

**EPA-450/3-76-018-d**

**April 1977**

**DETERMINING  
INPUT VARIABLES  
FOR CALCULATION  
OF IMPACT OF NEW  
SOURCE PERFORMANCE  
STANDARDS: WORKSHEETS  
FOR MINERAL PRODUCTS  
INDUSTRIES**



**U.S. ENVIRONMENTAL PROTECTION AGENCY  
Office of Air and Waste Management  
Office of Air Quality Planning and Standards  
Research Triangle Park, North Carolina 27711**

**DETERMINING INPUT VARIABLES  
FOR CALCULATION OF IMPACT OF NEW  
SOURCE PERFORMANCE STANDARDS:  
WORKSHEETS FOR MINERAL  
PRODUCTS INDUSTRIES**

by

The Research Corporation of New England  
129 Silas Deane Highway  
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U.S. ENVIRONMENTAL PROTECTION AGENCY  
Office of Air and Waste Management  
Office of Air Quality Planning and Standards  
Research Triangle Park, North Carolina 27711

April 1977

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Publication No. EPA-450/3-76-018-d

## FOREWORD

During 1974, two studies were initiated that ultimately resulted in the establishment of priorities for developing and promulgating New Source Performance Standards (NSPS). The procedures used to determine these priorities produced a great deal of information that is believed to be useful in the industries involved and, accordingly, is being published in this series of reports (EPA-450/3-76-017, EPA-450/3-76-018, EPA-450/3-76-019, and EPA-450/3-76-020). This information is organized as follows:

EPA-450/3-76-017 discusses (1) the mathematical model (Model IV) used to determine NSPS impacts over a 10-year period; (2) the methods used to attain input variables; and (3) the summary tables which are the heart of this study. Included in the summary tables are data related to (1) emission, growth, and replacement rates; (2) present and future production and capacity; (3) nationwide emissions; and (4) NSPS impact. These tables include information on 13 pollutants and nearly 200 stationary source categories.

EPA-450/3-3-76-018-a, -b, -c, -d, -e, and -f are the calculation sheets, showing how the input variables reported in EPA-450/3-76-017 were derived. All information sources, assumptions, and calculations are documented and explained. The appropriate worksheets are arranged alphabetically in the following volumes:

- 018-a - Stationary Combustion Sources
- 018-b - Chemical Processing Industries
- 018-c - Food and Agricultural Industries
- 018-d - Mineral Products Industries
- 018-e - Metallurgical Industries
- 018-f - Miscellaneous Sources (Evaporation Losses, Petroleum Industry, Wood Products Industry, and Assembly Plants)

The 018-a -f series is of interest only to those concerned with the detailed calculations used to determine the Model IV input variables.

EPA-450/3-76-019-a provides additional results and information produced during the priority study. Its major purpose is to describe the computer program used to rank all the Model IV input and output variables by pollutant (these rankings are reported in 019-b and -c). In addition, it contains (1) summaries of the control systems considered "best" for each source, (2) equipment retirement ages, and (3) emission trends for each source category.

EPA-450/3-76-019-b and c present the computer-generated ranked data for each pollutant. Ranking is from highest to lowest for each of the 21 variables, e.g., A (nationwide capacity) and  $E_u$  (uncontrolled emission rate). Volume 019-b contains ranked data for particulate, nitrogen oxide ( $NO_x$ ), and sulfur oxide ( $SO_x$ ) sources. In Volume 019-c, the remaining pollutant sources are ranked: hydrocarbons, carbon monoxide (CO), fluorides, hazardous material, acid mist, lead, ammonia, sulfides, chlorine, and trace metals.

EPA-450/3-76-020, the final document in this series, takes the objective impact values from EPA-450/3-76-017, adds subjective judgements, and uses these combined criteria to produce a priority list for NSPS development. The report then calculates nationwide emission trends over the next 15 years for each criteria pollutant (particulate,  $SO_x$ ,  $NO_x$ , hydrocarbons, and CO) based on a series of scenarios (e.g., no NSPS, 20 NSPS per year, etc.)

In summary, documents EPA-450/3-76-017 and 020 present the results of this study. Each stands alone, but they also complement each other, with 020 building on the results of 017. The remaining documents (018-a -f and 019-a -c) present additional and/or more detailed information derived from the impact and priority studies.

DETERMINATION OF INPUT VARIABLES  
FOR  
THE MINERAL PRODUCTS INDUSTRY

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

K:

Ref 044 (Technical Report No 6)  
 p 13

Identifies a typical asphalt batching plant  
 of 150 T/hr capacity with an annual  
 production of 112,500 T/yr. This they  
 explain is based on 50% on-stream time.

An estimate of capacity utilization (K) is made  
 based on an assumed operating schedule which  
 is believed typical.  $\frac{8 \text{ hr}}{\text{d}} \times \frac{5 \text{ d}}{\text{wk}} \times \frac{40 \text{ wk}}{\text{yr}} = 1600 \frac{\text{hr}}{\text{yr}}$

$$150 \frac{\text{T/yr}}{\text{hr}} \times 1600 \frac{\text{hr}}{\text{yr}} = 240,000 \text{ T/yr} \text{ capacity}$$

$$K = \frac{112,500}{240,000} = .469 \text{ or } K \approx .47$$

This implies that if we consider the 50% on-stream time  
 figure mention above; During an operating period  
 of  $8 \frac{\text{hr}}{\text{d}}, 5 \frac{\text{d}}{\text{wk}}, 40 \frac{\text{wk}}{\text{yr}}$  the process is operating  
 at peak capacity (design) however it is only  
 in production  $\approx 50\%$  of the time.

$$\therefore (K = .47)$$

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Source Asphalt Batching

$P_c$  : Ref 044 p 13

a 10% annual growth in asphalt production has occurred in the past several years and is expected to continue through the near future <sup>1 compund</sup>

however, the reference also states that in 1968 there are 4800 plants with 200 new plants expected to be constructed each year.

$$\text{Plants in 1975} = 4800 + 7(200)$$

$$\text{Plants}_{75} = 6200$$

This growth represents a simple rate of:

$$\frac{200}{6200} = .032 \text{ simple}$$

based on the assumption that the average new plant capacity is nearly the same as the existing plants

Ref 046 p 325 states that existing installations in Calif are on the order 100-150 T/hr whereas new sources may be on the order of 150-250 T/hr

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Computation Sheet For Industrial Factors

Calculations Done By 2). Marrone Date 11-21-74

Source Asphalt Batching

$P_c$  : cont'd

Assuming new plant size as 200 T/hr and existing plants at 150 T/hr then this would imply a simple growth rate of  $j$

$$\frac{200 \text{ plants} \times 200 \text{ T/hr}}{6200 \text{ plants} \times 150 \text{ T/hr}} = \frac{40 \times 10^3 \text{ T/hr}}{930 \times 10^3 \text{ T/hr}} = .043 \text{ simple}$$

We see that the predicted growth of 10% is better than twice the calculated values based on specified plant additions

We assume that a growth rate of 5% simple to be representative of this industry for the period 1975-1985.

$P_c = .05 \text{ simple}$

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Computation Sheet For Industrial Factors

Calculations Done By 2). Marrone Date 11-21-74

Source Asphalt Batching

A : Using the 6200 plants in 1975 and the  
 150 T/hr , 1600  $\frac{\text{hr}}{\text{yr}}$  operating mode for a typical  
 asphalt batching plant (at capacity) then we  
 may calculate A (1975 Production Capacity)

$$A = \underline{6200 \text{ plants}} \times \underline{150 \frac{\text{T/hr}}{\text{plant}}} \times \underline{1600 \frac{\text{hr}}{\text{yr}}}$$

$$A = 1480 \times 10^6 \text{ T/yr} \quad \text{asphalt mix produced}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Massone Date 11-21-74

Source Asphalt Batching

$P_B$  :

Ref 044 pg 13 Tech. Report 6

50 obsolete plants will be replaced  
 annually

The fifty plants that are replaced are assumed to be replaced with a total capacity equal to the obsolete capacity. This avoids the need to consider that the new plants replacing the obsolete plants will have a capacity greater than the existing.

$$P_{B75} = \frac{50}{6200} = .00806$$

$P_B = .008$  simple

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

The asphalt batching process involves the physical mixing of aggregate material (stone) with asphalt cement. Ref 177 pg 925 indicates that typical asphalt concrete is composed of 95% aggregate and 5% asphalt cement.

Ref 046 pg 326 describes the sources of particulate emissions

rotary drier  
hot aggregate bucket elevator  
vibrating screens  
hot aggregate bins  
weigh hopper  
mixer

Ref 044 pg 9 states that NSPS for particulate, will limit <sup>total</sup> emissions from the above locations.

