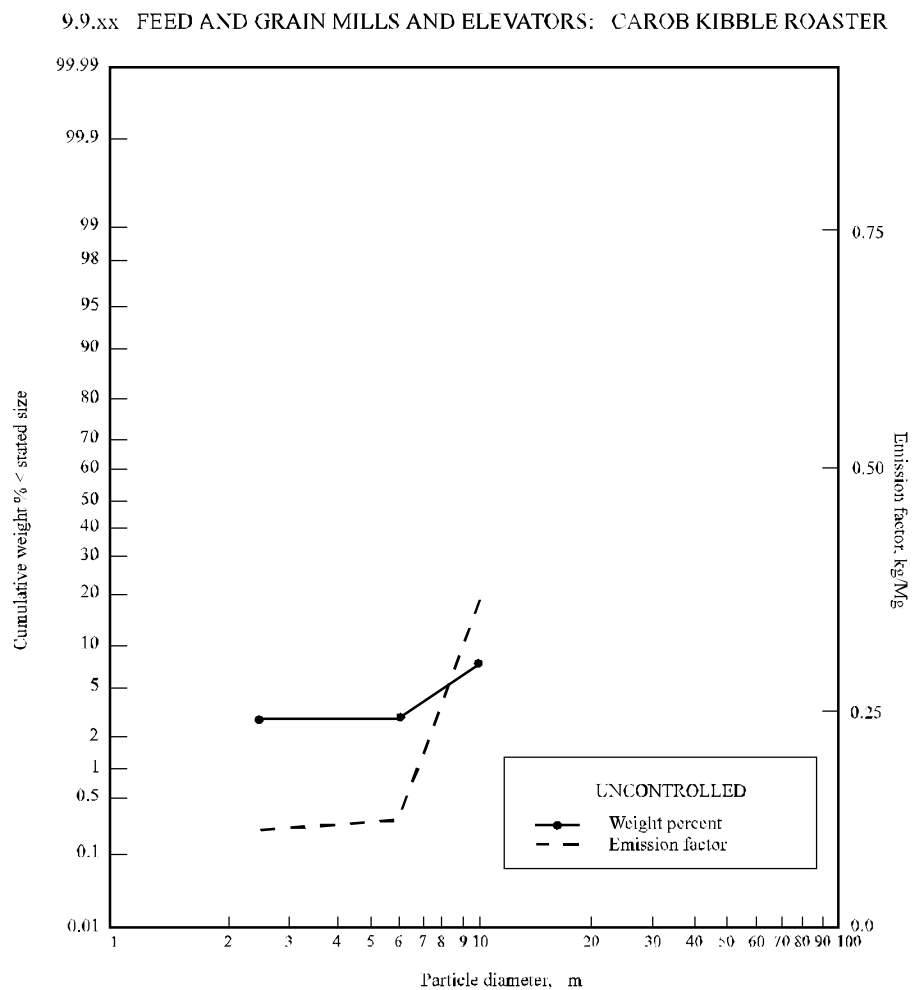
**SAMPLING TECHNIQUE:** Nelson Cascade Impactor

EMISSION FACTOR RATING: E

REFERENCE:

Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 152, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 9.9.xx FEED AND GRAIN MILLS AND ELEVATORS: CAROB KIBBLE ROASTER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------|--------------------------------|------------------------|
|                                  | Uncontrolled                   | Uncontrolled           |
| 2.5                              | 3.0                            | 0.11                   |
| 6.0                              | 3.2                            | 0.12                   |
| 10.0                             | 9.6                            | 0.36                   |

### 9.9.xx FEED AND GRAIN MILLS AND ELEVATORS: CAROB KIBBLE ROASTER

NUMBER OF TESTS: 1, conducted before controls

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |     |     |     |
|----------------|-----|-----|-----|
| Mean (Cum. %): | 3.0 | 3.2 | 9.6 |
|----------------|-----|-----|-----|

Standard deviation (Cum. %):

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 3.8 kg/Mg carob kibble roasted. Factor from Reference a, p. 4-175.

SOURCE OPERATION: Source roasts 300 kg carob pods per hour, 100% of the design rate. Roaster heat input is 795 kJ/hr of natural gas.

SAMPLING TECHNIQUE: Joy train with 3 cyclones

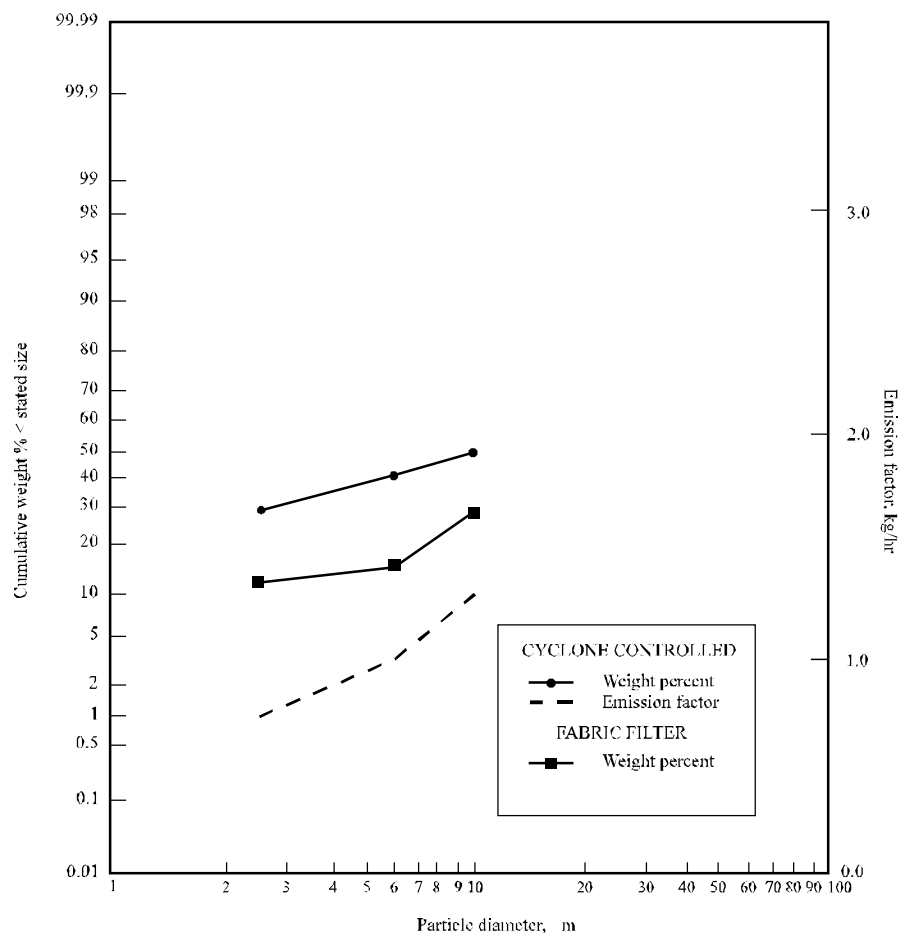
EMISSION FACTOR RATING: E

REFERENCES:

- a. H. J. Taback, *Fine Particle Emissions From Stationary And Miscellaneous Sources In The South Coast Air Basin*, PB 293 923/AS, National Technical Information Service, Springfield, VA, February 1979.
- b. Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System Series, Report No. 229, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 10.5 WOODWORKING WASTE COLLECTION OPERATIONS: BELT SANDER HOOD EXHAUST CYCLONE

10.5 WOODWORKING WASTE COLLECTION OPERATIONS:  
BELT SANDER HOOD EXHAUST CYCLONE



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                                 | Emission factor, kg/hr of cyclone operation |
|----------------------------------|--------------------------------|---------------------------------|---------------------------------------------|
|                                  | Cyclone                        | After cyclone and fabric filter |                                             |
| 2.5                              | 29.5                           | 14.3                            | 0.68                                        |
| 6.0                              | 42.7                           | 17.3                            | 0.98                                        |
| 10.0                             | 52.9                           | 32.1                            | 1.22                                        |

10.5 WOODWORKING WASTE COLLECTION OPERATIONS:  
BELT SANDER HOOD EXHAUST CYCLONE

NUMBER OF TESTS: (a) 1, conducted after cyclone control  
(b) 1, after cyclone and fabric filter control

|                 |                                                  |      |      |      |
|-----------------|--------------------------------------------------|------|------|------|
| STATISTICS: (a) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|                 | Mean (Cum. %):                                   | 29.5 | 42.7 | 52.9 |
|                 | Standard deviation (Cum. %):                     |      |      |      |
|                 | Min (Cum. %):                                    |      |      |      |
|                 | Max (Cum. %):                                    |      |      |      |
| (b)             | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|                 | Mean (Cum. %):                                   | 14.3 | 17.3 | 32.1 |
|                 | Standard deviation (Cum. %):                     |      |      |      |
|                 | Min (Cum. %):                                    |      |      |      |
|                 | Max (Cum. %):                                    |      |      |      |

TOTAL PARTICULATE EMISSION FACTOR: 2.3 kg particulate/hr of cyclone operation. For cyclone-controlled source, this emission factor applies to typical large diameter cyclones into which wood waste is fed directly, not to cyclones that handle waste previously collected in cyclones. If baghouses are used for waste collection, particulate emissions will be negligible. Accordingly, no emission factor is provided for the fabric filter-controlled source. Factors from AP-42.

SOURCE OPERATION: Source was sanding 2-ply panels of mahogany veneer, at 100% of design process rate of 1110 m<sup>2</sup>/hr.

SAMPLING TECHNIQUE: (a) Joy train with 3 cyclones  
(b) SASS train with cyclones

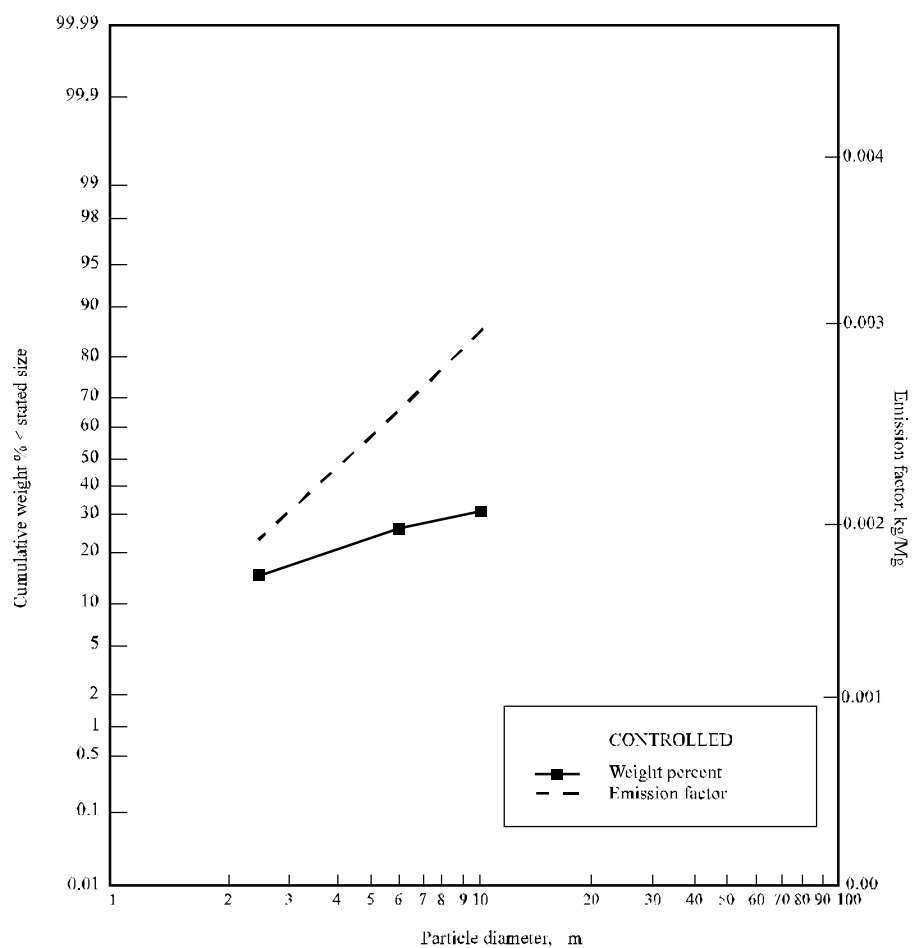
EMISSION FACTOR RATING: E

REFERENCE:

Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 238, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 11.10 COAL CLEANING: DRY PROCESS

11.10 COAL CLEANING: DRY PROCESS



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg      |
|----------------------------------------|--------------------------------|-----------------------------|
|                                        | After fabric filter control    | After fabric filter control |
| 2.5                                    | 16                             | 0.002                       |
| 6.0                                    | 26                             | 0.0025                      |
| 10.0                                   | 31                             | 0.003                       |

### 11.10 COAL CLEANING: DRY PROCESS

NUMBER OF TESTS: 1, conducted after fabric filter control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |    |    |    |
|----------------|----|----|----|
| Mean (Cum. %): | 16 | 26 | 31 |
|----------------|----|----|----|

Standard deviation (Cum. %):

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 0.01 kg particulate/Mg of coal processed. Emission factor is calculated from data in AP-42, Section 11.10, assuming 99% particulate control by fabric filter.

SOURCE OPERATION: Source cleans coal with the dry (air table) process. Average coal feed rate during testing was 70 tons/hr/table.

SAMPLING TECHNIQUE: Coulter counter

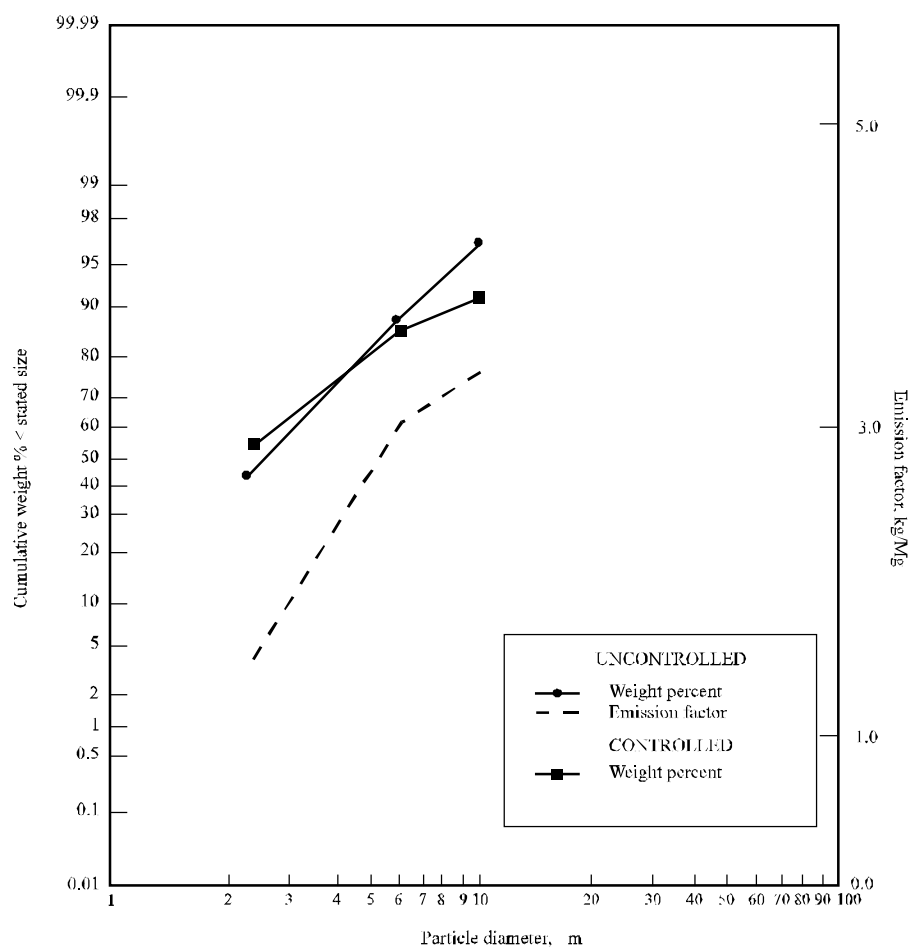
EMISSION FACTOR RATING: E

REFERENCE:

R. W. Kling, *Emissions From The Florence Mining Company Coal Processing Plant At Seward, PA*, Report No. 72-CI-4, York Research Corporation, Stamford, CT, February 1972.