Ref 043 pg 121

SO<sub>2</sub> emissions are attributable to burning high sulfur fuel oil

HC emissions are identified with the loading and mixing of asphalt cement in the final mixer.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-21-74  
 Source Asphalt Batching

## Particulates

$E_u$  : The majority of emissions for asphalt batching plants are attributable to the rotary drier

Ref 075 Table 8.1-1

$$E_{uncontrolled} = 45 \text{ lb/TON asphalt}$$

$$E_{precleaner} = 15 \text{ lb/TON asphalt}$$

This source states that most plants have at least a precleaner ( $\approx 67\% \text{ eff}$ )

These emission is associated with the dryer and all secondary particulate sources. Since it is most common for the secondary sources to be vented and controlled along with the dryer exhaust then the 15 lb/ton factor is representative & typical asphalt plant employing a precleaning system.

Ref 046 p 329 states that the usual primary collection device is a cyclone.

If the device is "dry" then the material captured may be added to the dryer hot aggregate and serve as fines.

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 11-21-74

Source Asphalt Batching

### Particulate

$E_u$  : cont'd

We assume ~~the~~ the particulate emissions after precleaning to be the "uncontrolled" level for this industry since employment of some kind of device is S.O.P.

$$\therefore E_u = 15 \text{ lb/TON}$$

asphalt  
concrete  
produced

$E_N$  :

Wet scrubbers and fabric filters have both been mentioned (044, 046, 049, 043, 092, 177) as suitable control devices on asphalt concrete plants.

A control system for new plants would consist of a precleaner and one of the above as a secondary collector. Vents from the weigh hoppers, storage hoppers, mixer, elevator, and screens would be ducted along with the dryer exhaust into the same control system.

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 11-21-74  
 Source Asphalt Batching

Particulate cont'd

$E_N$  :

Ref 075 Table 8.1-1 gives the overall efficiency attained by using various control systems in conjunction with a precleaner.

	lb/ton	EFF*
Multiple Centrifugal Scrubber	.3	99.3%
Baffle Spray Tower	.3	99.3%
Orifice-Type Scrubber	.04	99.9%
Baghouse	.1	99.8%
Properly Designed / Operated Control	.005-.02	99.96-99.99%

\* based on totally uncontrolled emission of 45 lb/ton

Ref 044 pg 10

99.7% overall efficiency is necessary to meet proposed standard for asphalt concrete plants.

This is specified by a limit of .031 gr/dscr

While the new standard does specify an efficiency of 99.7% we see no reason why a level of 99.9% could not be specified in light of the above information. We assume 99.9% eff attainable for 1975-1985  $E_N = .001 \times 45 = .045$

$$\therefore E_N = .045 \text{ lb/TON}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 4-28-75

Source Asphalt Batching

### Particulate

$E_s$ : We assume a typical plant size of 150 T/hr

This capacity rate refers to output however the product is composed of 95% aggregate and 5% asphalt which are both considered in the input process weight (Ref 117)

$$\text{Therefore } PWR = 150 \frac{\text{T}}{\text{hr}} \times 2000 \frac{\text{lb}}{\text{T}} = 300,000 \text{ lb/hr} \quad (\text{pg 925})$$

$E_g$  will be determined for New and Existing plants with the condition that all new plants must have a limit at least as stringent as the NSPS value of .04 gr/dscf (Ref 271)

Ref 144 pg 10 suggests a control efficiency 99.7% to meet the then proposed limit of .031 gr/dscf

We may develop the following equivalent emission factors from promulgated & proposed standards background information

$$\boxed{① .04 \text{ gr/dscf}}$$

$$\boxed{② \frac{.04}{.031} \times .003 = .00387} \Rightarrow \approx 99.6\% \text{ eff}$$

$$\therefore 1 \times 45 \text{ lb/ton} = \boxed{.175 \text{ lb/ton}}$$

$$\boxed{③ .175 \frac{\text{lb}}{\text{ton}} \times 150 \frac{\text{ton}}{\text{hr}} = 26.25 \text{ lb/hr}}$$

Promulgated  
NSPS  
equivalent  
factors

Emission limitations are compiled for each state based on Ref 084 & 148 and the above information. pg 7 & 8 give limits in lb/hr for existing and new plants.

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Computation Sheet For Emission Factors

Calculations Done By W. Marvone Date 11-22-74

Source Asphalt Batching

Particulate

$E_S$ : contd

Determination of typical flue gas volume rate

Ref 046 pg 328 based on two tests

	<u>lb/hr Process</u>	<u>T/hr</u>	<u>SCFM (TOTAL)</u>	<u>SCFM/T/hr</u>
Test #1 (C-426)	364,000	182.	23,800	130.8
Test #2 (C-537)	346,000	173	25,765	148.9

$$\text{Avg} \approx 140 \frac{\text{scfm}}{\text{T/hr}}$$

$$\frac{\text{SCFM}}{150 \text{T/hr}} = 140 \frac{\text{SCFM}}{\text{T/hr}} \times 150 \frac{\text{T/hr}}{\text{T/hr}}$$

$$\frac{\text{SCFM}}{150 \text{T/hr}} = 21,000$$

using a density at standard conditions of .075 lb/SCF we may calculate the approximate mass flow of exhaust gas.

$$21,000 \frac{\text{SCF}}{\text{MIN}} \times 60 \frac{\text{min}}{\text{hr}} \times .075 \frac{\text{lb}}{\text{SCF}} = 94,500 \frac{\text{lb}}{\text{hr}} \text{ exhaust gases}$$

for typical  
 150 T/hr asphalt  
 batching plant

**Asphalt Batching  
E<sub>s</sub> Determination  
(Particulates)**

Based on 150 T/hr or 300,000 lb/hr  
process weight

	Allowable lb/hr	
	<u>Existing</u>	<u>New</u>
Alabama	55**	26.25*
Alaska	180+	26.25*
Arizona	55**	26.25*
Arkansas	100	26.25***
Colorado	39**	26.25*
Calif.	40**	26.25*
Conn	28.35+	26.25***
Delaware	40	26.25***
D.C.	40**	26.25*
Florida	40**	26.25*
Georgia	74.2	26.25***
Hawaii	40**	26.25*
Idaho	55	26.25*
Illinois	36**	26.25*
Indiana	55**	26.25*
Iowa	27+	26.25***
Kansas	55**	26.25*
Kentucky	55**	26.25*
Louisiana	55**	26.25*
Maine	40**	26.25*
Maryland	55**	26.25*
Mass	13.4	6.7
Michigan	28.35+	26.25***
Minn	55**	26.25*
Miss	107**	26.25*
Missouri	55**	26.25*
Montana	55**	26.25*
Nebraska	40**	26.25*
Nevada	55**	26.25*
N.Hamp	40	26.25***
N.Jersey	30	26.25*
N.Mexico	40	26.25***
N.York	59**	26.25*
N.Carolina	42	26.25***
N.Dakota	55**	26.25

# Asphalt Batching

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$E_S$  cont'd  
(Particulate)

Allowable lb/..

	Existing	New
Ohio	55**	26.25*
Oklahoma	40	26.25***
Oregon	40	26.25**
Penn	3.6	3.6
R.I.	55**	26.25*
S. Carolina	67	26.25**
S. Dakota	55**	26.25*
Tenn	51.2	26.25***
Texas	105**	26.25*
Utah	337 ++	26.25*
Vermont	40**	26.25**
Virginia	40	26.25***
Wash	40	26.25***
W. Vir	40	26.25***
Wisconsin	28.35*	26.25***
Wyoming	40**	26.25*

\* No Reg for New Source — NSPS assumed

\*\* No Reg for existing Source (Asphalt Batch)  
Process Weight Rate Curve used with  
300,000 lb/hr PWR

\*\*\*  $E_S(\text{new}) > \text{NSPS} \therefore F_{(n-1)} = \text{NSPS}$

+ based on 21,000 scfm for 150 T/hr plant

++ 85% control required on uncontrolled  
emissions

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 6-9-75

Source Asphalt Batching

Particulate

$E_s$ :

$$E_s = \frac{\sum_{i=1}^{51} E_{si}}{51}$$

Distribution of capacity, by state was not obtained however, all will have process. We assume that average of  $E_{si}$  will approximate well the typical  $E_s$ .

$$E_{s\text{new}} = \frac{\sum E_{si}}{51} = \frac{1296.25}{51} = 25.41 \text{ lb/hr}$$

$$E_{s\text{existing}} = \frac{\sum E_{si}}{51} = \frac{2876.45}{51} = 56.40 \text{ lb/hr}$$

applying the plant size for this plant weight rate (150 T/hr) we obtain;

$$E_s(\text{new}) = \frac{25.41}{150} = .169 \text{ lb/ton asphalt concrete}$$

$$E_s(\text{existing}) = \frac{56.40}{150} = .376 \text{ lb/ton asphalt concrete}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 11-22-74

Source Asphalt Batching

### Hydrocarbons

$E_u$  : As mentioned O43 pg 121 indicates the loading and mixing of asphalt cement in the mixer is the source of hydrocarbons.

Emission data for this pollutant from asphalt batching was not found in the literature. We make the assumption however, that hydrocarbon emissions may be approximated by applying factors for coating of asphalt to roofing material

Ref 075 Table 8.2-1

Using Spraying & Dipping factor of 2 lb/TON saturated felt and estimate (bottom of Table) that 65% of felt weight is asphalt

$$E = \frac{2 \text{ lb}}{\text{TON Felt Sat}} \times \frac{\text{TON Felt Sat}}{.65 \text{ TON Asphalt Used}} = \frac{3.33 \text{ lb}}{\text{TON Asphalt used}}$$

For a typical Asphalt Batching Plant of 150 T/hr. with 5% of concrete composed of asphalt cement

$$150 \frac{\text{TON}}{\text{hr}} \times .05 = 7.5 \frac{\text{T}}{\text{hr}} \text{ asphalt used}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-22-74

Source Asphalt Batching

Hydrocarbons cont'd

$E_u$  :

$$\text{Emission} = \frac{3.33 \frac{\text{lb HC}}{\text{TON Asphalt}} \times 7.5 \frac{\text{TON Asphalt}}{\text{hr}}}{150 \frac{\text{TON Asphalt concrete}}{\text{hr}}}$$

$$E_u = .167 \text{ lb/TON Asphalt concrete}$$

hydrocarbon emissions from the mixer, while vented to the primary and secondary control devices, are not expected to be controlled appreciably especially if water scrubbers and baghouses are employed.

Ref 043 pg 122 states "the hydrocarbon emission problem is a difficult one that can really only be handled by thermal incineration. However this technique is not frequently used: The primary method of control is to maintain a tight enclosure of the mixer!"

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74  
 Source Asphalt Batching

### Hydrocarbons cont'd

$E_N$ : It is our assessment that while particulates may be controlled successfully by the two-stage control system, hydrocarbon emissions are not eliminated and no feasible system has been proven.

We will assume  $E_N = 0$  for maximum impact to flag this industry as in potential need of control technology..

$$E_N = 0 \quad \text{MAX IMPACT}$$

$E_S$ : Hydrocarbon emission regulations do not apply to this type of source so  $E_S$  is assumed equal to  $E_u$

$$E_S = .167 \frac{\text{lb}}{\text{TON Asphalt Concrete}}$$

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Source Asphalt Batching

SO<sub>x</sub>  
E<sub>u</sub>:

Ref 043 pg 121 suggests that SO<sub>x</sub> emissions are attributable to combustion of high sulfur fuel oil in the drier and heaters. The two fuels normally employed are natural gas and fuel oil (No. 6). Ref 516 pg 326 reports operating temperature for drier at 250-350°F.

We do not know the % breakdown of driers using oil and those using gas. We assume for the purpose of this study a 50% split.

The sulfur content of the natural gas is considered negligible. Ref 022 Tabl 4-2 %S of Residual oil 1.5% S

Using 21,000 SCFM for 150  $\frac{\text{hr}}{\text{hr}}$  asphalt concrete plant and drier temp of 300°F we will obtain an estimate for emission of SO<sub>x</sub> from fuel oil combustion

$$Q = \omega C_p \Delta T \quad \text{assume } T_1 = 70^\circ\text{F}$$

$\omega$  = lbmoles of air

$C_p$  = 7  $\frac{\text{BTU}}{\text{lbmole } ^\circ\text{F}}$

$$\Delta T = T_2 - T_1 = 300^\circ\text{F} - 70^\circ\text{F} = 230^\circ\text{F}$$

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 11-22-74

Source Asphalt Batching

~~SO<sub>x</sub>~~ ~~E<sub>s</sub>~~ cont'd

Ref 143 sec F-147

$$\omega = 21,000 \frac{\text{SEF}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \times .075 \frac{\text{lb}}{\text{SEF}} \times \frac{1 \text{ lb mole air}}{28.96 \text{ lb}}$$

$$\omega = 3263 \frac{\text{lb mole air}}{\text{hr}}$$

$$\text{Heat requirement} = Q = 3,263 \frac{\text{lb mole}}{\text{hr}} \times \frac{7 \text{ BTU}}{\text{lb mole }^{\circ}\text{F}} \times 230^{\circ}\text{F}$$

$$Q \approx 5.25 \times 10^6 \frac{\text{BTU}}{\text{hr}}$$

Ref 101 Table 9-9

For NO 6 oil  $7.998 - 8.108 \text{ lb/gal}$

$150,700 - 152,000 \text{ BTU/gal}$

using  $8 \text{ lb/gal}$  and  $151,350 \frac{\text{BTU}}{\text{gal}}$

$$\frac{151,350}{8} = 18,919 \text{ BTU/lb}$$

Fuel rate requirement :

$$\frac{5.25 \times 10^6 \frac{\text{BTU}}{\text{hr}}}{1.8919 \times 10^4 \frac{\text{BTU}}{\text{lb}}} = 2.77 \times 10^2 \frac{\text{lb oil}}{\text{hr}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

$SO_x$  cont'd

$$E_u: \quad \therefore 277 \frac{\text{lb}}{\text{hr}} \text{ fuel oil}$$

with the assumption that all sulfur is emitted and in the form  $SO_2$  we obtain;

$$277 \frac{\text{lb oil}}{\text{hr}} \times .015 \times 2 \frac{\text{lb } SO_2}{\text{lb S}} = 8.31 \frac{\text{lb } SO_2}{\text{hr}}$$

and

$$\frac{8.31 \frac{\text{lb } SO_2}{\text{hr}}}{150 \frac{\text{Ton}}{\text{hr}}} = .055 \frac{\text{lb } SO_2}{\text{Ton}} \text{ Asphalt concrete}$$

$$\text{this also represents } \frac{8.31 \frac{\text{lb } SO_2}{\text{hr}}}{5.25 \frac{10^6 \text{ BTU}}{\text{hr}}} = 1.58 \frac{\text{lb } SO_2}{10^6 \text{ BTU}}$$

We may also calculate the emission from <sup>not gas</sup> fuel combustion

$$Q = 5.25 \times 10^6 \text{ BTU/hr}$$

$$\text{Ref 075 pg 14-1} \quad \frac{\text{BTU}}{\text{ft}^3} = 1050$$

$$\frac{\text{grain } S}{10^6 \text{ ft}^3} = 2000$$

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 Wethersfield, Connecticut 06109

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By J. Marone Date 11-22-74

Source Asphalt Batching

$\frac{SO_x}{E_u}$  cont'd

$$5.25 \times 10^6 \frac{\text{BTU}}{\text{hr}} \times \frac{\text{ft}^3}{1050 \text{ BTU}} \times \frac{2000 \text{ grains}}{10^6 \text{ ft}^3} \times \frac{1 \text{ lb S}}{7000 \text{ grains}} \times \frac{2 \text{ lb SO}_2}{1 \text{ lb S}}$$

$$E \approx .0029 \text{ lb SO}_2/\text{hr}$$

and

$$\frac{.0029 \text{ lb SO}_2/\text{hr}}{150 \text{ TON/hr}} = .000019 \text{ lb SO}_2/\text{TON Asphalt concrete}$$

$$\text{or } \frac{.0029 \text{ lb SO}_2/\text{hr}}{5.25 \times 10^6 \text{ BTU/h}} = .00055 \text{ lb SO}_2/\text{10}^6 \text{ BTU}$$

The actual emissions from this industrial source, assuming a 50% - 50% split for fuel usage is calculated by.

$$.5 \left( \frac{.000019 \text{ lb SO}_2}{\text{TON}} \right) + .5 \left( \frac{.055 \text{ lb SO}_2}{\text{TON}} \right) = \frac{\text{negligible}}{\downarrow} .0000095 + .0275 \approx .0275$$

$$E_u = .0275 \text{ lb SO}_2/\text{TON asphalt concrete}$$

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Source Asphalt Batching

~~SO<sub>x</sub>~~ /  $E_N$ :

Add-on control systems are not amenable to this type of source for SO<sub>x</sub> emissions. Fuel switching is a feasible scheme. It is assumed that .5% S may be substituted for NO.6 residual fuel oil. It is conceivable that any sulfur content may be proposed or a switch specified to natural gas only however, it is reasonable to assume that economics and fuel availability will affect these alternatives. Our assumption of .5% S fuel oil and maintenance of the 50% - 50% split in natural gas & fuel oil is considered a reasonable assumption.

$$E = .5 \times 0 \frac{\text{lb}}{\text{ton}} + .5 \times \left( \frac{.055}{2} \right)$$

$$E_N = .0138 \frac{\text{lb}}{\text{ton}}$$

Asphalt concrete

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 Source Asphalt Batching

SO<sub>x</sub>

$E_s$ :  
oil

The allowable emissions for existing and new sources will be synthesized from the attached tabular data.

The following assumptions were made.

- ① where ground level conc were stated we assumed this state to have average SO<sub>2</sub> limitation. (5 states plus 1 state existing)
- ② where no reg appears  $E_{sc} = E_u = 1.58 \text{ lb SO}_2 / 10^6 \text{ BTU}$
- ③ Louisiana and California is assumed to have an average limitation

$$E_s = \frac{\sum_{i=1}^n E_{si}}{n}$$

We make the assumption that the asphalt batching capacity is distributed equally throughout states; distribution was not found in literature.