## 11.10 COAL CLEANING: THERMAL DRYER

11.10 COAL CLEANING: THERMAL DRYER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                    | Emission factor, kg/Mg |                    |
|----------------------------------|--------------------------------|--------------------|------------------------|--------------------|
|                                  | Uncontrolled                   | After wet scrubber | Uncontrolled           | After wet scrubber |
| 2.5                              | 42                             | 53                 | 1.47                   | 0.016              |
| 6.0                              | 86                             | 85                 | 3.01                   | 0.026              |
| 10.0                             | 96                             | 91                 | 3.36                   | 0.027              |

### 11.10 COAL CLEANING: THERMAL DRYER

NUMBER OF TESTS: (a) 1, conducted before control  
(b) 1, conducted after wet scrubber control

|             |                                         |     |     |      |
|-------------|-----------------------------------------|-----|-----|------|
| STATISTICS: | (a) Aerodynamic particle diameter (µm): | 2.5 | 6.0 | 10.0 |
|             | Mean (Cum. %):                          | 42  | 86  | 96   |
|             | Standard deviation (Cum. %):            |     |     |      |
|             | Min (Cum. %):                           |     |     |      |
|             | Max (Cum. %):                           |     |     |      |

|                                         |     |     |      |
|-----------------------------------------|-----|-----|------|
| (b) Aerodynamic particle diameter (µm): | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                          | 53  | 85  | 91   |
| Standard deviation (Cum. %):            |     |     |      |
| Min (Cum. %):                           |     |     |      |
| Max (Cum. %):                           |     |     |      |

TOTAL PARTICULATE EMISSION FACTOR: 3.5 kg particulate/Mg of coal processed (after cyclone) before wet scrubber control. After wet scrubber control, 0.03 kg/Mg. These are site-specific emission factors and are calculated from process data measured during source testing.

**SOURCE OPERATION:** Source operates a thermal dryer to dry coal cleaned by wet cleaning process. Combustion zone in the thermal dryer is about 1000°F, and the air temperature at the dryer exit is about 125°F. Coal processing rate is about 450 tons per hour. Product is collected in cyclones.

SAMPLING TECHNIQUE: (a) Coulter counter  
(b) Each sample was dispersed with aerosol OT, and further dispersed using an ultrasonic bath. Isoton was the electrolyte used.

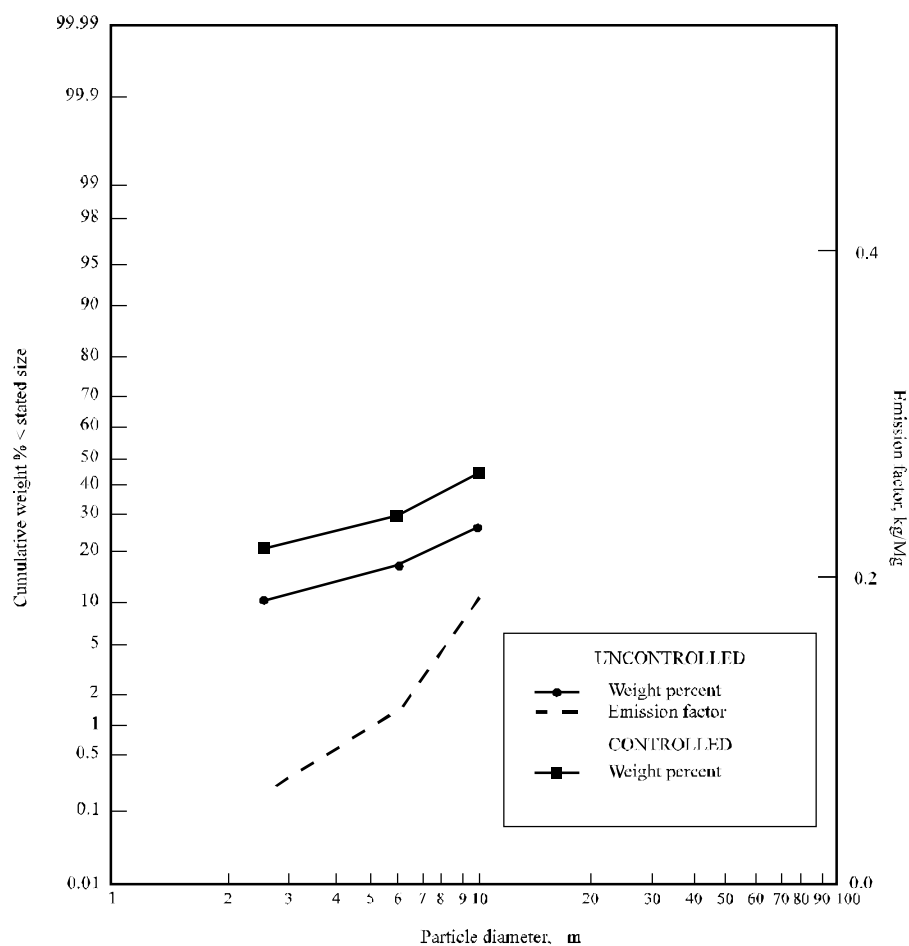
EMISSION FACTOR RATING: E

REFERENCE:

R. W. Kling, *Emission Test Report, Island Creek Coal Company Coal Processing Plant, Vansant, Virginia*, Report No. Y-7730-H, York Research Corporation, Stamford, CT, February 1972.

## 11.10 COAL PROCESSING: THERMAL INCINERATOR

11.10 COAL PROCESSING: THERMAL INCINERATOR



| Aerodynamic<br>particle<br>diameter, μm | Cumulative wt. % < stated size |                       | Emission factor, kg/Mg |
|-----------------------------------------|--------------------------------|-----------------------|------------------------|
|                                         | Uncontrolled                   | Cyclone<br>controlled | Uncontrolled           |
| 2.5                                     | 9.6                            | 21.3                  | 0.07                   |
| 6.0                                     | 17.5                           | 31.8                  | 0.12                   |
| 10.0                                    | 26.5                           | 43.7                  | 0.19                   |

## 11.10 COAL PROCESSING: THERMAL INCINERATOR

NUMBER OF TESTS: (a) 2, conducted before controls  
(b) 2, conducted after multicyclone control

|             |     |                                                  |      |      |      |
|-------------|-----|--------------------------------------------------|------|------|------|
| STATISTICS: | (a) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             |     | Mean (Cum. %):                                   | 9.6  | 17.5 | 26.5 |
|             |     | Standard deviation (Cum. %):                     |      |      |      |
|             |     | Min (Cum. %):                                    |      |      |      |
|             |     | Max (Cum. %):                                    |      |      |      |
|             | (b) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             |     | Mean (Cum. %):                                   | 26.4 | 35.8 | 46.6 |
|             |     | Standard deviation (Cum. %):                     |      |      |      |
|             |     | Min (Cum. %):                                    |      |      |      |
|             |     | Max (Cum. %):                                    |      |      |      |

TOTAL PARTICULATE EMISSION FACTOR: 0.7 kg particulate/Mg coal dried, before multicyclone control. Factor from AP-42, Section 11.10.

SOURCE OPERATION: Source is a thermal incinerator controlling gaseous emissions from a rotary kiln drying coal. No additional operating data are available.

SAMPLING TECHNIQUE: Andersen Mark III Impactor

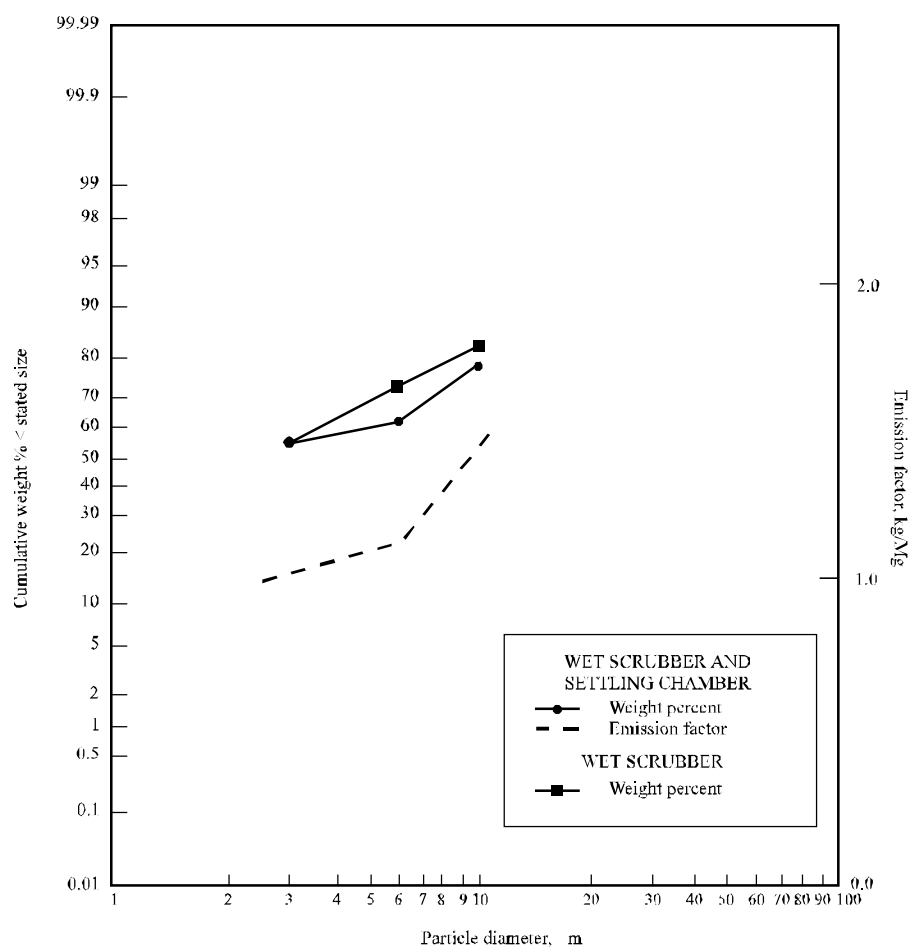
EMISSION FACTOR RATING: D

REFERENCE:

Confidential test data from a major coal processor, PEI Associates, Inc., Golden, CO, January 1985.

## 11.20 LIGHTWEIGHT AGGREGATE (CLAY): COAL-FIRED ROTARY KILN

11.20 LIGHTWEIGHT AGGREGATE (CLAY): COAL-FIRED ROTARY KILN

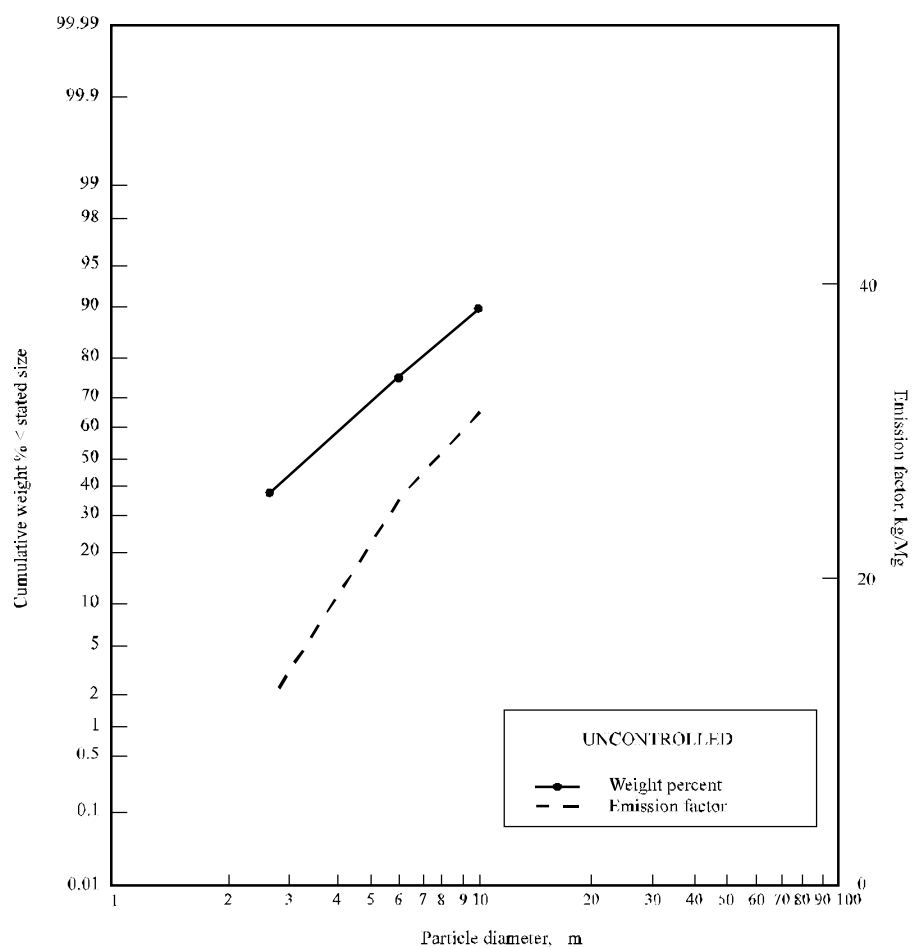


| Aerodynamic particle diameter, m | Cumulative wt. % < stated size    |              | Emission factor, kg/Mg            |
|----------------------------------|-----------------------------------|--------------|-----------------------------------|
|                                  | Wet scrubber and settling chamber | Wet scrubber | Wet scrubber and settling chamber |
| 2.5                              | 55                                | 55           | 0.97                              |
| 6.0                              | 65                                | 75           | 1.15                              |
| 10.0                             | 81                                | 84           | 1.43                              |



## 11.20 LIGHTWEIGHT AGGREGATE (CLAY): DRYER

11.20 LIGHTWEIGHT AGGREGATE (CLAY): DRYER



| Aerodynamic<br>particle<br>diameter, $\mu\text{m}$ | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------------------|--------------------------------|------------------------|
|                                                    | Uncontrolled                   | Uncontrolled           |
| 2.5                                                | 37.2                           | 13.0                   |
| 6.0                                                | 74.8                           | 26.2                   |
| 10.0                                               | 89.5                           | 31.3                   |

### 11.20 LIGHTWEIGHT AGGREGATE (CLAY): DRYER

NUMBER OF TESTS: 5, conducted before controls

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 37.2 | 74.8 | 89.5 |
|----------------|------|------|------|

|                              |     |     |     |
|------------------------------|-----|-----|-----|
| Standard deviation (Cum. %): | 3.4 | 5.6 | 3.6 |
|------------------------------|-----|-----|-----|

|               |      |      |      |
|---------------|------|------|------|
| Min (Cum. %): | 32.3 | 68.9 | 85.5 |
|---------------|------|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 41.0 | 80.8 | 92.7 |
|---------------|------|------|------|

TOTAL PARTICULATE EMISSION FACTOR: 65 kg/Mg clay feed to dryer. From AP-42, Section 11.20.