$E_s$  (existing) :

$$6 \cdot E_u + 59.16 = \frac{9.48 + 59.16}{37+6} = \frac{68.6}{43}$$

$$E_s(\text{existing}) = 1.596 \text{ lb SO}_2 / 10^6 \text{ BTU}$$

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Source Asphalt Batching

$\text{SO}_x / E_{S,\text{oil}}$  cont'd

$E_s(\text{now})$

$$6 \times E_u + 54.71 = \frac{9.48 + 54.71}{6 + 38} = \frac{64.19}{44}$$

$$E_s(\text{now}) \approx 1.46 \text{ lb SO}_2 / 10^6 \text{ BTU}$$

Since  $E_s(\text{exist}) > E_u$  we assign  $E_s(\text{exist}) = E_u = 1.58 \text{ lb SO}_2 / 10^6 \text{ BTU}$

$$E_s(\text{now}) = 1.46 \text{ lb SO}_2 / 10^6 \text{ BTU}$$

Using  $5.25 \times 10^6 \text{ BTU/hr}$  for a 150 T/hr plant we may convert these values of  $E_s$  to  $\text{lb/TON}$

$$E_s(\text{now}) = .051 \text{ lb SO}_2 / \text{TON}$$

$E_s$ :  
Gas

The allowable emission from natural gas combustion is assumed equal to  $E_u$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 11-22-74

Source Asphalt Batching

$\cancel{SO_x}$  /  $E_s$

We calculate the allowable emissions as follows  
 with 50-50 split

$$E_s(\text{existing}) = \frac{.5 \times (.000019 \frac{\text{lb SO}_x}{\text{ton}}) + .5 (.055 \frac{\text{lb SO}_x}{\text{ton}})}{\text{Nat Gas} \quad \text{oil}} \approx .0275 \frac{\text{lb SO}_x}{\text{ton}}$$

$$E_s(\text{existing}) = .0275 \frac{\text{lb SO}_x}{\text{ton}} \quad \text{asphalt concrete}$$

$$E_s(\text{new}) = \frac{.5 \times (.000019 \frac{\text{lb SO}_x}{\text{ton}}) + .5 (.051 \frac{\text{lb SO}_x}{\text{ton}})}{\text{Nat Gas} \quad \text{oil}} \approx .0255 \frac{\text{lb SO}_x}{\text{ton}}$$

$$E_s(\text{new}) = .0255 \frac{\text{lb SO}_x}{\text{ton}} \quad \text{asphalt concrete}$$

Asphalt BatchingSO<sub>2</sub> Allowable Emissions

21 of 22

< 10 x 10<sup>6</sup> BTU/HR  
Fuel Burning equipment

	% S limitation		lb SO <sub>2</sub> /10 <sup>6</sup> BTU	
	Existing	New	Existing	New
Alabama			1.35*	1.2
Alaska			1.0	1.0
Arizona			**	**
Arkansas			**	**
Colorado			.3	.3
California			+	+
Conn.	.5	.5	.55	.55
Delaware	.3	.3	.33++	.33++
D.C.	.5	.5	.55++	.55++
Florida			0	0
Georgia	2.5	2.5	2.75++	2.75++
Hawaii	2.0	2.0	2.2++	2.2++
Idaho	.3	.3	.33++	.33++
Illinois			1.0	1.0
Indiana			1.2	1.2
Iowa			1.5	1.5
Kansas			0	0
Kentucky			2.5	2.5
Louisiana			0	0
Maine	2.5	2.5	2.75++	2.75++
Maryland	.5	.5	.55++	.55++
Mass.			1.1	1.1
Michigan			0	0
Minn.	2.0	2.0	2.2++	2.2++
Miss.			4.8	2.4
Missouri			2.0	.5
Montana			2.0	2.0
Nebraska			**	**
Nevada			2.0	2.0
N.Hampshire	1.0	1.0	1.1++	1.1++
N.Jersey			.3	.3
N.Mexico			0	0
New York			.4	.4
N.Carolina			2.3	1.6
N.Dakota			3.0	3.0
Ohio			1.9*	1.9*

	% S limitation		lb SO <sub>2</sub> /10 <sup>6</sup> BTU	
	<u>Exhibit</u>	<u>New</u>	<u>Exhibit</u>	<u>New</u>
Oklahoma			**	.3
Oregon			1.4	1.4
Conn.			2.0*	2.0*
R.I.	1.0	1.0	1.1++	1.1++
Carolina			1.6	1.6
South Dakota			3.0	3.0
Tennessee	2.0	2.0	2.2++	2.2+
Texas			**	**
Utah	1.5	1.5	1.65++	1.65++
Vermont	1.0	1.0	1.1++	1.1++
Virginia			**	**
Washington			1.5	1.5
W. Virginia	1.5	1.5	1.65++	1.65++
Wisconsin			⊖	⊖
Wyoming			⊖	⊖

Ref 148 & 084

\* Average of data appearing

\*\* ground level conc specified

+ Reg stated for county only

++ lb SO<sub>2</sub>/10<sup>6</sup>BTU calc from sulfur content using Conn as ref  $\frac{.55}{.5} = 1.1$  ratio

⊖ No reg

Δ stack ppm stated

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Computation Sheet For Industrial Factors

Calculations Done By J. Marone Date 11-26-74

Source Asphalt Roofing

K:

Capacity data for this particular industry was not presented so as to be compared with production data. Therefore a true capacity utilization factor will be estimated otherwise.

The asphalt roofing manufacturing operation is a continuous operation. We make the assumption that the value of K may be approximated by considering it to be similar in operation to Paper Processing. Ref 144 pg 48 gives an average value of K for the period 1965 - 1973 for the Paper Processing Industry of .91. Our estimate of K for Asphalt roofing plants will be  $K = .90$

$$K = .90$$

same for  
 asphalt "blowing"  
 asphalt saturator

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By V. Marone Date 11-26-74

Source Asphalt Roofing

$P_c$ :

The growth in this industry is reported in Ref 021 pg 1-1 to be about 2.75% /yr

This is based on a "simple" growth projection from shipment data during the period 1963-1971 Table 1-1

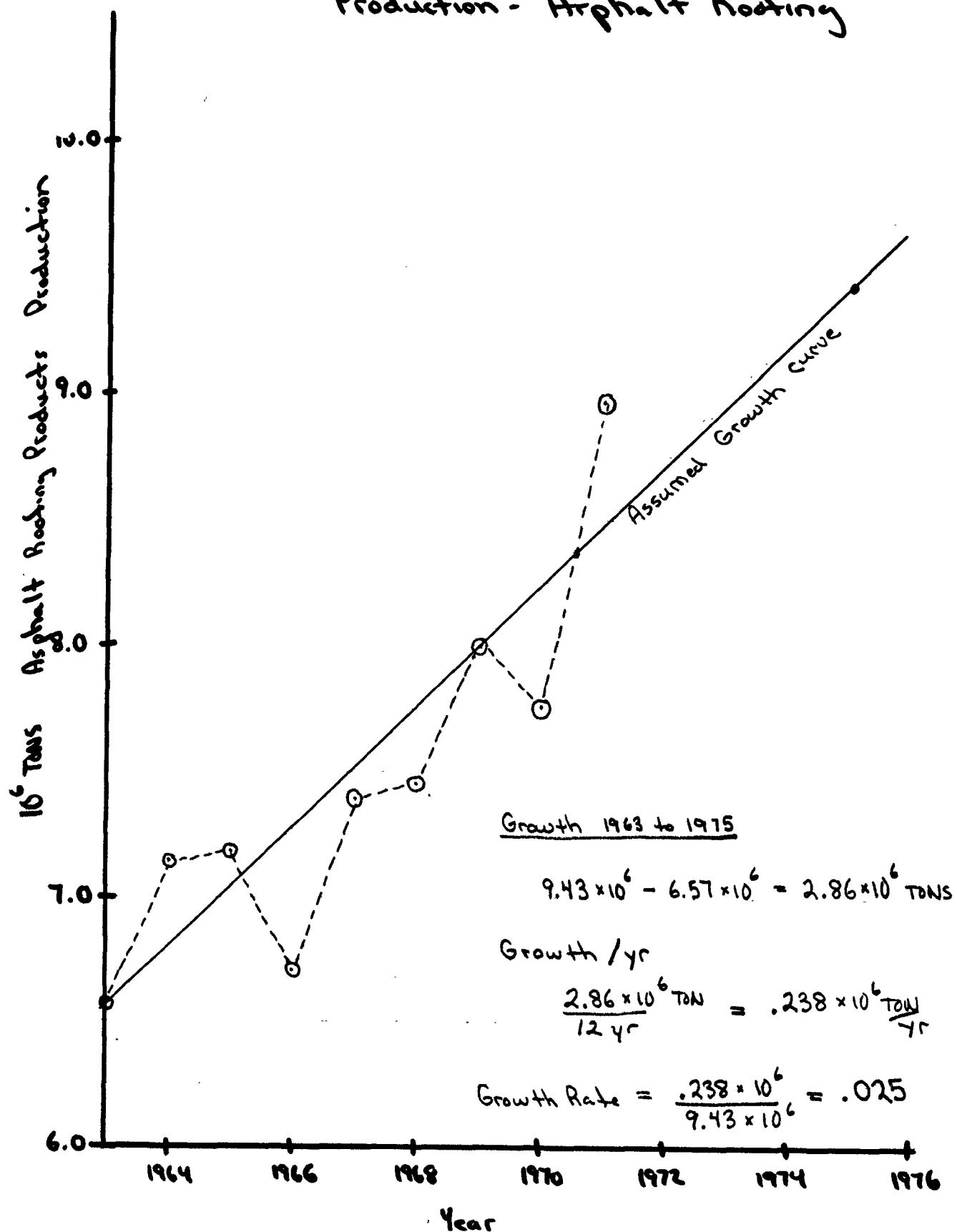
We will replot this data and determine the actual growth (simple also) however, based on the year 1975. It is not clear whether ref 021 did use 1975 as a baseline or not.

Based on the development on the attached graph we estimate a 2.5% growth (simple) in the production of asphalt products

$$P_c = .025 \text{ simple}$$

same for asphalt "blowing"  
and asphalt saturator

# Production - Asphalt Roofing



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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-26-74

Source Asphalt Roofing

A :

This industry may be considered as composed of two distinct "primary" pollutant sources. They are identified as the asphalt blowing operation and the asphalt saturator. Since, not all asphalt roofing plants actually blow their own asphalt (this is often done at the refinery.) then the value of A developed for these two sources will be different.

Ref 047 pg 159 estimates 50% of asphalt is blown in roofing plants.

$$\text{therefore } A_{\text{blowing}} = .5 \times A_{\text{sat}} \quad \text{based on asphalt input.}$$

Our value of A and all emission figures will be developed on the basis of asphalt input.

Ref 075 pg 8.2-1 60% of felt product is asphalt

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Calculations Done By J. Marrone Date 11-26-74  
 Source Asphalt Roofing

A:

From attached graph of production we may obtain the 1975 estimated production of asphalt roofing products

$$P_{75} = 9.43 \times 10^6 \text{ TONS/yr}$$

If  $K = .9$  and 60% of product is asphalt then the asphalt input capacity for this industry is calculated;

$$\frac{9.43 \times 10^6 \text{ TON Product} \times \frac{.6 \text{ TON Asphalt}}{\text{TON Product}}}{.9}$$

$$A_{\text{saturator}} = 6.29 \times 10^6 \text{ TONS yr asphalt input}$$

with only 50% of asphalt "blown" at the roofing plant;

$$A_{\text{blowing}} = 3.15 \times 10^6 \text{ TONS yr asphalt input}$$

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Calculations Done By W. Marrone Date 11-26-74  
 Source Asphalt Batching

$P_B$  :

A specific category relative to asphalt roofing plants was not found in the IRS Depreciation Guidelines Ref 037. We make the assumption that this activity however may be considered similarly with that covered under Section 26.2 pg 32-33 of Ref 037. This category describes the asset guideline period for equipment used in the production of converted products such as coated paper.

Asset Guideline period = 12 yrs

$P_B$  est  $\rightarrow 2 \times \text{IRS} = 24 \text{ yrs}$

$\frac{100\% \text{ depreciation}}{24 \text{ yrs}} \approx 4.2\%/\text{yr simple}$

$$P_B = .042 \text{ simple}$$

Same for  
 asphalt blowing,  
 asphalt saturator

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Computation Sheet For Emission Factors

Calculations Done By 2). Maronne Date 11-26-74  
Source Asphalt Roofing

Blowing:

$E_u$ : Ref 075 Table 8.2-1

$$E_{up} = 2.5 \text{ lb Part/TON Sat Felt}$$

$$E_{HC} = 1.5 \text{ lb HC/TON Sat Felt}$$

$$E_{CO} = .9 \text{ lb CO/TON Sat Felt}$$

converting this to asphalt input  
which is assumed equal to asphalt blown (60% of sat felt is asphalt)

$$E_u(\text{part}) = 2.5 \frac{\text{lb P}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6 \text{ TON Asphalt}} \approx 4.2 \frac{\text{lb}}{\text{TON Asphalt blown}}$$

$$E_u(\text{HC}) = 1.5 \frac{\text{lb HC}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6 \text{ TON Asphalt}} = 2.5 \frac{\text{lb}}{\text{TON Asphalt blown}}$$

$$E_u(\text{CO}) = .9 \frac{\text{lb CO}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6 \text{ TON Asphalt}} = 1.5 \frac{\text{lb}}{\text{TON Asphalt blown}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-26-74  
 Source Asphalt Roofing

Blowing: cont'd

$E_N$

Ref 021 Table 6-3 specifies 99% control efficiency on asphalt blowing operation using an afterburner. We assume that design would incorporate control of all three pollutants (Part, HC, and CO)

$$\therefore E_N = .01 \times E_u$$

$$\therefore E_N (\text{Part}) = .01 \times 4.2 = .042 \text{ lb/ton asphalt blown}$$

$$E_N (\text{HC}) = .01 \times 2.5 = .025 \text{ lb/ton asphalt blown}$$

$$E_N (\text{CO}) = .01 \times 1.5 = .015 \text{ lb/ton asphalt blown}$$

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Calculations Done By W. Marone Date 11-26-74  
 Source Asphalt Roofing

### Blowing:

$E_s$ : regulations for HC and CO are not applicable to asphalt roofing plants  
 Ref 148 & 084

$$\therefore E_s = E_u$$

Hydrocarbons  $E_s(\text{HC}) = 2.5 \text{ lb/TON Asphalt blown}$

Carbon Monoxide  $E_s(\text{CO}) = 1.5 \text{ lb/TON Asphalt blown}$

### Particulates

Using 50 TPH as a typical plant size  
 Ref 021 pg 2-9 Table 2.1

$$50 \frac{\text{TON}}{\text{HR}} \text{ asphalt prod} \times \frac{.6 \text{ TON asphalt}}{\text{TON asphalt prod.}} = 30 \frac{\text{TON}}{\text{hr}} \text{ asphalt}$$

assuming all asphalt input is blown then the process weight for the blowing operation is  
 $30 \frac{\text{TON}}{\text{hr}} (60,000 \frac{\text{lb}}{\text{hr}})$

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 Source Asphalt Roofing

Blowing:

$E_s$  cont'd

From Ref H8 § 084 Generalized process weight rate curve for particulates,

Process weight rate = 60,000 lb/hr

Allowable emission = 35.5 lb/hr

$$E_s = \frac{35.5 \text{ lb/hr}}{30 \text{ TON/hr}} = 1.18 \frac{\text{lb Part}}{\text{TON asphalt blown}}$$

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Source Asphalt Roofing

## Saturator :

Ref 075 Table 8.2-1

$E_u$

Emissions from the saturator are identified as particulates however as discussed in Ref 021 pg 2-4 they are in actuality hydrocarbon droplets (vapor mist)

We use the emission for spraying and dipping as typical

$$E = \frac{2 \text{ lb}}{\text{TON Sat Felt}} \times \frac{1 \text{ TON Sat Felt}}{.6 \text{ TON asphalt}}$$

$$\therefore E = 3.33 \text{ lb Part/TON asphalt input}$$

From Ref 021 pg 2-4

$$\textcircled{1} \quad 45 \text{ lb/hr HC} \quad 16,500 \text{ lb/hr felt}$$

$$\frac{45 \text{ lb}}{16,500 \frac{\text{lb felt}}{\text{hr}}} \times \frac{\text{TON felt}}{2000 \text{ lb}} = 5.45 \text{ lb / TON Felt}$$

$$\frac{5.45 \text{ lb}}{\text{TON Felt}} \times \frac{\text{Ton Felt}}{.6 \text{ Asphalt}} \approx 9.1 \text{ lb / TON asphalt input}$$

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 Source Asphalt Roofing

### Saturator:

$E_u$  cont'd

Ref 021 pg 2-4

① 23-69 lb/hr HC avg 46 lb/hr (assume hydrocarbon emission to be in  $\rightarrow$  mist form i.e. particulate)

$$\frac{46 \text{ lb}}{16,000 \text{ lb felt}} \times \frac{\text{Tow}}{2000 \text{ lb}} = 5.75 \text{ lb/Ton felt}$$

$$5.75 \frac{\text{lb}}{\text{Tow felt}} \times \frac{\text{Tow felt}}{.6 \text{ Tow Asphalt}} \approx 9.6 \frac{\text{lb}}{\text{Ton asphalt input}}$$

We estimate  $E_u$  from the average of these three factors.

$$E_u \approx \frac{(3.33 + 9.1 + 9.6)}{3} \text{ lb/Ton asphalt input}$$

$$\therefore E_u = 7.3 \text{ lb Part/Ton asphalt input}$$

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Source Asphalt Roofing

### Saturator :

$E_N$  Ref 021 pg 6-7 Table 6.3

Control efficiency with Afterburner on  
 new asphalt roofing saturator 99%

$$\therefore E_N = .01 \times E_u = .01 \times 7.3 \text{ lb/ton}$$

$$E_N = .073 \text{ lb/ton asphalt input}$$

### $E_s$ :

Using, as before, 50 TPH as a typical process capacity.