SOURCE OPERATION: No information on source operation is available

SAMPLING TECHNIQUE: Brink Impactor

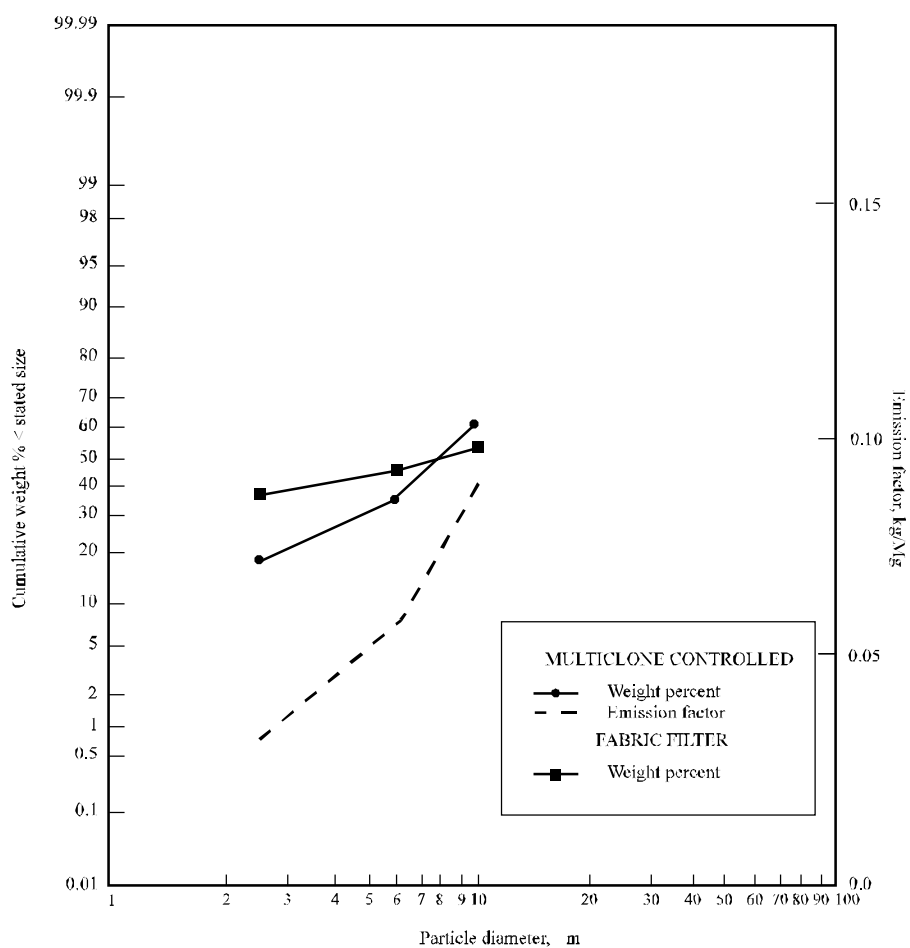
EMISSION FACTOR RATING: C

REFERENCE:

Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 88, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 11.20 LIGHTWEIGHT AGGREGATE (CLAY): RECIPROCATING GRATE CLINKER COOLER

### 11.20 LIGHTWEIGHT AGGREGATE (CLAY): RECIPROCATING GRATE CLINKER COOLER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |               | Emission factor, kg/Mg |
|----------------------------------|--------------------------------|---------------|------------------------|
|                                  | Multiclone                     | Fabric filter | Multiclone             |
| 2.5                              | 19.3                           | 39            | 0.03                   |
| 6.0                              | 38.1                           | 48            | 0.06                   |
| 10.0                             | 56.1                           | 54            | 0.09                   |

## 11.20 LIGHTWEIGHT AGGREGATE (CLAY): RECIPROCATING GRATE CLINKER COOLER

NUMBER OF TESTS: (a) 12, conducted after Multicyclone control  
(b) 4, conducted after Multicyclone and fabric filter control

|                                                                  |      |      |      |
|------------------------------------------------------------------|------|------|------|
| STATISTICS: (a) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                                   | 19.3 | 38.1 | 56.7 |
| Standard deviation (Cum. %):                                     | 7.9  | 14.9 | 17.9 |
| Min (Cum. %):                                                    | 9.3  | 18.6 | 29.2 |
| Max (Cum. %):                                                    | 34.6 | 61.4 | 76.6 |

|                                                      |     |     |      |
|------------------------------------------------------|-----|-----|------|
| (b) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5 | 6.0 | 10.0 |
| Mean (Cum. %):                                       | 39  | 48  | 54   |
| Standard deviation (Cum. %):                         |     |     |      |
| Min (Cum. %):                                        |     |     |      |
| Max (Cum. %):                                        |     |     |      |

TOTAL PARTICULATE EMISSION FACTOR: 0.157 kg particulate/Mg clay processed, after multicyclone control. Factor calculated from data in Reference b. After fabric filter control, particulate emissions are negligible.

SOURCE OPERATION: Sources produce lightweight clay aggregate in a coal-fired rotary kiln and reciprocating grate clinker cooler.

SAMPLING TECHNIQUE: (a) Andersen Impactor  
(b) Andersen Impactor

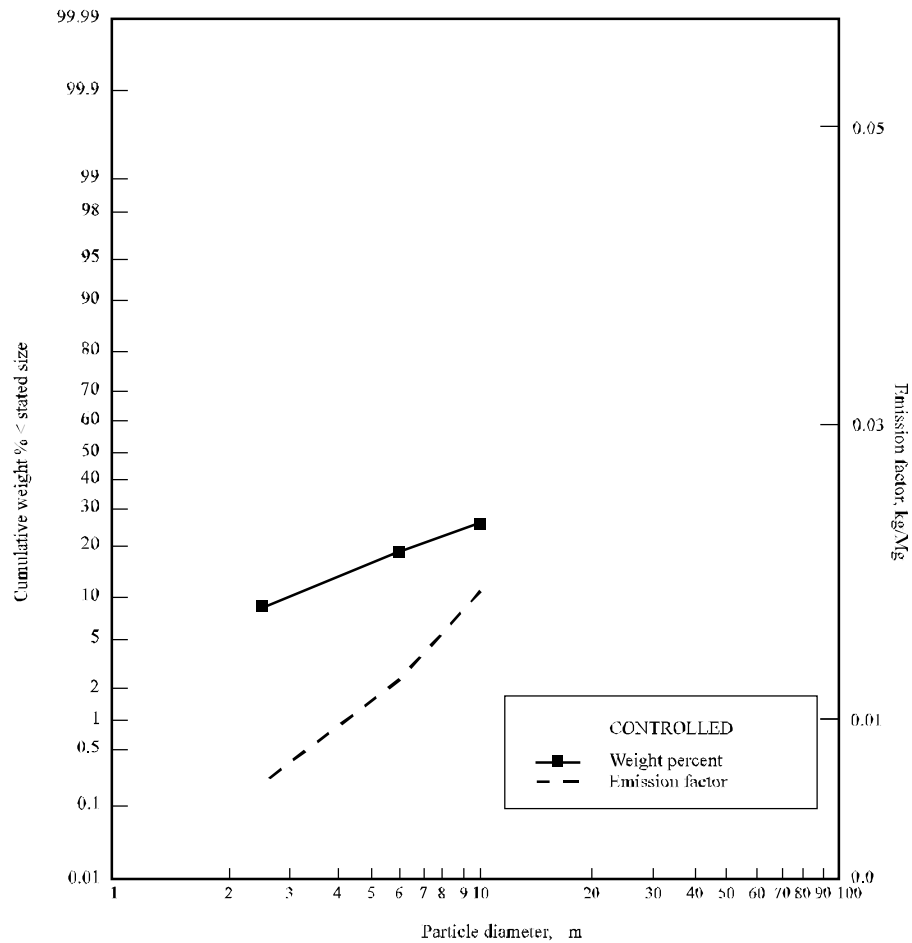
EMISSION FACTOR RATING: C

### REFERENCES:

- Emission Test Report, Lightweight Aggregate Industry, Texas Industries, Inc.*, EMB-80-LWA-3, in U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1981.
- Emission Test Report, Lightweight Aggregate Industry, Arkansas Lightweight Aggregate Corporation*, EMB-80-LWA-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1981.
- Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 342, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 11.20 LIGHTWEIGHT AGGREGATE (SHALE): RECIPROCATING GRATE CLINKER COOLER

### 11.20 LIGHTWEIGHT AGGREGATE (SHALE): RECIPROCATING GRATE CLINKER COOLER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg   |
|----------------------------------------|--------------------------------|--------------------------|
|                                        | Settling chamber control       | Settling chamber control |
| 2.5                                    | 8.2                            | 0.007                    |
| 6.0                                    | 17.6                           | 0.014                    |
| 10.0                                   | 25.6                           | 0.020                    |

11.20 LIGHTWEIGHT AGGREGATE (SHALE):  
RECIPROCATING GRATE CLINKER COOLER

NUMBER OF TESTS: 4, conducted after settling chamber control

|                                                 |      |      |      |
|-------------------------------------------------|------|------|------|
| STATISTICS: Aerodynamic particle diameter (µm): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                  | 8.2  | 17.6 | 25.6 |
| Standard deviation (Cum. %):                    | 4.3  | 2.8  | 1.7  |
| Min (Cum. %):                                   | 4.0  | 15.0 | 24.0 |
| Max (Cum. %):                                   | 14.0 | 21.0 | 28.0 |

TOTAL PARTICULATE EMISSION FACTOR: 0.08 kg particulate/Mg of aggregate produced.  
Factor calculated from data in reference.

SOURCE OPERATION: Source operates 2 kilns to produce lightweight shale aggregate, which is cooled and classified on a reciprocating grate clinker cooler. Normal production rate of the tested kiln is 23 tons/hr, about 66% of rated capacity. Kiln rotates at 2.8 rpm. Feed end temperature is 1100°F.

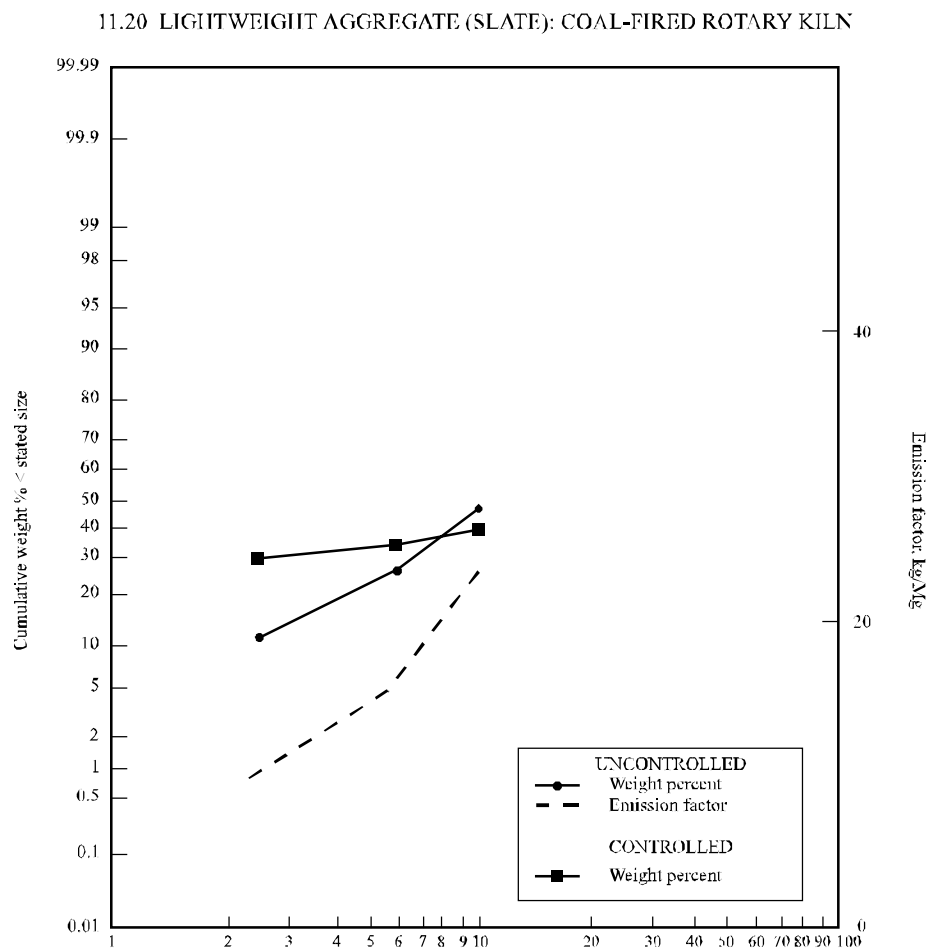
SAMPLING TECHNIQUE: Andersen Impactor

EMISSION FACTOR RATING: B

REFERENCE:

*Emission Test Report, Lightweight Aggregate Industry, Vulcan Materials Company,*  
EMB-80-LWA-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, March  
1982.

## 11.20 LIGHTWEIGHT AGGREGATE (SLATE): COAL-FIRED ROTARY KILN

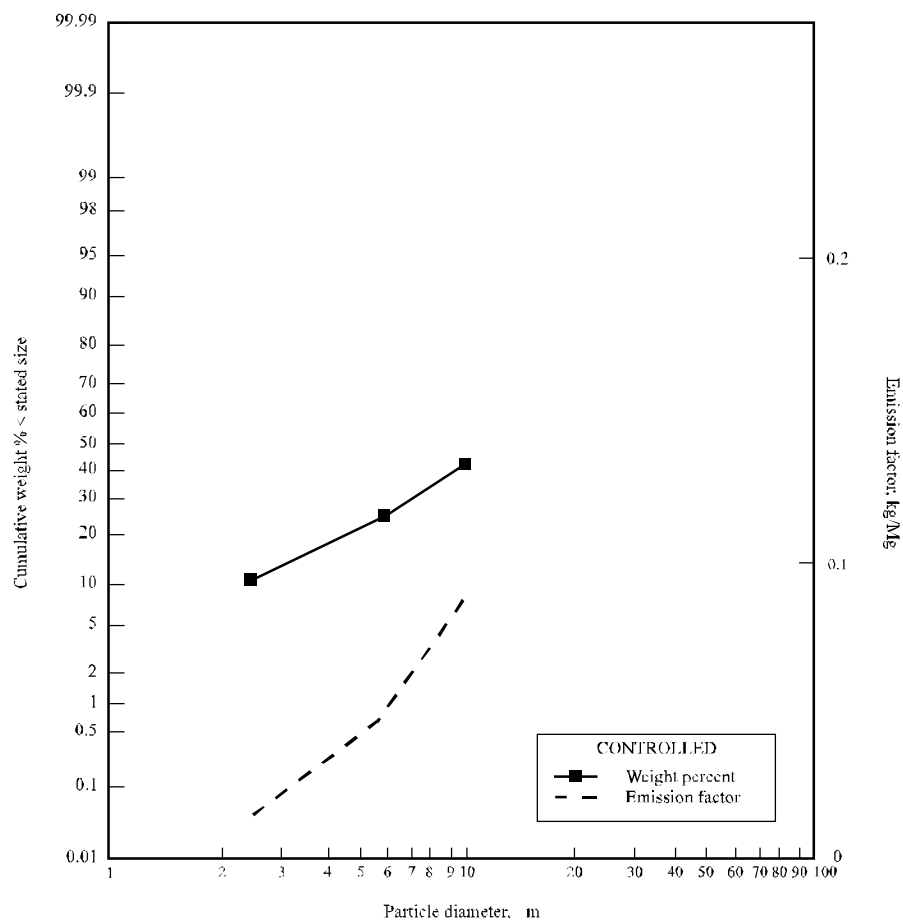


| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                            | Emission factor, kg/Mg |                            |
|----------------------------------|--------------------------------|----------------------------|------------------------|----------------------------|
|                                  | Without controls               | After wet scrubber control | Without controls       | After wet scrubber control |
| 2.5                              | 13                             | 33                         | 7.3                    | 0.59                       |
| 6.0                              | 29                             | 36                         | 16.2                   | 0.65                       |
| 10.0                             | 42                             | 39                         | 23.5                   | 0.70                       |



## 11.20 LIGHTWEIGHT AGGREGATE (SLATE): RECIPROCATING GRATE CLINKER COOLER

### 11.20 LIGHTWEIGHT AGGREGATE (SLATE): RECIPROCATING GRATE CLINKER COOLER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg         |
|----------------------------------------|--------------------------------|--------------------------------|
|                                        | After settling chamber control | After settling chamber control |
| 2.5                                    | 9.8                            | 0.02                           |
| 6.0                                    | 23.6                           | 0.05                           |
| 10.0                                   | 41.0                           | 0.09                           |

11.20 LIGHTWEIGHT AGGREGATE (SLATE):  
RECIPROCATING GRATE CLINKER COOLER

NUMBER OF TESTS: 5, conducted after settling chamber control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

Mean (Cum. %): 9.8 23.6 41.0

Standard deviation (Cum. %):

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 0.22 kg particulate/Mg of raw material feed. Factor calculated from data in reference.

SOURCE OPERATION: Source produces lightweight slate aggregate in a coal-fired kiln and a reciprocating grate clinker cooler. During testing, source was operating at a feed rate of 33 tons/hr, 83% of rated capacity. Firing zone temperatures are about 2125°F, and kiln rotates at 3.25 rpm.