$$50 \frac{\text{ton sat}}{\text{hr}} = 100,000 \frac{\text{lb sat}}{\text{hr}}$$

This weight is considered the process weight rate and from the Generalized Weight Rate Curve the allowable emission is 40 lb/hr

$$E_s = \frac{40 \text{ lb/hr}}{50 \frac{\text{ton sat}}{\text{hr}}} \times \frac{1}{\frac{.6 \text{ ton asphalt}}{\text{ton sat}}} = 1.33 \frac{\text{lb}}{\text{ton asphalt input}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 11-26-74  
 Source Asphalt Roofing

### Summary of Emission Factors

lb/ton asphalt input

	Particulate			Hydrocarbon			Carbon Monoxide		
	E <sub>u</sub>	E <sub>s</sub>	E <sub>n</sub>	E <sub>u</sub>	E <sub>s</sub>	E <sub>n</sub>	E <sub>u</sub>	E <sub>s</sub>	E <sub>n</sub>
Asphalt Blowing	4.2	1.18	.042	2.5	2.5	.025	1.5	1.5	.015
Asphalt Saturator	7.3	1.33	.073	/	/	/	/	/	/

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-6-74  
 Source Concrete Batching

Ref 146 p 38 states that about 63% of all cement plant product (portland cement) is consumed by the ready-mix concrete industry.

From data in ref 215 (1974 edition) pg 275-278 we estimate that in 1972 ≈ 65% of cement production went to ready-mix concrete plants.

We assume a value of 65% to be representative of the percentage of cement production to the concrete batching industry during the period 1975 - 1985.

Ref 146 pg 39 also states that the concrete industry should be in a good position to maintain a good supply of cement since they have been the former's most regular and largest customers.

Using the 1975 production estimate of portland cement (pg 2 of Portland Cement Industrial Factors)

$$492 \times 10^6 \frac{\text{bbl cement}}{\text{yr}} \quad \text{and} \quad 1 \text{ bbl cement} = 376 \text{ lb}$$

$$\begin{aligned} P_{75}(\text{cement}) &= 492 \times 10^6 \frac{\text{bbl}}{\text{yr}} \times \frac{376 \text{ lb}}{\text{bbl}} \times \frac{\text{Ton}}{2000 \text{ lb}} \\ &= 92.5 \times 10^6 \text{ Ton/yr} \end{aligned}$$

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 Source Concrete Batching

With the assumption of 65% of cement production going to concrete batching industry

$$.65 \times 92.5 \times 10^6 \frac{\text{TON}}{\text{yr}}$$

$$\text{Cement to Concrete Plants} = 60.1 \times 10^6 \frac{\text{TON cement}}{\text{yr}}$$

Ref 075 Table 8.10-1 Note @ 735 lb cement /  $\text{yd}^3$  concrete  
 4000 lb concrete /  $\text{yd}^3$  concrete

$$\frac{735}{4000} \approx .184 \frac{\text{lb cement}}{\text{lb concrete}} \text{ or } \frac{\text{TON}}{\text{TON}}$$

We may then calculate the concrete production in 1975

$$\text{Concrete P}_{75} = 60.1 \times 10^6 \frac{\text{TON cement}}{\text{yr}} \times \frac{\text{TON concrete}}{.184 \text{ TON cement}}$$

$$P_{75} = 326.6 \times 10^6 \frac{\text{TON}}{\text{yr}} \text{ concrete}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-6-74

Source Concrete Batching

K :

Since the figure developed for concrete production is based on cement input (as supplied by portland cement plant) then the value of K is considered equal to one. It does not refer to true capacity utilization

$$(K = 1.0)$$

A :

$$\text{Since } K=1 \quad A = P_{75} = 326.6 \times 10^6 \frac{\text{TON}}{\text{Yr}} \text{ concrete}$$

$$A = 326.6 \times 10^6 \frac{\text{TON}}{\text{Yr}} \text{ concrete}$$

$P_c$  :

By assuming that 65% of cement production during the period 1975 to 1985 goes to the concrete batching industry this inherently implies that the growth in concrete batching will mirror the Portland Cement industry

$$\therefore P_c = .03 \text{ compound}$$

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Source Concrete Batching

$P_B$  :

Ref 037 Class 32.3

Asset Guideline period 15 yrs

$P_B$  est  $\rightarrow 2 \times \text{IRS} = 30 \text{ yrs}$

$\frac{100\% \text{ depreciation}}{30 \text{ yrs}} = 3.33\% / \text{yr simple}$

$$\therefore P_B = .033 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marvone Date 12-6-74  
 Source Concrete Batching

### Particulate

$E_u$ : Ref 075 Table 8.10-1

$$\text{Uncontrolled Plant} \quad .2 \frac{\text{lb}}{\text{yd}^3}$$

concrete

using  $4000 \frac{\text{lb}}{\text{yd}^3}$  typical of concrete

$$E = .2 \frac{\text{lb}}{\text{yd}^3} \times \frac{\text{yd}^3}{4000 \text{ lb}} \times \frac{2000 \text{ lb}}{\text{TON}} = .1 \frac{\text{lb}}{\text{TON}}$$

$$\therefore E_u = .1 \frac{\text{lb}}{\text{TON}} \text{ concrete}$$

$E_N$ : Ref 075 Table 8.10-1

Good controlled plant } enclosure at dumping & loading areas,  
 conveyors and elevators, control of  
 storage bins with filters, use of  
 water sprays

$$.02 \frac{\text{lb}}{\text{yd}^3}$$

$$\text{then } E = .02 \frac{\text{lb}}{\text{yd}^3} \times \frac{\text{yd}^3}{4000 \text{ lb}} \times \frac{2000 \text{ lb}}{\text{TON}} = .01 \frac{\text{lb}}{\text{TON}} \text{ concrete}$$

$$\therefore E_N = .01 \frac{\text{lb}}{\text{TON}} \quad ^{47}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-6-74  
 Source Concrete Batching

$E_s$ : cont'd

Ref 146 pg 39

Readimix concrete plants - 5000

Ref 217 pg 6-228 Table 8

We assume air-entrained concrete with typical water usage of 34 gal /  $\text{yd}^3$  concrete.

$$34 \frac{\text{Gal}}{\text{yd}^3 \text{ concrete}} \times 8.346 \frac{\text{lb H}_2\text{O}}{\text{Gal}} \times \frac{\text{yd}^3}{4000 \text{ lb concrete}} = .071 \frac{\text{lb H}_2\text{O}}{\text{lb concrete}}$$

or 7.1% water in concrete

or 142 lb  $\text{H}_2\text{O}$  / TON concrete

$$\text{Average Plant size} = 326.6 \times 10^6 \frac{\text{TON concrete}}{\text{yr}} / 5000$$

$$= 65,320 \text{ TON concrete/yr}$$

per plant

$$\text{Assumed operating schedule } 8 \frac{\text{hr}}{\text{d}} \times \frac{5 \text{ d}}{\text{wk}} \times \frac{45 \text{ hr}}{\text{yr}} = 1800 \frac{\text{hr}}{\text{yr}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-6-74

Source Concrete Batching

Particulates cont'd

$E_s$  :

Process weight rate calc

65,320  $\frac{\text{TON}}{\text{yr}}$

7.1% water (not included in process weight)

1800 hr/yr operation

$$\text{PWR} = 65,320 \frac{\text{TON}}{\text{yr}} \times \frac{1\text{t}}{1800 \text{ hr}} \times \frac{2000 \text{ lb}}{\text{TON}} \times .929$$

$$\text{PWR} = 67,425 \text{ lb/hr input } (33.7 \frac{\text{TON}}{\text{hr}})$$

Ref 084 & 148

Only Conn, Ind., Virginia, and S.C. have regulation applicable to concrete batching plants

Conn:  $E_{S_i} = .02 \text{ lb/yd}^3$  or  $E_u = .01 \text{ lb/TON}$  concrete

Virginia:  $E_{S_i} = 1.13 \text{ lb/TON}$  concrete since  $E_u > E_{S_i}$  we assume  $E_{S_i} = E_u = .1 \frac{\text{lb}}{\text{TON}}$

S.C.:  $E_{S_i} = .85 \text{ lb/TON}$  concrete since  $E_{S_i} > E_u$  we assume  $E_{S_i} = E_u = .1 \frac{\text{lb}}{\text{TON}}$

Ind: by process curve  $E_{S_i} = 2.4 \frac{\text{lb}}{\text{TON}}$  since  $E_u > E_{S_i}$  we assume  $E_{S_i} = E_u = .1 \frac{\text{lb}}{\text{TON}}$

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Source Concrete Batching

$E_s$ :

Particulates cont'd

For the remaining states in which specific regulation applicable to concrete batching do not exist we determine the allowable emission based on the Generalized Process Weight Rate Curve.