SAMPLING TECHNIQUE: Andersen Impactor

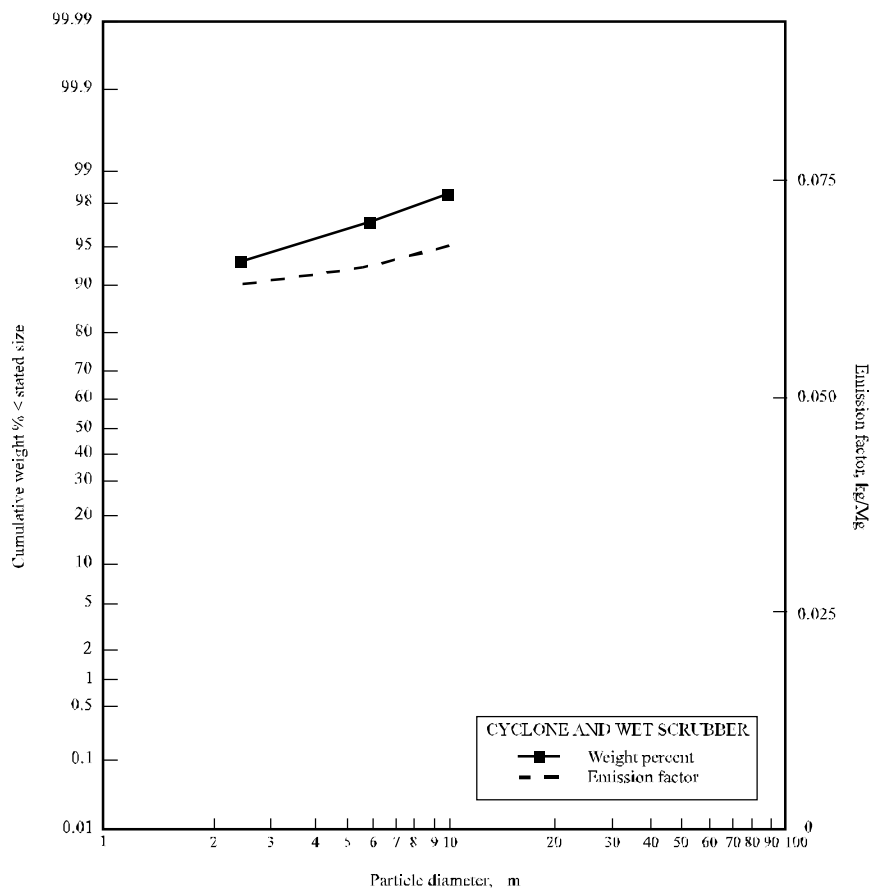
EMISSION FACTOR RATING: C

REFERENCE:

*Emission Test Report, Lightweight Aggregate Industry, Galite Corporation, EMB-80-LWA-6,*  
U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1982.

## 11.21 PHOSPHATE ROCK PROCESSING: CALCINER

### 11.21 PHOSPHATE ROCK PROCESSING: CALCINER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size              | Emission factor, kg/Mg                      |
|----------------------------------|---------------------------------------------|---------------------------------------------|
|                                  | After cyclone <sup>a</sup> and wet scrubber | After cyclone <sup>a</sup> and wet scrubber |
| 2.5                              | 94.0                                        | 0.064                                       |
| 6.0                              | 97.0                                        | 0.066                                       |
| 10.0                             | 98.0                                        | 0.067                                       |

<sup>a</sup> Cyclones are typically used in phosphate rock processing as product collectors. Uncontrolled emissions are emissions in the air exhausted from such cyclones.

## 11.21 PHOSPHATE ROCK PROCESSING: CALCINER

NUMBER OF TESTS: 6, conducted after wet scrubber control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 94.0 | 97.0 | 98.0 |
|----------------|------|------|------|

|                              |     |     |     |
|------------------------------|-----|-----|-----|
| Standard deviation (Cum. %): | 2.5 | 1.6 | 1.5 |
|------------------------------|-----|-----|-----|

|               |      |      |      |
|---------------|------|------|------|
| Min (Cum. %): | 89.0 | 95.0 | 96.0 |
|---------------|------|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 98.0 | 99.2 | 99.7 |
|---------------|------|------|------|

TOTAL PARTICULATE EMISSION FACTOR: 0.0685 kg particulate/Mg of phosphate rock calcined, after collection of airborne product in a cyclone, and wet scrubber controls. Factor from reference cited below.

**SOURCE OPERATION:** Source is a phosphate rock calciner fired with No. 2 oil, with a rated capacity of 70 tons/hr. Feed to the calciner is beneficiated rock.

**SAMPLING TECHNIQUE:** Andersen Impactor.

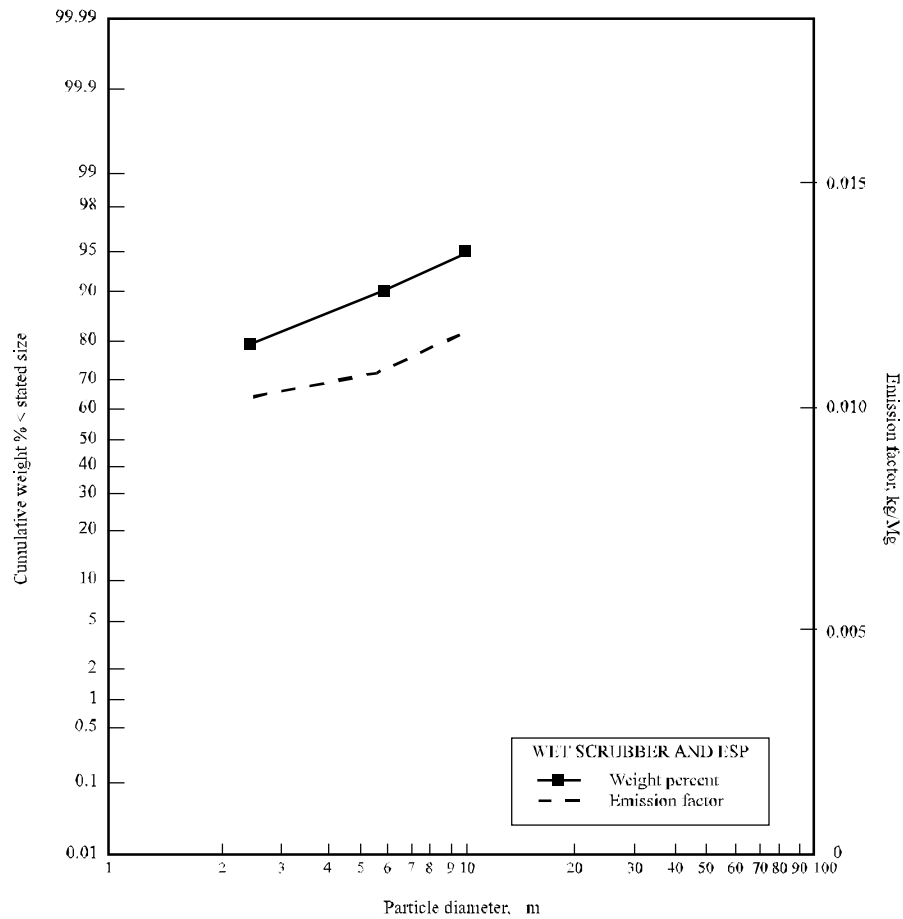
EMISSION FACTOR RATING: C

REFERENCE:

*Air Pollution Emission Test, Beker Industries, Inc., Conda, ID, EMB-75-PRP-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1975.*

# 11.21 PHOSPHATE ROCK PROCESSING: OIL-FIRED ROTARY AND FLUIDIZED-BED TANDEM DRYERS

11.21 PHOSPHATE ROCK PROCESSING:  
OIL-FIRED ROTARY AND FLUIDIZED-BED TANDEM DRYERS



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size     | Emission factor, kg/Mg             |
|----------------------------------|------------------------------------|------------------------------------|
|                                  | After wet scrubber and ESP control | After wet scrubber and ESP control |
| 2.5                              | 78.0                               | 0.010                              |
| 6.0                              | 88.8                               | 0.011                              |
| 10.0                             | 93.8                               | 0.012                              |

11.21 PHOSPHATE ROCK PROCESSING:  
OIL-FIRED ROTARY AND FLUIDIZED-BED TANDEM DRYERS

NUMBER OF TESTS: 2, conducted after wet scrubber and electrostatic precipitator control

|                                                 |      |      |      |
|-------------------------------------------------|------|------|------|
| STATISTICS: Aerodynamic particle diameter (µm): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                  | 78.0 | 88.8 | 93.8 |
| Standard deviation (Cum. %):                    | 22.6 | 9.6  | 2.5  |
| Min (Cum. %):                                   | 62   | 82   | 92   |
| Max (Cum. %):                                   | 94   | 95   | 95   |

TOTAL PARTICULATE EMISSION FACTOR: 0.0125 kg particulate/Mg phosphate rock processed, after collection of airborne product in a cyclone and wet scrubber/ESP controls. Factor from reference cited below.

SOURCE OPERATION: Source operates a rotary and a fluidized bed dryer to dry various types of phosphate rock. Both dryers are fired with No. 5 fuel oil, and exhaust into a common duct. The rated capacity of the rotary dryer is 300 tons/hr, and that of the fluidized bed dryer is 150-200 tons/hr. During testing, source was operating at 67.7% of rated capacity.

SAMPLING TECHNIQUE: Andersen Impactor

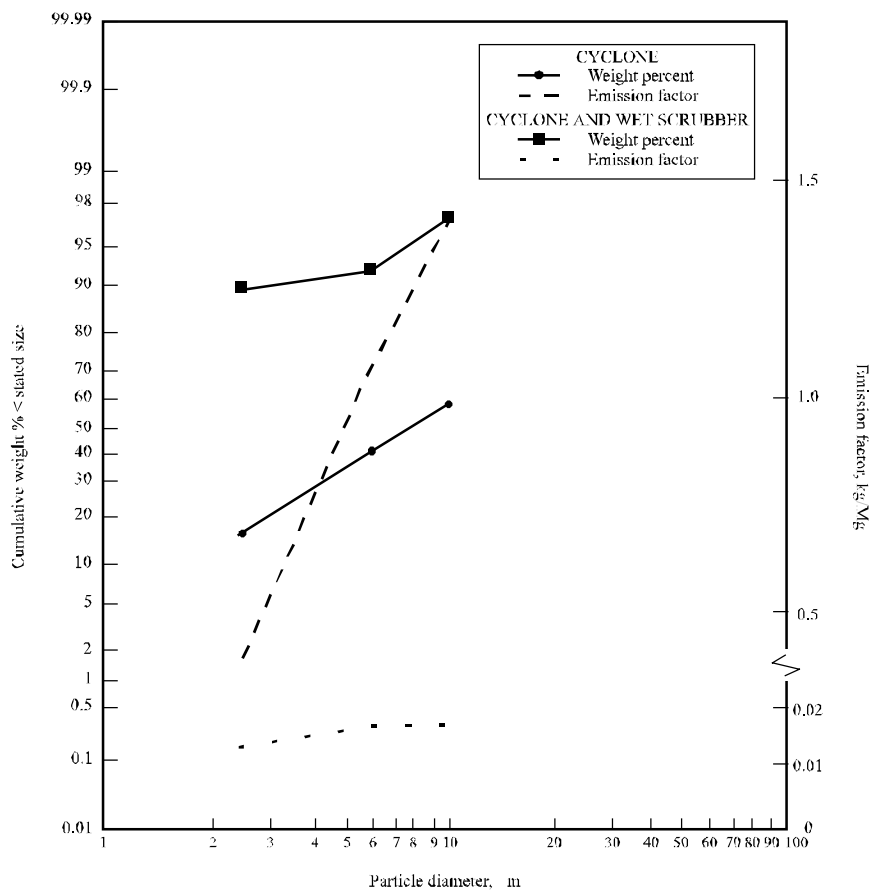
EMISSION FACTOR RATING: C

REFERENCE:

*Air Pollution Emission Test, W. R. Grace Chemical Company, Bartow, FL, EMB-75-PRP-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1976.*

## 11.21 PHOSPHATE ROCK PROCESSING: OIL-FIRED ROTARY DRYER

### 11.21 PHOSPHATE ROCK PROCESSING: OIL-FIRED ROTARY DRYER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size |                    | Emission factor, kg/Mg     |                    |
|----------------------------------|--------------------------------|--------------------|----------------------------|--------------------|
|                                  | After cyclone <sup>a</sup>     | After wet scrubber | After cyclone <sup>a</sup> | After wet scrubber |
| 2.5                              | 15.7                           | 89                 | 0.38                       | 0.017              |
| 6.0                              | 41.3                           | 92.3               | 1.00                       | 0.018              |
| 10.0                             | 58.3                           | 96.6               | 1.41                       | 0.018              |

<sup>a</sup> Cyclones are typically used in phosphate rock processing as product collectors. Uncontrolled emissions are emissions in the air exhausted from such cyclones.

## 11.21 PHOSPHATE ROCK PROCESSING: OIL-FIRED ROTARY DRYER

NUMBER OF TESTS: (a) 3, conducted after cyclone  
(b) 2, conducted after wet scrubber control

|             |     |                                                  |      |      |      |
|-------------|-----|--------------------------------------------------|------|------|------|
| STATISTICS: | (a) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             |     | Mean (Cum. %):                                   | 15.7 | 41.3 | 58.3 |
|             |     | Standard deviation (Cum. %):                     | 5.5  | 9.6  | 13.9 |
|             |     | Min (Cum. %):                                    | 12   | 30   | 43   |
|             |     | Max (Cum. %):                                    | 22   | 48   | 70   |
|             | (b) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|             |     | Mean (Cum. %):                                   | 89.0 | 92.3 | 96.6 |
|             |     | Standard Deviation (Cum. %):                     | 7.1  | 6.0  | 3.7  |
|             |     | Min (Cum. %):                                    | 84   | 88   | 94   |
|             |     | Max (Cum. %):                                    | 94   | 96   | 99   |

Impactor cut points for the tests conducted before control are small, and many of the data points are extrapolated. These particle size distributions are related to specific equipment and source operation, and are most applicable to particulate emissions from similar sources operating similar equipment. Table 11.21-2, Section 11.21, AP-42 presents particle size distributions for generic phosphate rock dryers.

TOTAL PARTICULATE EMISSION FACTORS: After cyclone, 2.419 kg particulate/Mg rock processed. After wet scrubber control, 0.019 kg/Mg. Factors from reference cited below.

SOURCE OPERATION: Source dries phosphate rock in #6 oil-fired rotary dryer. During these tests, source operated at 69% of rated dryer capacity of 350 tons/day, and processed coarse pebble rock.

SAMPLING TECHNIQUE: (a) Brinks Cascade Impactor  
(b) Andersen Impactor

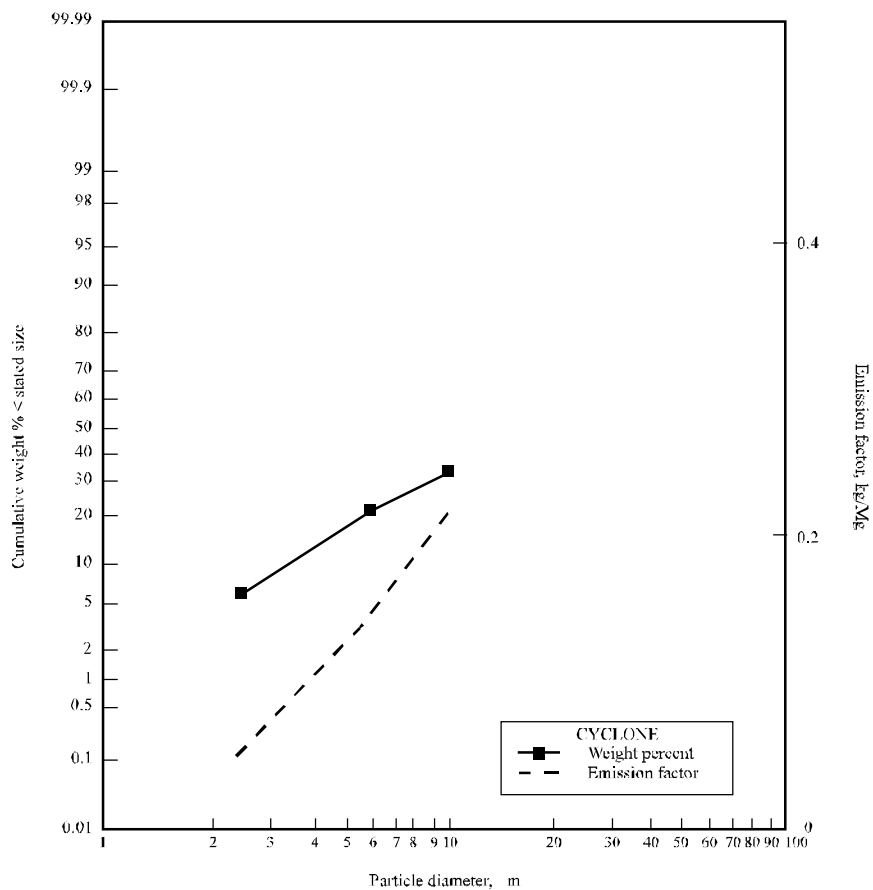
EMISSION FACTOR RATING: D

REFERENCE:

*Air Pollution Emission Test, Mobil Chemical, Nichols, FL, EMB-75-PRP-3, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1976.*

## 11.21 PHOSPHATE ROCK PROCESSING: BALL MILL

### 11.21 PHOSPHATE ROCK PROCESSING: BALL MILL



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg     |
|----------------------------------|--------------------------------|----------------------------|
|                                  | After cyclone <sup>a</sup>     | After cyclone <sup>a</sup> |
| 2.5                              | 6.5                            | 0.05                       |
| 6.0                              | 19.0                           | 0.14                       |
| 10.0                             | 30.8                           | 0.22                       |

<sup>a</sup> Cyclones are typically used in phosphate rock processing as product collectors. Uncontrolled emissions are emissions in the air exhausted from such cyclones.

## 11.21 PHOSPHATE ROCK PROCESSING: BALL MILL

NUMBER OF TESTS: 4, conducted after cyclone

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |     |      |      |
|----------------|-----|------|------|
| Mean (Cum. %): | 6.5 | 19.0 | 30.8 |
|----------------|-----|------|------|

|                              |     |     |     |
|------------------------------|-----|-----|-----|
| Standard deviation (Cum. %): | 3.5 | 0.9 | 2.6 |
|------------------------------|-----|-----|-----|

|               |   |    |    |
|---------------|---|----|----|
| Min (Cum. %): | 3 | 18 | 28 |
|---------------|---|----|----|

|               |    |    |    |
|---------------|----|----|----|
| Max (Cum. %): | 11 | 20 | 33 |
|---------------|----|----|----|

Impactor cutpoints were small, and most data points were extrapolated.

TOTAL PARTICULATE EMISSION FACTOR: 0.73 kg particulate/Mg of phosphate rock milled, after collection of airborne product in cyclone. Factor from reference cited below.

SOURCE OPERATION: Source mills western phosphate rock. During testing source was operating at 101% of rated capacity, producing 80 tons/hr.

SAMPLING TECHNIQUE: Brink Impactor

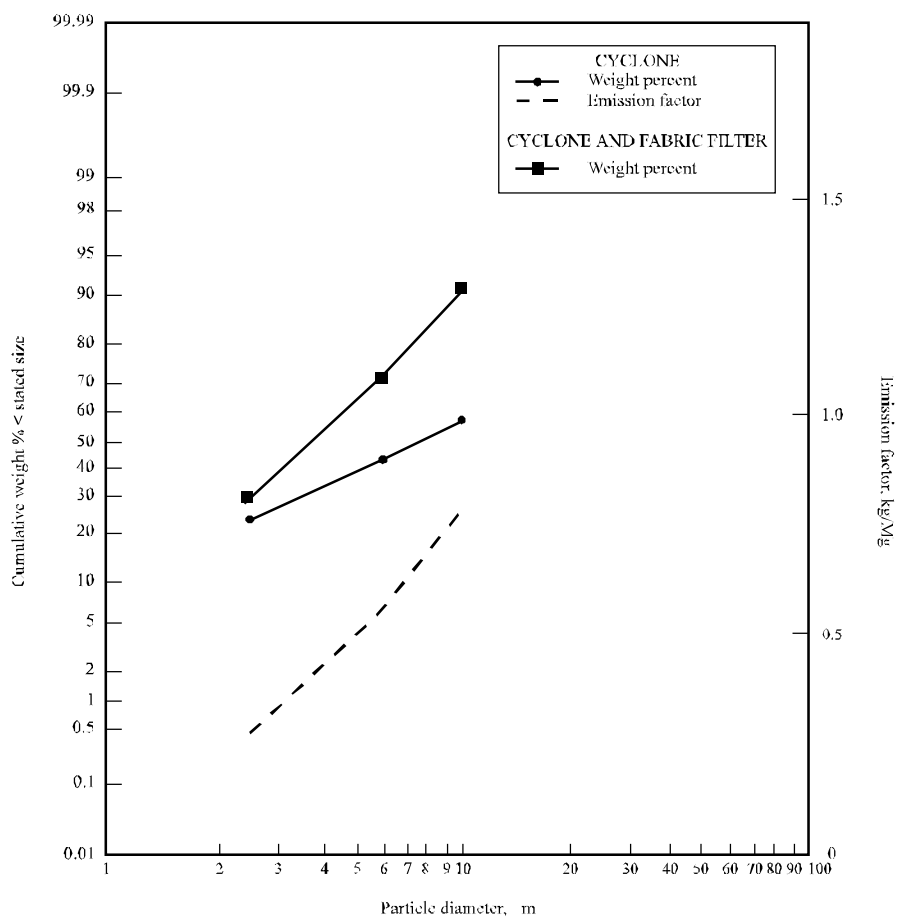
EMISSION FACTOR RATING: C

REFERENCE:

*Air Pollution Emission Test, Beker Industries, Inc., Conda, ID, EMB-75-PRP-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1975.*

## 11.21 PHOSPHATE ROCK PROCESSING: ROLLER MILL AND BOWL MILL GRINDING

11.21 PHOSPHATE ROCK PROCESSING: ROLLER MILL AND BOWL MILL GRINDING



| Aerodynamic particle diameter, μm | Cumulative wt. % < stated size |                     | Emission factor, kg/Mg     |                     |
|-----------------------------------|--------------------------------|---------------------|----------------------------|---------------------|
|                                   | After cyclone <sup>a</sup>     | After fabric filter | After cyclone <sup>a</sup> | After fabric filter |
| 2.5                               | 21                             | 25                  | 0.27                       | Negligible          |
| 6.0                               | 45                             | 70                  | 0.58                       | Negligible          |
| 10.0                              | 62                             | 90                  | 0.79                       | Negligible          |

<sup>a</sup> Cyclones are typically used in phosphate rock processing as product collectors. Uncontrolled emissions are emissions in the air exhausted from such cyclones.

## 11.21 PHOSPHATE ROCK PROCESSING: ROLLER MILL AND BOWL MILL GRINDING

NUMBER OF TESTS: (a) 2, conducted after cyclone  
(b) 1, conducted after fabric filter control

|                 |                                                  |      |      |      |
|-----------------|--------------------------------------------------|------|------|------|
| STATISTICS: (a) | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|                 | Mean (Cum. %):                                   | 21.0 | 45.0 | 62.0 |
|                 | Standard deviation (Cum. %):                     | 1.0  | 1.0  | 0    |
|                 | Min (Cum. %):                                    | 20.0 | 44.0 | 62.0 |
|                 | Max (Cum. %):                                    | 22.0 | 46.0 | 62.0 |
| (b)             | Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
|                 | Mean (Cum. %):                                   | 25   | 70   | 90   |
|                 | Standard deviation (Cum. %):                     |      |      |      |
|                 | Min (Cum. %):                                    |      |      |      |
|                 | Max (Cum. %):                                    |      |      |      |

TOTAL PARTICULATE EMISSION FACTOR. 0.73 kg particulate/Mg of rock processed, after collection of airborne product in a cyclone. After fabric filter control, 0.001 kg particulate/Mg rock processed. Factors calculated from data in reference cited below. See Table 11.21-3 for guidance.

SOURCE OPERATION: During testing, source was operating at 100% of design process rate. Source operates 1 roller mill with a rated capacity of 25 tons/hr of feed, and 1 bowl mill with a rated capacity of 50 tons/hr of feed. After product has been collected in cyclones, emissions from each mill are vented to a coin baghouse. Source operates 6 days/week, and processes Florida rock.

SAMPLING TECHNIQUE: (a) Brink Cascade Impactor  
(b) Andersen Impactor

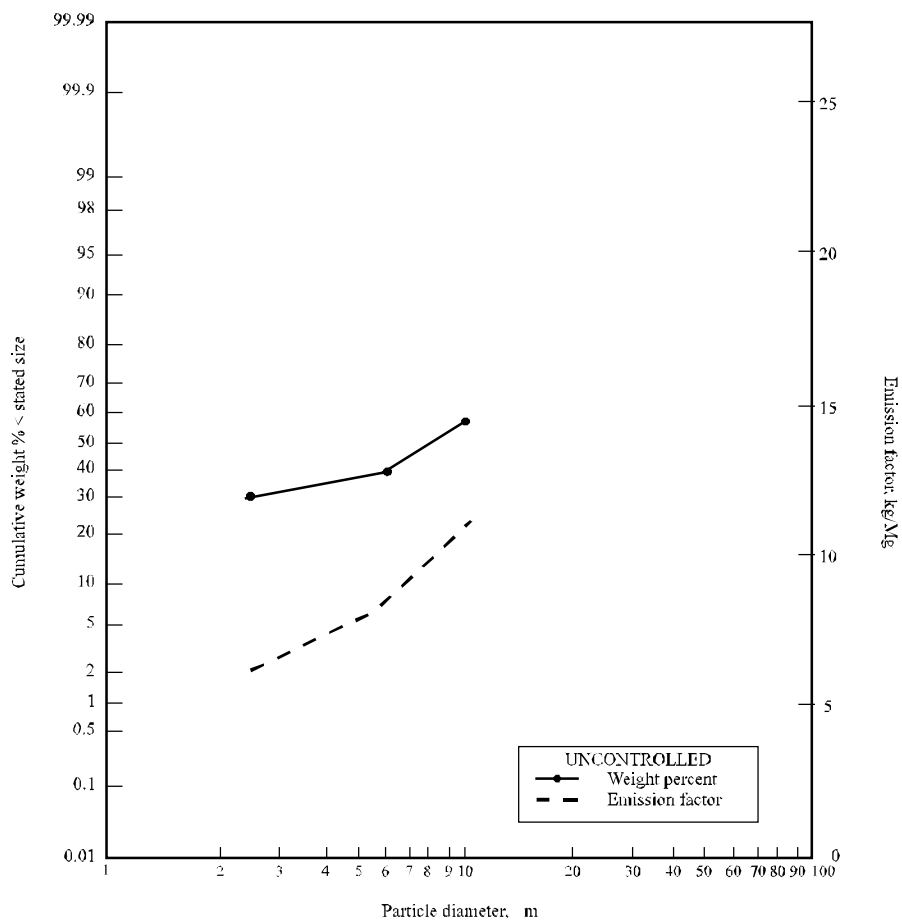
EMISSION FACTOR RATING: D

REFERENCE:

*Air Pollution Emission Test, The Royster Company, Mulberry, FL, EMB-75-PRP-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1976.*

## 11.26 NONMETALLIC MINERALS: TALC PEBBLE MILL

### 11.26 NONMETALLIC MINERALS: TALC PEBBLE MILL



| Aerodynamic<br>particle<br>diameter, $\mu\text{m}$ | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------------------|--------------------------------|------------------------|
|                                                    | Before controls                | Before controls        |
| 2.5                                                | 30.1                           | 5.9                    |
| 6.0                                                | 42.4                           | 8.3                    |
| 10.0                                               | 56.4                           | 11.1                   |

## 11.26 NONMETALLIC MINERALS: TALC PEBBLE MILL

NUMBER OF TESTS: 2, conducted before controls

|                                                              |      |      |      |
|--------------------------------------------------------------|------|------|------|
| STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                               | 30.1 | 42.4 | 56.4 |
| Standard deviation (Cum. %):                                 | 0.8  | 0.2  | 0.4  |
| Min (Cum. %):                                                | 29.5 | 42.2 | 56.1 |
| Max (Cum. %):                                                | 30.6 | 42.5 | 56.6 |

TOTAL PARTICULATE EMISSION FACTOR: 19.6 kg particulate/Mg ore processed. Calculated from data in reference.

SOURCE OPERATION: Source crushes talc ore then grinds crushed ore in a pebble mill. During testing, source operation was normal according to the operators. An addendum to the reference indicates throughput varied between 2.8 and 4.4 tons/hr during these tests.

SAMPLING TECHNIQUE: Sample was collected in an alundum thimble and analyzed with a Spectrex Prototron Particle Counter Model ILI 1000.

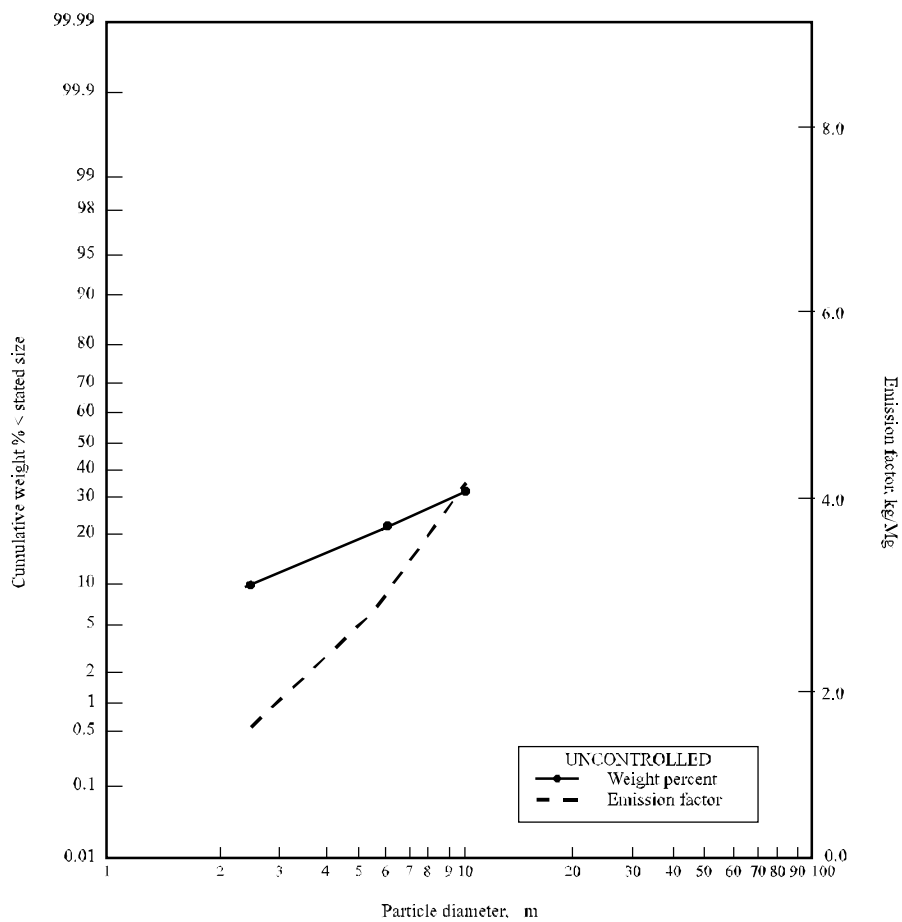
EMISSION FACTOR RATING: E

REFERENCE:

*Air Pollution Emission Test, Pfizer, Inc., Victorville, CA, EMB-77-NMM-5, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.*

# 11.xx NONMETALLIC MINERALS: FELDSPAR BALL MILL

## 11.xx NONMETALLIC MINERALS: FELDSPAR BALL MILL



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------|--------------------------------|------------------------|
|                                  | Before controls                | Before controls        |
| 2.5                              | 11.5                           | 1.5                    |
| 6.0                              | 22.8                           | 2.9                    |
| 10.0                             | 32.3                           | 4.2                    |

## 11.xx NONMETALLIC MINERALS: FELDSPAR BALL MILL

NUMBER OF TESTS: 2, conducted before controls

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 11.5 | 22.8 | 32.3 |
|----------------|------|------|------|

|                              |     |     |     |
|------------------------------|-----|-----|-----|
| Standard deviation (Cum. %): | 6.4 | 7.4 | 6.7 |
|------------------------------|-----|-----|-----|

|               |     |      |      |
|---------------|-----|------|------|
| Min (Cum. %): | 7.0 | 17.5 | 27.5 |
|---------------|-----|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 16.0 | 28.0 | 37.0 |
|---------------|------|------|------|

**TOTAL PARTICULATE EMISSION FACTOR:** 12.9 kg particulate/Mg feldspar produced. Calculated from data in reference and related documents.

**SOURCE OPERATION:** After crushing and grinding of feldspar ore, source produces feldspar powder in a ball mill.

**SAMPLING TECHNIQUE:** Alundum thimble followed by 12-inch section of stainless steel probe followed by 47-mm type SGA filter contained in a stainless steel Gelman filter holder. Laboratory analysis methods: microsieve and electronic particle counter.