From PWR Curve  
 Ref 084 9/148                    36.5 lb/hr

$$\frac{36.5 \frac{\text{lb}}{\text{hr}} \times 1800 \text{ hr}}{65,320 \frac{\text{ton}}{\text{yr}}} \approx 1 \frac{\text{lb}}{\text{ton}}$$

Since  $E_{si} > E_u$  we assume  $E_{si} = E_u = .1 \frac{\text{lb}}{\text{ton}}$

We see that only one state (Conn) appears to require control more stringent than  $E_u$ . We will estimate  $E_s$  by weighting the allowable emission thus:

$\frac{2}{50}$  or 2% of states require  $.01 \frac{\text{lb}}{\text{ton}}$

$\frac{49}{50}$  or 98% of states requires  $.1 \frac{\text{lb}}{\text{ton}}$

$$E_s = .98(.1) + .02(.01)$$

$$E_s = .098 + .0002 = .0982$$

$$\therefore E_s = .098 \frac{\text{lb}}{\text{ton}} \text{ concrete}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marvone Date 12-5-74  
 Source Portland Cement

K:

Oversupply plagued this industry during the 1960's when capacity utilization was between 75-80%.

Ref 146 p 36

K in 1970	88.4%
K in 1971	87.7%
K in 1972	> 90%

Ref 125 pg 6 states that the current rate is 85% and that maximum profits are realized at 85-90% utilization.

We assume a rate of 90% as reasonable for the period 1975 - 1985.

$$\text{K} = .90$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Morrone Date 12-5-74  
 Source Portland Cement

A:

based on the attached graph, the production estimate of portland cement in 1975 is  $492 \times 10^6$  bbl/yr

$$P_{75} = 492 \times 10^6 \text{ bbl/yr}$$

Ref 216 pg 130  $1 \text{ bbl} = 376 \text{ lb cement}$

Using  $K = .9$  we may calculate the production capacity in 1975

$$A = \frac{492 \times 10^6 \frac{\text{bbl}}{\text{yr}} \times 376 \frac{\text{lb}}{\text{bbl}} \times \frac{\text{TON}}{2000 \text{ lb}}}{.90} \cong 103 \times 10^6 \frac{\text{TON}}{\text{yr}}$$

$$\therefore A = 103 \times 10^6 \frac{\text{TON}}{\text{yr}} \text{ cement produced}$$

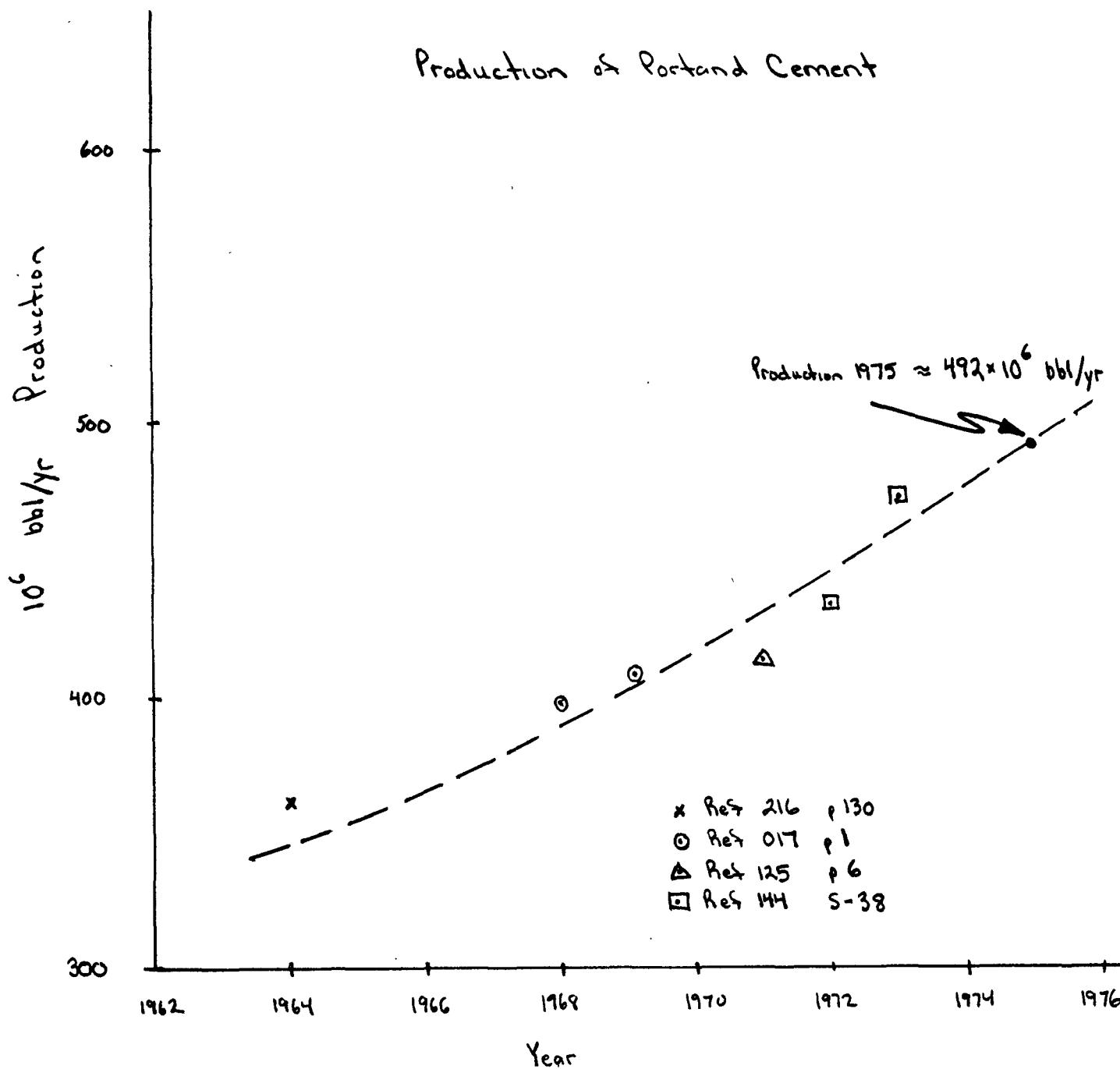
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Computation Sheet For Industrial Factors

Calculations Done By J.W. Marrone Date 12-5-74

Source Portland Cement



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Calculations Done By W. Marone Date 12-5-74

Source Portland Cement

$\rho_c$ :

Ref 125 p6 implies a growth in cement production from 1971 to 1975 of 3% /yr which we assume will continue for the period 1975 to 1985

$$\rho_c = .03 \text{ compound}$$

$\rho_B$ : Ref 037 Class 32.2

Asset Guideline period = 20 yrs

$\rho_B$  est  $\rightarrow 2 \times \text{IRS} = 40 \text{ yrs}$

$\frac{100\% \text{ depreciation}}{40 \text{ yrs}} = 2.5\% / \text{yr}$  simple

$$\rho_B = .025 \text{ simple}$$

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Source Portland Cement

Ref 125 pg 102

in 1973 58% of US capacity is wet process cement plant  
42% " " " " dry "

This same source indicates a condition in this industry of moving toward increased dry process production due to lower fuel consumption. The dry process is limited to a low moisture feed which may not always be available.

Note!! We make the assumption that 50% of the capacity will still be wet process during the period 1975-1985 so that emission factors developed for this industry will be the average from the two different process.

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Computation Sheet For Emission Factors

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 Source Portland Cement

### Particulates

$E_u$  : Ref 075 Table 8.6-1

Factors assumed (believed) to be in terms of  
 lb/TON cement product.

Kiln	<u>lb/TON</u>		<u>Avg lb/TON</u>
	<u>Wet Process</u>	<u>Dry Process</u>	
Kiln	22.8	245	237
Cooler, dryer grinder	32	96	64

$$E = 237 + 64 \approx 301 \text{ lb/TON cement}$$

$$\therefore E_u = 301 \text{ lb/TON cement}$$

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Calculations Done By W. Marrone Date 12-5-74  
 source Portland Cement

### Particulates cont'd

$E_N$ :

Ref 017 p14 & 15 describe tests performed on various wet and dry process portland cement plants. [Tests presented in Ref 058 Tabl 4 & 5]

It was noticed that for the dry-process plant the highest efficiency attained (99.8%) was with a cyclone and baghouse system.

For the wet process the efficiency attained was 99.9% using a baghouse

It is recognized the cyclones and electrostatic precipitators are more often used in wet process plants, however we assume the use of baghouses.

$$Eff = \frac{99.9 + 99.8}{2} = 99.85\%$$

$$\therefore E_N = .0015 \times E_u = .0015 \times 301 = .45 \frac{\text{lb}}{\text{TON}}$$

$$E_N = .45 \frac{\text{lb}}{\text{TON cement}}$$

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Computation Sheet For Emission Factors

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 Source Portland Cement

Particulate cont'd

Ref 273 pg 24880 promulgated standard  
 is equivalent to proposed.