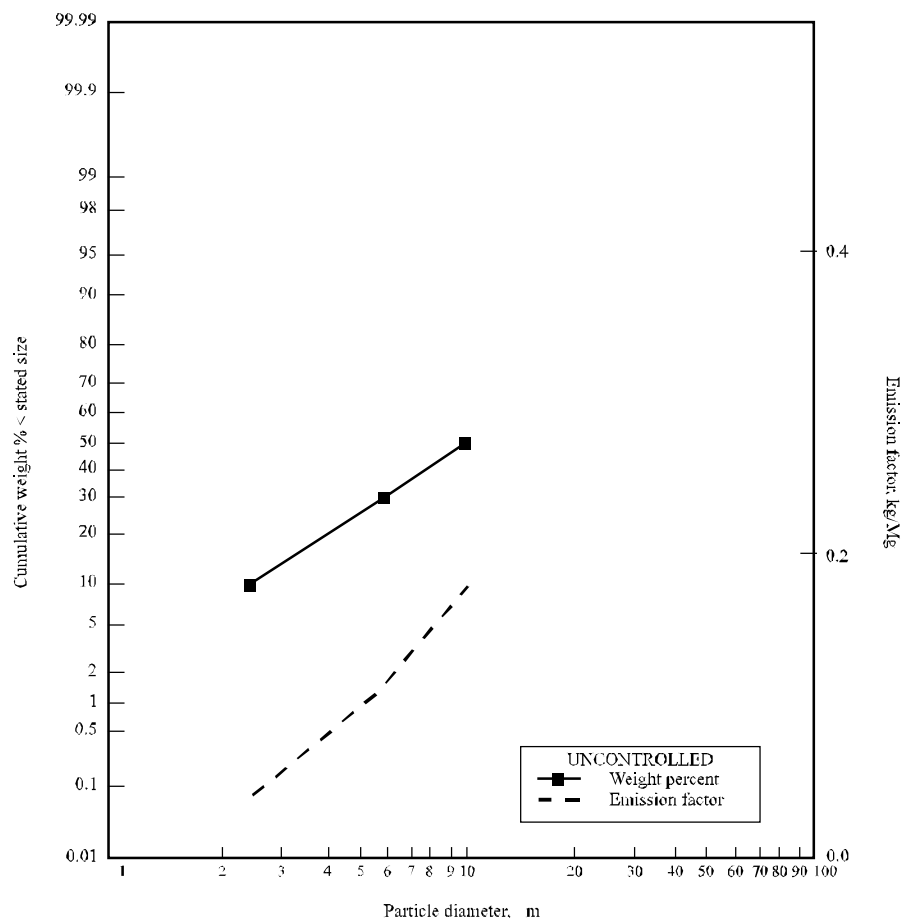
EMISSION FACTOR RATING: D

REFERENCE:

*Air Pollution Emission Test, International Minerals and Chemical Company, Spruce Pine, NC, EMB-76-NMM-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1976.*

# 11.xx NONMETALLIC MINERALS: FLUORSPAR ORE ROTARY DRUM DRYER

## 11.xx NONMETALLIC MINERALS: FLUORSPAR ORE ROTARY DRUM DRYER



| Aerodynamic particle diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg      |
|----------------------------------|--------------------------------|-----------------------------|
|                                  | After fabric filter control    | After fabric filter control |
| 2.5                              | 10                             | 0.04                        |
| 6.0                              | 30                             | 0.11                        |
| 10.0                             | 48                             | 0.18                        |

11.xx NONMETALLIC MINERALS: FLUORSPAR ORE ROTARY DRUM DRYER

NUMBER OF TESTS: 1, conducted after fabric filter control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

Mean (Cum. %): 10 30 48

Standard deviation (Cum. %):

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 0.375 kg particulate/Mg ore dried, after fabric filter control. Factors from reference.

SOURCE OPERATION: Source dries fluorspar ore in a rotary drum dryer at a feed rate of 2 tons/hr.

SAMPLING TECHNIQUE: Andersen Mark III Impactor

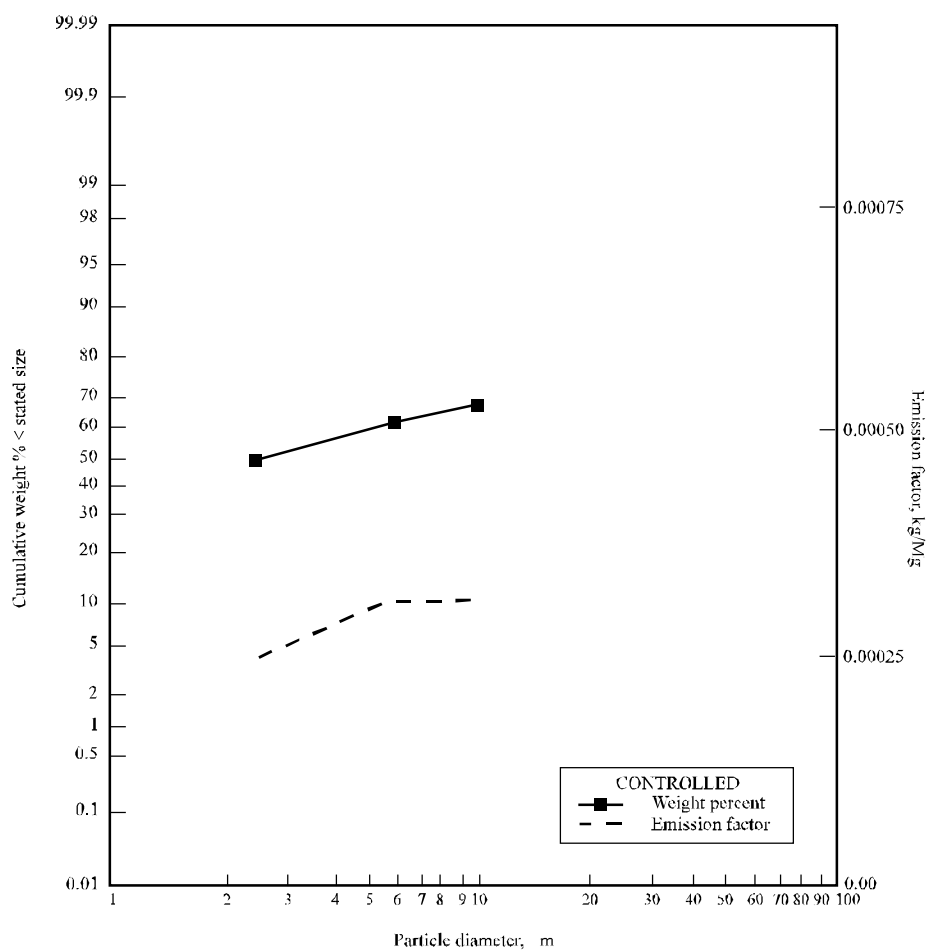
EMISSION FACTOR RATING: E

REFERENCE:

Confidential test data from a major fluorspar ore processor, PEI Associates, Inc., Golden, CO, January 1985.

## 12.1 PRIMARY ALUMINUM PRODUCTION: BAUXITE PROCESSING - FINE ORE STORAGE

### 12.1 PRIMARY ALUMINUM PRODUCTION: BAUXITE PROCESSING - FINE ORE STORAGE



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg   |
|----------------------------------------|--------------------------------|--------------------------|
|                                        | Fabric filter controlled       | Fabric filter controlled |
| 2.5                                    | 50.0                           | 0.00025                  |
| 6.0                                    | 62.0                           | 0.0003                   |
| 10.0                                   | 68.0                           | 0.0003                   |

## 12.1 PRIMARY ALUMINUM PRODUCTION: BAUXITE PROCESSING - FINE ORE STORAGE

NUMBER OF TESTS: 2, after fabric filter control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 50.0 | 62.0 | 68.0 |
|----------------|------|------|------|

|                              |      |      |      |
|------------------------------|------|------|------|
| Standard deviation (Cum. %): | 15.0 | 19.0 | 20.0 |
|------------------------------|------|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Min (Cum. %): | 35.0 | 43.0 | 48.0 |
|---------------|------|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 65.0 | 81.0 | 88.0 |
|---------------|------|------|------|

TOTAL PARTICULATE EMISSION FACTOR: 0.0005 kg particulate/Mg of ore filled, with fabric filter control. Factor calculated from emission and process data in reference.

**SOURCE OPERATION:** The facility purifies bauxite to alumina. Bauxite ore, unloaded from ships, is conveyed to storage bins from which it is fed to the alumina refining process. These tests measured the emissions from the bauxite ore storage bin filling operation (the ore drop from the conveyer into the bin), after fabric filter control. Normal bin filling rate is between 425 and 475 tons per hour.

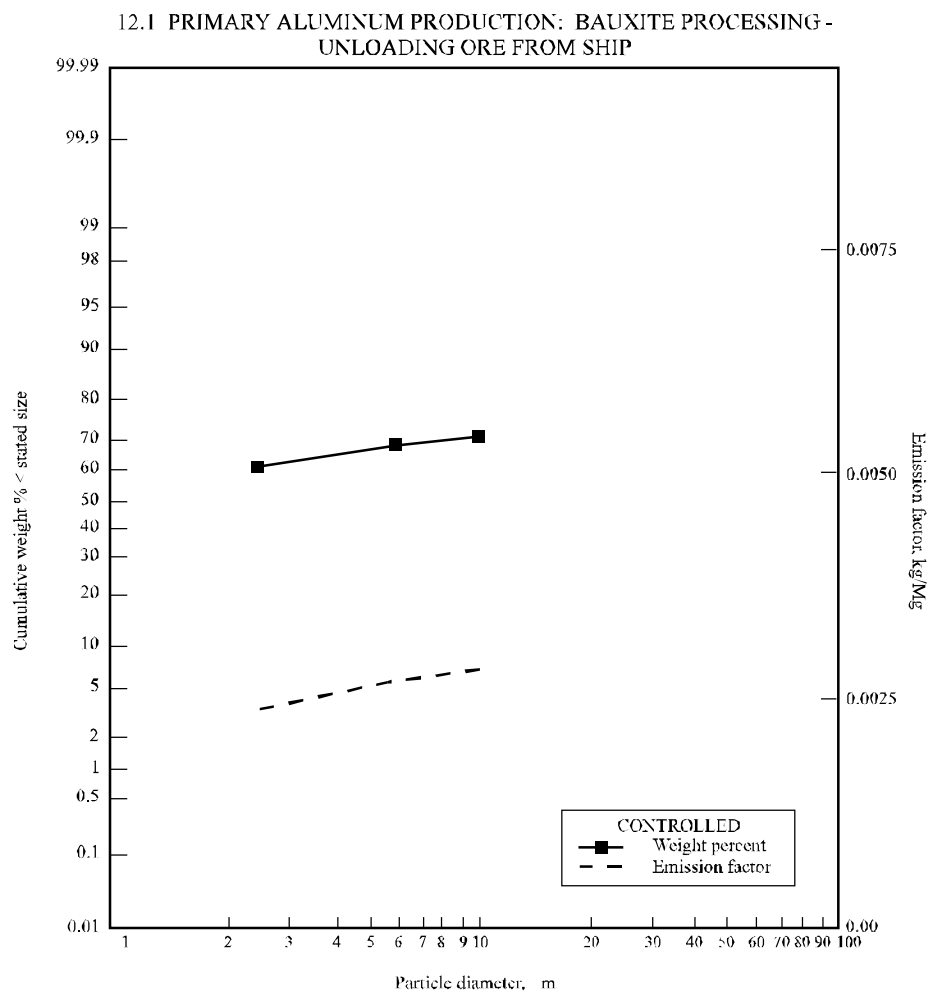
**SAMPLING TECHNIQUE:** Andersen Impactor

EMISSION FACTOR RATING: E

REFERENCE:

*Emission Test Report, Reynolds Metals Company, Corpus Christi, TX, EMB-80-MET-9,  
U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.*

## 12.1 PRIMARY ALUMINUM PRODUCTION: BAUXITE PROCESSING - UNLOADING ORE FROM SHIP



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg     |
|----------------------------------------|--------------------------------|----------------------------|
|                                        | Wet<br>scrubber controlled     | Wet<br>scrubber controlled |
| 2.5                                    | 60.5                           | 0.0024                     |
| 6.0                                    | 67.0                           | 0.0027                     |
| 10.0                                   | 70.0                           | 0.0028                     |

## 12.1 PRIMARY ALUMINUM PRODUCTION: BAUXITE PROCESSING - UNLOADING ORE FROM SHIP

NUMBER OF TESTS: 1, after venturi scrubber control

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 60.5 | 67.0 | 70.0 |
|----------------|------|------|------|

Standard deviation (Cum. %):

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 0.004 kg particulate/Mg bauxite ore unloaded after scrubber control. Factor calculated from emission and process data contained in reference.

**SOURCE OPERATION:** The facility purifies bauxite to alumina. Ship unloading facility normally operates at 1500-1700 tons/hr, using a self-contained extendable boom conveyor that interfaces with a dockside conveyor belt through an accordion chute. The emissions originate at the point of transfer of the bauxite ore from the ship's boom conveyor as the ore drops through the chute onto the dockside conveyor. Emissions are ducted to a dry cyclone, and then to a Venturi scrubber. Design pressure drop across scrubber is 15 inches, and efficiency during test was 98.4%.

**SAMPLING TECHNIQUE:** Andersen Impactor

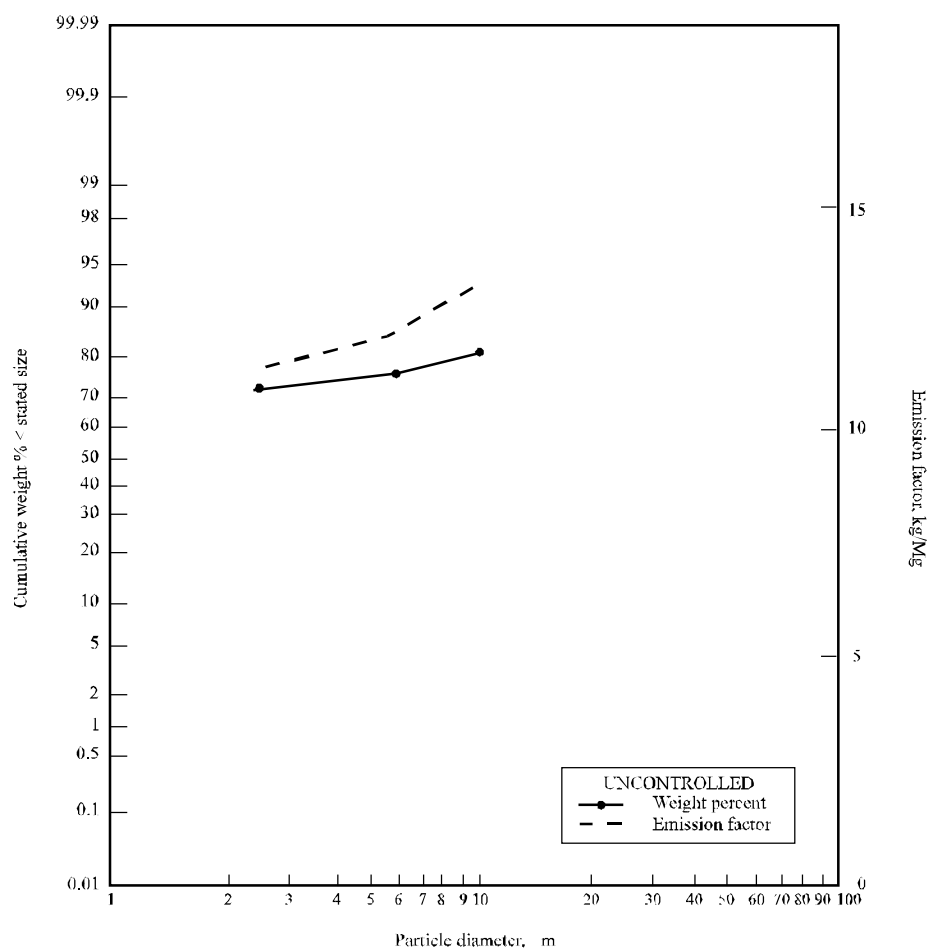
EMISSION FACTOR RATING: E

REFERENCE:

*Emission Test Report, Reynolds Metals Company, Corpus Christi, TX, EMB-80-MET-9,  
U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.*

## 12.13 STEEL FOUNDRIES: CASTINGS SHAKEOUT

12.13 STEEL FOUNDRIES: CASTINGS SHAKEOUT



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 72.2                           | 11.6                   |
| 6.0                                    | 76.3                           | 12.2                   |
| 10.0                                   | 82.0                           | 13.1                   |

## 12.13 STEEL FOUNDRIES: CASTINGS SHAKEOUT

NUMBER OF TESTS: 2, conducted at castings shakeout exhaust hood before controls

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 72.2 | 76.3 | 82.0 |
|----------------|------|------|------|

|                              |     |     |     |
|------------------------------|-----|-----|-----|
| Standard deviation (Cum. %): | 5.4 | 6.9 | 4.3 |
|------------------------------|-----|-----|-----|

|               |      |      |      |
|---------------|------|------|------|
| Min (Cum. %): | 66.7 | 69.5 | 77.7 |
|---------------|------|------|------|

|               |      |      |      |
|---------------|------|------|------|
| Max (Cum. %): | 77.6 | 83.1 | 86.3 |
|---------------|------|------|------|

TOTAL PARTICULATE EMISSION FACTOR: 16 kg particulate/Mg metal melted, without controls. Although no nonfurnace emission factors are available for steel foundries, emissions are presumed to be similar to those in iron foundries. Nonfurnace emission factors for iron foundries are presented in AP-42, Section 12.13.

SOURCE OPERATION: Source is a steel foundry casting steel pipe. Pipe molds are broken up at the castings shakeout operation. No additional information is available.

**SAMPLING TECHNIQUE:** Brink Model BMS-11 Impactor

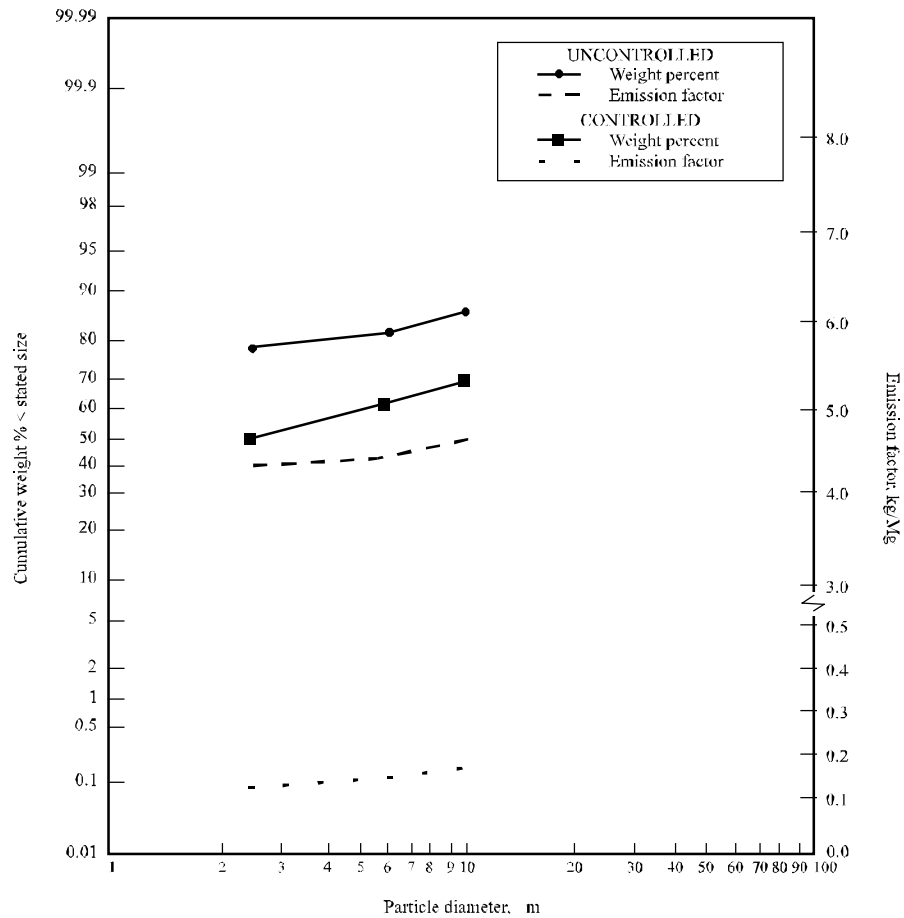
EMISSION FACTOR RATING: D

REFERENCE:

Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 117, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 12.13 STEEL FOUNDRIES: OPEN HEARTH EXHAUST

12.13 STEEL FOUNDRIES: OPEN HEARTH EXHAUST



| Aerodynamic particle diameter, $\mu\text{m}$ | Cumulative wt. % < stated size |      | Emission factor, kg/Mg |      |
|----------------------------------------------|--------------------------------|------|------------------------|------|
|                                              | Uncontrolled                   | ESP  | Uncontrolled           | ESP  |
| 2.5                                          | 79.6                           | 49.3 | 4.4                    | 0.14 |
| 6.0                                          | 82.8                           | 58.6 | 4.5                    | 0.16 |
| 10.0                                         | 85.4                           | 66.8 | 4.7                    | 0.18 |

### 12.13 STEEL FOUNDRIES: OPEN HEARTH EXHAUST

NUMBER OF TESTS: (a) 1, conducted before control  
(b) 1, conducted after ESP control

|                                                                  |      |      |      |
|------------------------------------------------------------------|------|------|------|
| STATISTICS: (a) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                                   | 79.6 | 82.8 | 85.4 |
| Standard Deviation (Cum. %):                                     |      |      |      |
| Min (Cum. %):                                                    |      |      |      |
| Max (Cum. %):                                                    |      |      |      |

|                                                      |      |      |      |
|------------------------------------------------------|------|------|------|
| (b) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                       | 49.3 | 58.6 | 66.8 |
| Standard Deviation (Cum. %):                         |      |      |      |
| Min (Cum. %):                                        |      |      |      |
| Max (Cum. %):                                        |      |      |      |

TOTAL PARTICULATE EMISSION FACTOR: 5.5 kg particulate/Mg metal processed, before control. Emission factor from AP-42, Section 12.13. AP-42 gives an ESP control efficiency of 95 to 98.5%. At 95% efficiency, factor after ESP control is 0.275 kg particulate/Mg metal processed.

SOURCE OPERATION: Source produces steel castings by melting, alloying, and casting pig iron and steel scrap. During these tests, source was operating at 100% of rated capacity of 8260 kg metal scrap feed/hour, fuel oil-fired, and 8-hour heats.

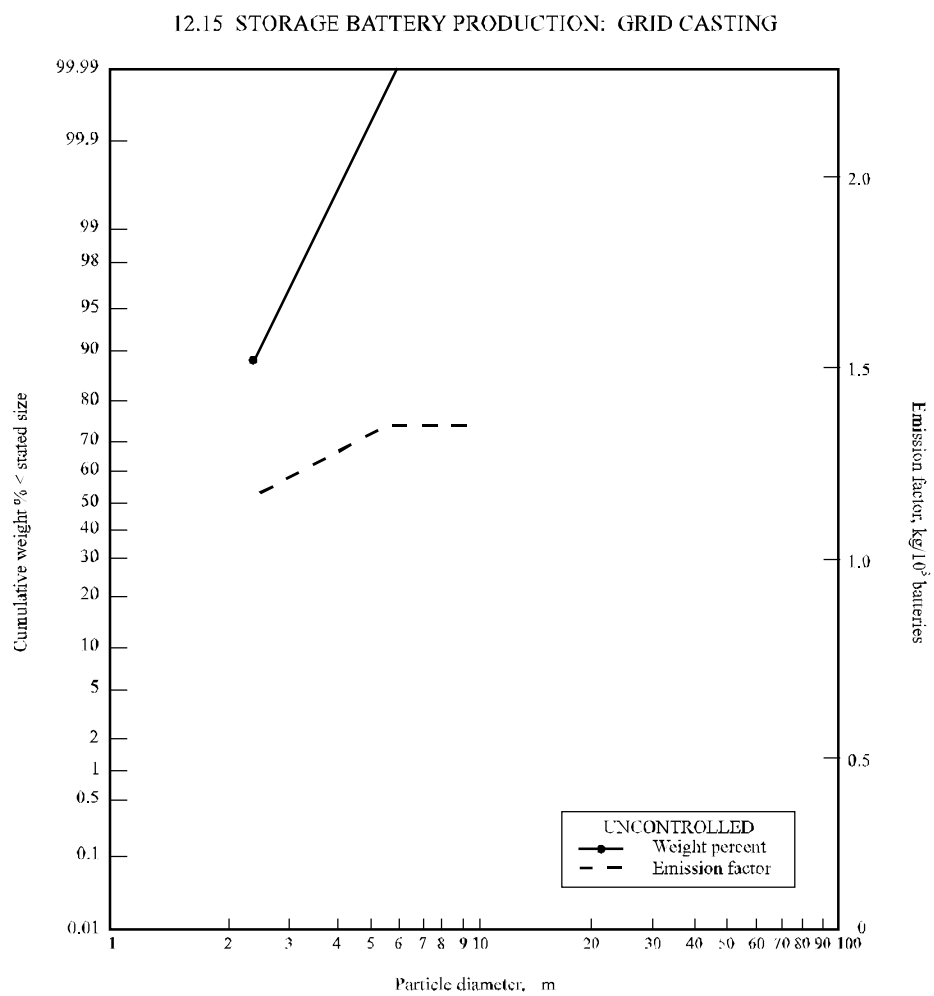
SAMPLING TECHNIQUE: (a) Joy train with 3 cyclones  
(b) SASS train with cyclones

EMISSION FACTOR RATING: E

#### REFERENCE:

Emission test data from Environmental Assessment Data Systems, Fine Particle Emission Information System, Series Report No. 233, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1983.

## 12.15 STORAGE BATTERY PRODUCTION: GRID CASTING



| Aerodynamic<br>particle<br>diameter, $\mu\text{m}$ | Cumulative wt. % < stated size | Emission factor<br>( $\text{kg}/10^3 \text{ batteries}$ ) |
|----------------------------------------------------|--------------------------------|-----------------------------------------------------------|
|                                                    | Uncontrolled                   | Uncontrolled                                              |
| 2.5                                                | 87.8                           | 1.25                                                      |
| 6.0                                                | 100                            | 1.42                                                      |
| 10.0                                               | 100                            | 1.42                                                      |

## 12.15 STORAGE BATTERY PRODUCTION: GRID CASTING

NUMBER OF TESTS: 3, conducted before control

STATISTICS: Aerodynamic particle diameter (µm):      2.5      6.0      10.0

|                              |      |     |     |
|------------------------------|------|-----|-----|
| Mean (Cum. %):               | 87.8 | 100 | 100 |
| Standard deviation (Cum. %): | 10.3 | —   | —   |
| Min (Cum. %):                | 75.4 | 100 | 100 |
| Max (Cum. %):                | 100  | 100 | 100 |

Impactor cut points were so small that most data points had to be extrapolated.

TOTAL PARTICULATE EMISSION FACTOR: 1.42 kg particulate/10<sup>3</sup> batteries produced, without controls. Factor from AP-42, Section 12.15.

SOURCE OPERATION: During tests, plant was operated at 39% of design process rate. Six of nine of the grid casting machines were operating during the test. Typically, 26,500 to 30,000 pounds of lead per 24-hour day are charged to the grid casting operation.

SAMPLING TECHNIQUE: Brink Impactor

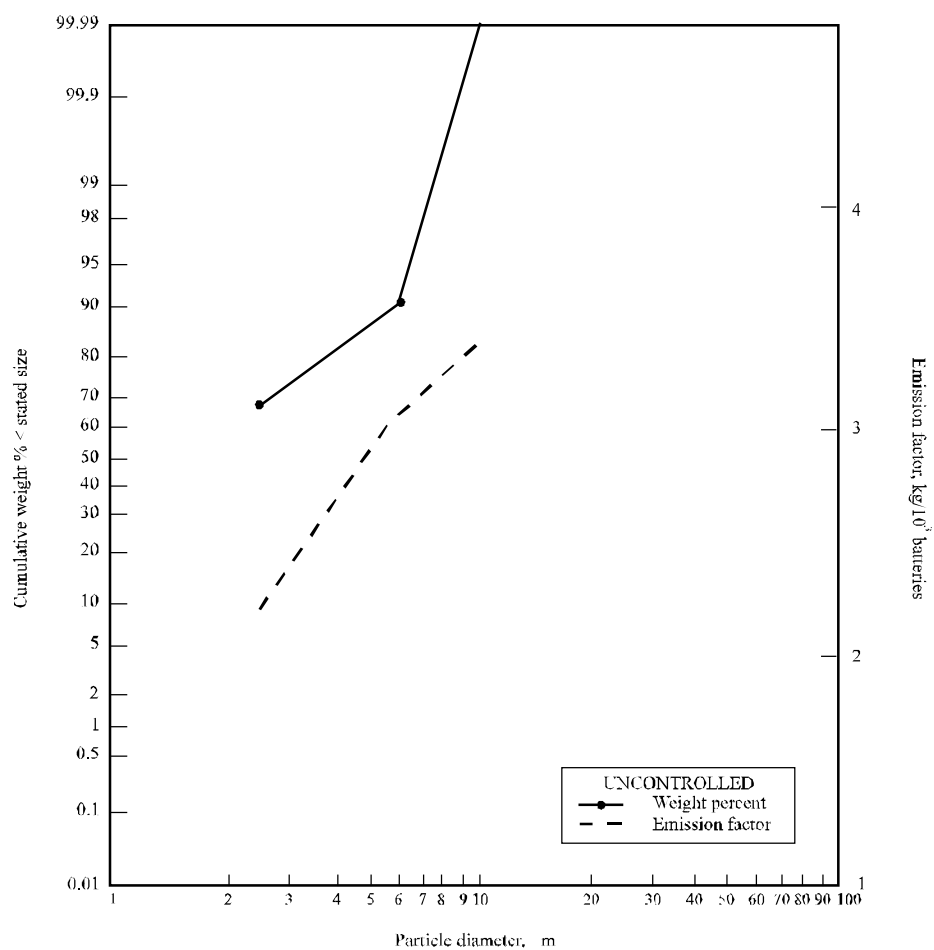
EMISSION FACTOR RATING: E

REFERENCE:

*Air Pollution Emission Test, Globe Union, Inc., Canby, OR, EMB-76-BAT-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1976.*

## 12.15 STORAGE BATTERY PRODUCTION: GRID CASTING AND PASTE MIXING

12.15 STORAGE BATTERY PRODUCTION: GRID CASTING AND PASTE MIXING



| Aerodynamic<br>particle<br>diameter, $\mu\text{m}$ | Cumulative wt. % < stated size | Emission factor<br>( $\text{kg}/10^3$ batteries) |
|----------------------------------------------------|--------------------------------|--------------------------------------------------|
|                                                    | Uncontrolled                   | Uncontrolled                                     |
| 2.5                                                | 65.1                           | 2.20                                             |
| 6.0                                                | 90.4                           | 3.05                                             |
| 10.0                                               | 100                            | 3.38                                             |

## 12.15 STORAGE BATTERY PRODUCTION: GRID CASTING AND PASTE MIXING

NUMBER OF TESTS: 3, conducted before control

|                                                              |      |      |      |
|--------------------------------------------------------------|------|------|------|
| STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                               | 65.1 | 90.4 | 100  |
| Standard deviation (Cum. %):                                 | 24.8 | 7.4  | —    |
| Min (Cum. %):                                                | 44.1 | 81.9 | 100  |
| Max (Cum. %):                                                | 100  | 100  | 100  |

TOTAL PARTICULATE EMISSION FACTOR: 3.38 kg particulate/ $10^3$  batteries, without controls. Factor is from AP-42, Section 12.15, and is the sum of the individual factors for grid casting and paste mixing.

SOURCE OPERATION: During tests, plant was operated at 39% of the design process rate. Grid casting operation consists of 4 machines. Each 2,000 lb/hr paste mixer is controlled for product recovery by a separate low-energy, impingement-type wet collector designed for an 8 - 10 inch w. g. pressure drop at 2,000 acfm.

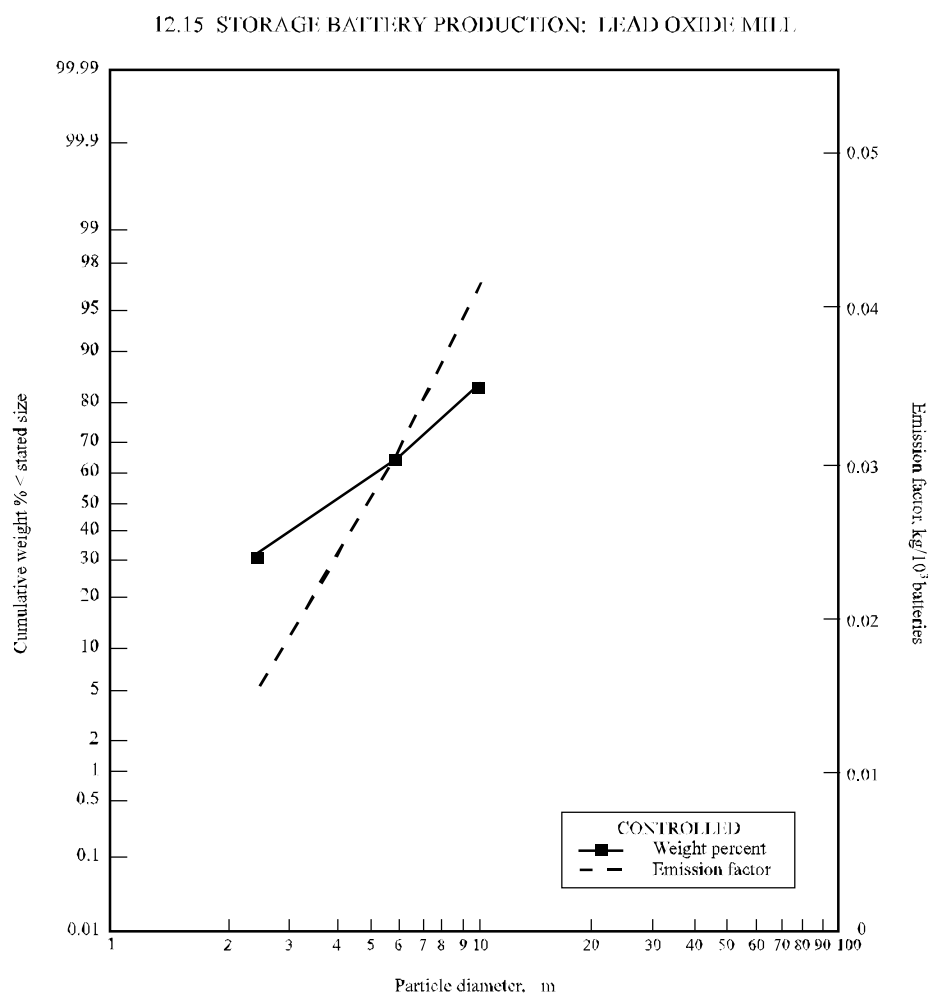
SAMPLING TECHNIQUE: Brink Impactor

EMISSION FACTOR RATING: E

REFERENCE:

*Air Pollution Emission Test, Globe Union, Inc., Canby, OR, EMB-76-BAT-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1976.*

## 12.15 STORAGE BATTERY PRODUCTION: LEAD OXIDE MILL



| Aerodynamic<br>particle<br>diameter, $\mu\text{m}$ | Cumulative wt. % < stated size | Emission factor<br>( $\text{kg}/10^3 \text{ batteries}$ ) |
|----------------------------------------------------|--------------------------------|-----------------------------------------------------------|
|                                                    | After fabric filter            | After fabric filter                                       |
| 2.5                                                | 32.8                           | 0.016                                                     |
| 6.0                                                | 64.7                           | 0.032                                                     |
| 10.0                                               | 83.8                           | 0.042                                                     |

## 12.15 STORAGE BATTERY PRODUCTION: LEAD OXIDE MILL

NUMBER OF TESTS: 3, conducted after fabric filter

|                                                              |      |      |      |
|--------------------------------------------------------------|------|------|------|
| STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                               | 32.8 | 64.7 | 83.8 |
| Standard deviation (Cum. %):                                 | 14.1 | 29.8 | 19.5 |
| Min (Cum. %):                                                | 17.8 | 38.2 | 61.6 |
| Max (Cum. %):                                                | 45.9 | 97.0 | 100  |

TOTAL PARTICULATE EMISSION FACTOR: 0.05 kg particulate/ $10^3$  batteries, after typical fabric filter control (oil-to-cloth ratio of 4:1). Emissions from a well-controlled facility (fabric filters with an average air-to-cloth ratio of 3:1) were 0.025 kg/ $10^3$  batteries (Table 12.15-1 of AP-42).

SOURCE OPERATION: Plant receives metallic lead and manufactures lead oxide by the ball mill process. There are 2 lead oxide production lines, each with a typical feed rate of 15 100-pound lead pigs per hour. Product is collected with a cyclone and baghouses with 4:1 air-to-cloth ratios.

SAMPLING TECHNIQUE: Andersen Impactor

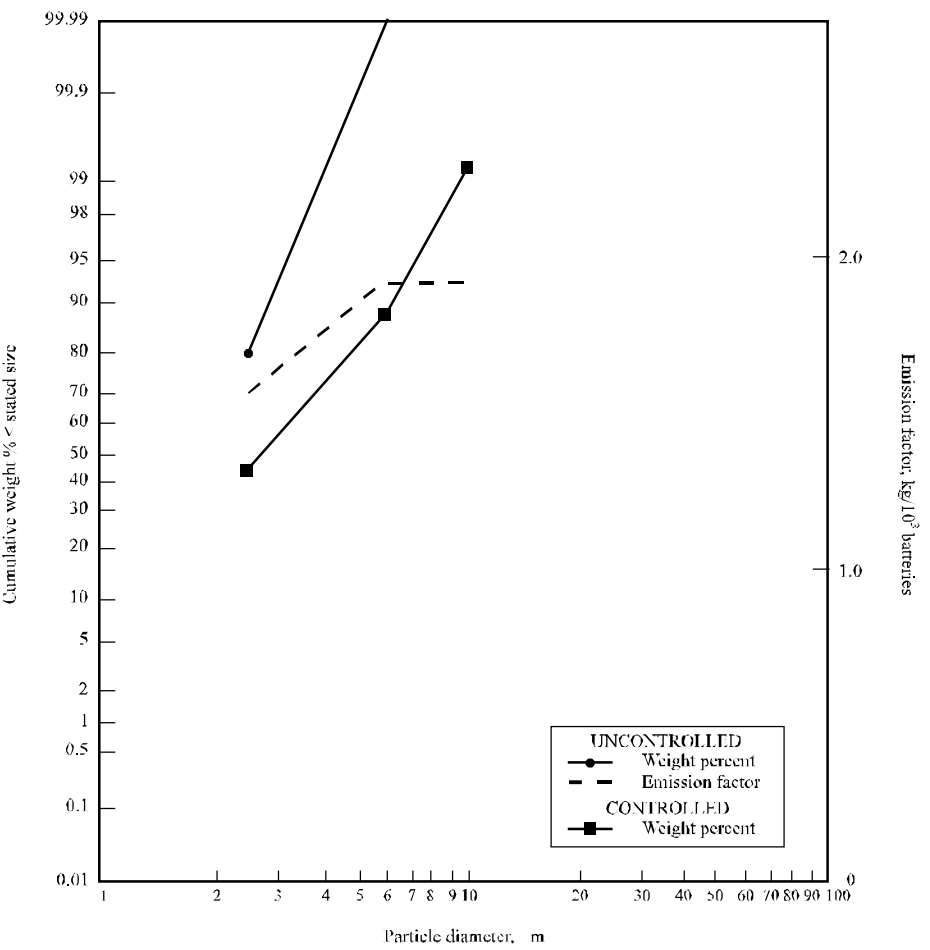
EMISSION FACTOR RATING: E

REFERENCE:

*Air Pollution Emission Test, ESB Canada Limited, Mississauga, Ontario, EMB-76-BAT-3,*  
U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1976.

12.15 STORAGE BATTERY PRODUCTION: PASTE MIXING AND LEAD OXIDE CHARGING

12.15 STORAGE BATTERY PRODUCTION: PASTE MIXING AND LEAD OXIDE CHARGING



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size |               | Emission factor<br>(kg/10 <sup>3</sup> batteries) |
|----------------------------------------|--------------------------------|---------------|---------------------------------------------------|
|                                        | Uncontrolled                   | Fabric filter | Uncontrolled                                      |
| 2.5                                    | 80                             | 47            | 1.58                                              |
| 6.0                                    | 100                            | 87            | 1.96                                              |
| 10.0                                   | 100                            | 99            | 1.96                                              |

## 12.15 STORAGE BATTERY PRODUCTION: PASTE MIXING AND LEAD OXIDE CHARGING

NUMBER OF TESTS: (a) 1, conducted before control  
(b) 4, conducted after fabric filter control

|                                                                  |      |      |      |
|------------------------------------------------------------------|------|------|------|
| STATISTICS: (a) Aerodynamic particle diameter ( $\mu\text{m}$ ): | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                                   | 80   | 100  | 100  |
| Standard deviation (Cum. %):                                     |      |      |      |
| Min (Cum. %):                                                    |      |      |      |
| Max (Cum. %):                                                    |      |      |      |
| (b) Aerodynamic particle diameter ( $\mu\text{m}$ ):             | 2.5  | 6.0  | 10.0 |
| Mean (Cum. %):                                                   | 47   | 87   | 99   |
| Standard deviation (Cum. %):                                     | 33.4 | 14.5 | 0.9  |
| Min (Cum. %):                                                    | 36   | 65   | 98   |
| Max (Cum. %):                                                    | 100  | 100  | 100  |

Impactor cut points were so small that many data points had to be extrapolated. Reliability of particle size distributions based on a single test is questionable.

TOTAL PARTICULATE EMISSION FACTOR: 1.96 kg. particulate/ $10^3$  batteries, without controls.  
Factor from AP-42, Section 12.15.

SOURCE OPERATION: During test, plant was operated at 39% of the design process rate. Plant has normal production rate of 2,400 batteries per day and maximum capacity of 4,000 batteries per day. Typical amount of lead oxide charged to the mixer is 29,850 lb/8-hour shift. Plant produces wet batteries, except formation is carried out at another plant.

SAMPLING TECHNIQUE: (a) Brink Impactor  
(b) Andersen Impactor

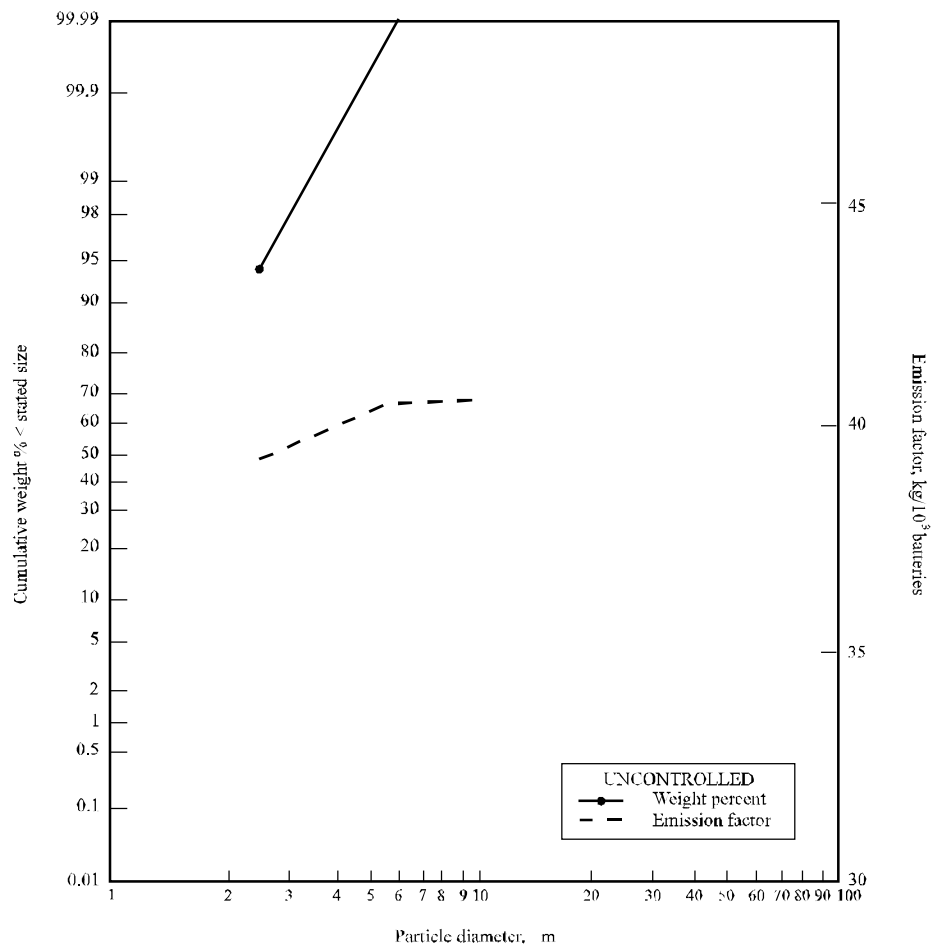
EMISSION FACTOR RATING: E

REFERENCE:

*Air Pollution Emission Test, Globe Union, Inc., Canby, OR, EMB-76-BAT-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1976.*

12.15 STORAGE BATTERY PRODUCTION: THREE-PROCESS OPERATION

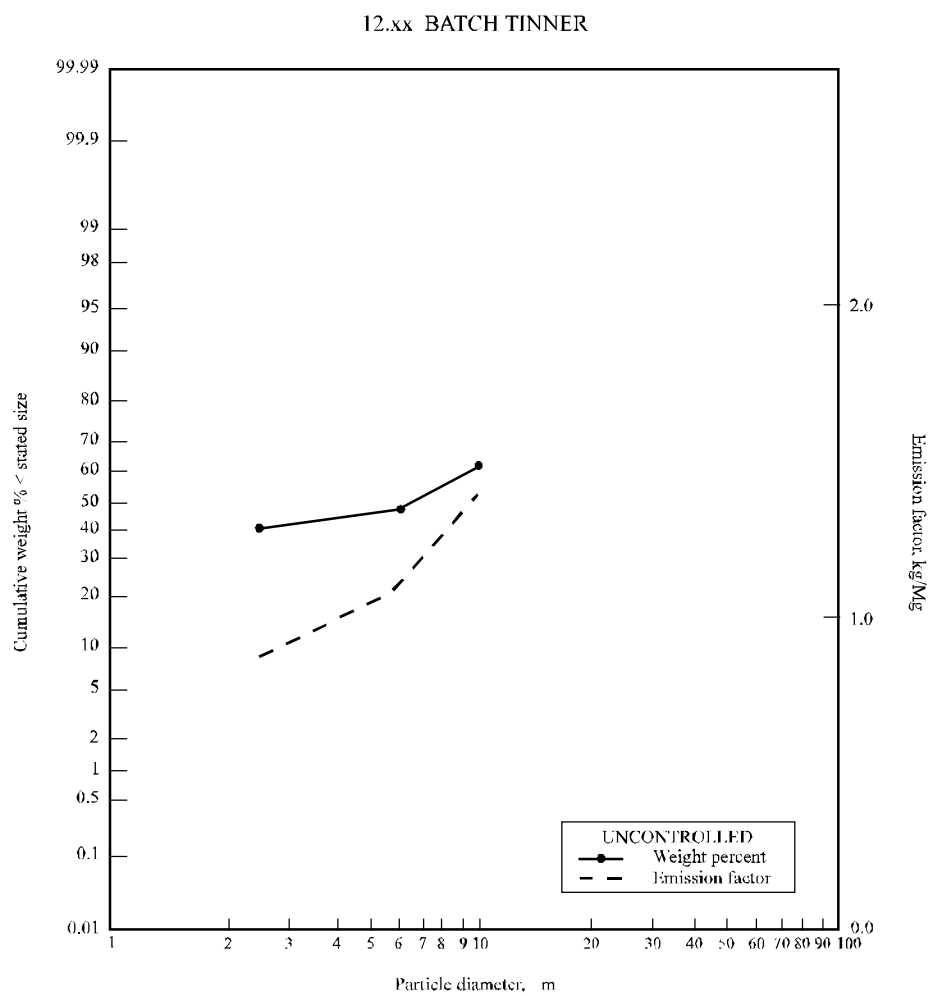
12.15 STORAGE BATTERY PRODUCTION: THREE-PROCESS OPERATION



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor<br>(kg/10 <sup>3</sup> batteries) |
|----------------------------------------|--------------------------------|---------------------------------------------------|
|                                        | Uncontrolled                   | Uncontrolled                                      |
| 2.5                                    | 93.4                           | 39.3                                              |
| 6.0                                    | 100                            | 42                                                |
| 10.0                                   | 100                            | 42                                                |



## 12.xx BATCH TINNER



| Aerodynamic<br>particle<br>diameter, m | Cumulative wt. % < stated size | Emission factor, kg/Mg |
|----------------------------------------|--------------------------------|------------------------|
|                                        | Uncontrolled                   | Uncontrolled           |
| 2.5                                    | 37.2                           | 0.93                   |
| 6.0                                    | 45.9                           | 1.15                   |
| 10.0                                   | 55.9                           | 1.40                   |

## 12.xx BATCH TINNER

NUMBER OF TESTS: 2, conducted before controls

STATISTICS: Aerodynamic particle diameter ( $\mu\text{m}$ ): 2.5 6.0 10.0

|                |      |      |      |
|----------------|------|------|------|
| Mean (Cum. %): | 37.2 | 45.9 | 55.9 |
|----------------|------|------|------|

Standard deviation (Cum. %):

Min (Cum. %):

Max (Cum. %):

TOTAL PARTICULATE EMISSION FACTOR: 2.5 kg particulate/Mg tin consumed, without controls. Factor from AP-42, Section 12.14.

SOURCE OPERATION: Source is a batch operation applying a lead/tin coating to tubing. No further source operating information is available.

**SAMPLING TECHNIQUE:** Andersen Mark III Impactor

EMISSION FACTOR RATING: D

REFERENCE:

Confidential test data, PEI Associates, Inc., Golden, CO, January 1985.