$E_s$  :

Ref 147 pg 27-28 gives proposed standards  
 for new portland cement plants

.3 lb/TON dry feed from kiln

.1 lb/TON dry feed from clinker cooler

---

.4 lb/TON dry feed

from Ref 216 p 130 . 600 lb feed  $\rightarrow$  1 bbl cement (376 lb)

or

$\frac{600 \text{ lb feed}}{376 \text{ lb cement}} \approx 1.6$  feed to product ratio

therefore

$$E_{\text{prop}} = .4 \frac{\text{lb}}{\text{TON Feed}} \times \frac{1.6 \text{ TON Feed}}{\text{TON cement}} = .64 \frac{\text{lb}}{\text{TON cement}}$$

The emission regulations will be determined for new and existing plants. In any state the allowable level for new plants will not be permitted to be greater than  $.64 \frac{\text{lb}}{\text{TON cement}}$  (.4 lb/TON Feed)

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74  
Source Portland Cement

Particulate cont'd

$E_S$ :

Ref 215 1972 169 cement plants  
461 kilns  
 $85.4 \times 10^6$  TONS/yr capacity

then

$$\frac{\text{TON}}{\text{plant}} = \frac{85.4 \times 10^6 \frac{\text{TON}}{\text{yr}} \times 5.32 \frac{\text{bbl}}{\text{TON}}}{169 \text{ plant}} \approx 2.69 \times 10^6 \text{ bbl/yr per plant}$$

$$\frac{\text{bbl/yr}}{\text{kiln}} = \frac{85.4 \times 10^6 \frac{\text{TON}}{\text{yr}} \times 5.32 \frac{\text{bbl}}{\text{TON}}}{461 \text{ kiln}} = .99 \times 10^6 \text{ bbl/yr per kiln}$$

Since regulation would apply individually to each kiln we use the process production rate for a kiln

$$\approx 1 \times 10^6 \text{ bbl/yr}$$

assuming 8400 hr/yr, 5.32 bbl/TON cement, and a feed to product ratio of 1.6 we may estimate the average process weight rate.

$$\text{P.W.R.} = 1.0 \times 10^6 \frac{\text{bbl}}{\text{yr}} \times \frac{8400 \text{ hr}}{8400 \text{ hr}} \times \frac{\text{TON cement}}{5.32 \text{ bbl}} \times \frac{1.6 \text{ TON Feed}}{\text{TON cement}} \times \frac{2000 \text{ lb}}{\text{TON}}$$

$$\text{P.W.R.} = 71,608 \text{ lb/hr input}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 12-5-74  
 Source Portland Cement

Particulate cont'd

$E_s$ : Ref 058 Appendix pg 33-47 gives the yearly cement production capacities by state for the year 1966

We assume this breakdown representative and applicable to the period 1975 - 1985

The following table (pg 7 & 8) gives the fractional capacity in each state ( $A_i$ ) and the applicable Emission limitation for new and existing portland cement plants. (Process weight rate 78,608 lb/hr feed)

Portland Cement

7 of 25

## Allowable Particulate Emissions

lb/TON cement

	A <sub>i</sub>	Existing	New
Alabama	.019		
Texas			
Oklahoma	.011		
Kansas	.009		
Colorado	.010		
California	.124		
Conn.			
Penns.			
D.C.			
Florida	.031	1.34	.64
Georgia	.010		
Hawaii	.005		
Idaho	.002		
Illinois	.039		
Indiana	.043	4.00	.64
Iowa	.035	.90	.64
Kansas	.027		
Kentucky	.008		
Louisiana	.013		
Maine	.004		
Maryland	.016		
Mass.			
Michigan	.083		
Minn.	.004		
Miss.	.007		
Missouri	.041		
Montana	.006		
Nebraska	.010		
Nevada	.006		
N.H.			
N.J.			
N.Mexico	.005		
N.York	.078	1.82	.64
N.Carolina	.007	1.74	.64
N.Dakota			
Ohio	.040		

# Portland Cement

8 of 25

lb/ton cement

	<u>A<sub>c</sub></u>	<u>Existing</u>	<u>New</u>
Oklahoma	.018		
Oregon	.008		
Conn.	.100	1.25	.64
R. I.			
S. Carolina	.012	1.41	.64
N. Dakota	.007		
Tennessee	.020		.64
Texas	.092		
Utah	.006		
Vermont			
Virginia	.015	1.85	.64
Washington	.015		
S. Virginia	.008		
Wisconsin	.007		.64
Wyoming	<u>.002</u>		
$\Sigma 1.003$			
rounding error			
<u>OK</u>			

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 4-25-75  
 Source Portland Cement

Particulars cont'd

$E_s$ : For those states which have existing regulations for cement plants an  $E'_s$  is developed from  $\sum E_{sc} \times A_i$ . For those states with no regulation  $E''_s$  is obtained from the <sup>generalized</sup> process weight rate table and  $E_s = \sum E_{sc} \times A_i : E_s = E'_s + E''_s$

Since no state has a regulation for new plants which is more stringent than the proposed emission standard then we may conclude that  $E_s(\text{new}) = E_s(\text{proposed})$

$$E_s(\text{new}) = .64 \text{ lb/ton cement}$$

For existing plants:

8 states have regulations that apply,

$$E'_s = .031(1.34) + .043(4.0) + .035(.90) + .078(1.82) + .007(1.74) \\ + .10(1.25) + .012(1.41) + .015(1.85)$$

$$E'_s = .042 + .172 + .032 + .142 + .012 + .125 + .017 + .028$$

$$E'_s = .57 \text{ lb/ton cement}$$

For the remaining states  $\sum A_i = 1 - .321 = .679$

$$\text{PWR} = 71,608 \text{ lb/hr feed}$$

$$\text{with Prod/Feed} = 1/1.6$$

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Computation Sheet For Emission Factors

Calculations Done By 2). Marone Date 4-25-75  
 Source Portland Cement

Particulate cont'd

$E_s'$ : Allowable emission from PWR table using 71,608 lb/hr input  
 $E_s'' = 38 \text{ lb/hr}$

$$E_A = \frac{38 \text{ lb/hr}}{71,608 \text{ lb/hr feed}} \times \frac{\frac{1.6 \text{ lb feed}}{1 \text{ lb cement}}}{\frac{\text{TON}}{2000 \text{ lb}}} = 1.698 \text{ lb/TON cement}$$

$$E_s' = E_A \times A_i = 1.698 \times .679 = 1.15$$

$$E_s = E_s' + E_s'' = .57 + 1.15 = 1.72 \text{ lb/TON cement}$$

$E_s (\text{existing}) = 1.72 \text{ lb/TON cement}$

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Calculations Done By W. Manrone Date 12-5-74  
 Source Portland Cement

SO<sub>x</sub>

Ref 215 p 275 (1974 Edition)

In 1972 the following fuel usages were reported for this industry.

7,339,000 TONS coal

12,231,000 bbl oil (assume residual)

223,350,522,000 ft<sup>3</sup> gas

Using heating values from Ref 022 Table 4-1 pg 4-2

Gas: 1040 BTU/ft<sup>3</sup>

$$\text{Residual oil: } .6384 \times 10^{10} \frac{\text{BTU}}{10^3 \text{ BBL}} \quad \text{or} \quad 6.384 \times 10^6 \frac{\text{BTU}}{\text{BBL}}$$

$$\text{Coal: } 2.62 \times 10^{10} \frac{\text{BTU}}{10^3 \text{ TONS}} \quad \text{or} \quad 26.2 \times 10^6 \frac{\text{BTU}}{\text{TON}}$$

We then calculate the BTU supplied by each fuel

$$\text{Gas} = 1040 \frac{\text{BTU}}{\text{ft}^3} \times 223,350,522 \times 10^6 \text{ ft}^3 \approx 23.23 \times 10^{10} \text{ BTU}$$

$$\text{Res Oil} = 6.384 \times 10^6 \frac{\text{BTU}}{\text{BBL}} \times 12.231 \times 10^6 \text{ BBL} = 7808 \times 10^{10} \text{ BTU}$$

$$\text{Coal} = 26.2 \times 10^6 \frac{\text{BTU}}{\text{TON}} \times 7.339 \times 10^6 \text{ TONS} = 19,228 \times 10^{10} \text{ BTU}$$

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Calculations Done By W. Marrone Date 12-5-74  
Source Portland Cement

SO<sub>x</sub>/ cont'd

The supply of heating value by fuel is

71.06% from coal

28.86% from oil

.08% from gas

Ref 022 %S in coal = 2%

Table 4-2 %S in residual oil = 1.5%

Ref 075 Table 8.6-1

Mineral Source	10.2 lb/TON
Gas Comb	neg
Oil Comb	4.2 S or 6.3 lb/TON
Coal Comb	6.8 S 13.6 lb/TON

An emission factor from the fuel is calculated based on these figures and the weight factor for each fuel.

$$E_{fuel} = (0 \times .0008) + (6.3 \times .2886) + (13.6 \times .7106)$$

$$= 0 + 1.818 + 9.664$$

$$E_{fuel} \approx 11.5 \text{ lb/TON}$$

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Calculations Done By W. Marrone, Date 12-5-74  
Source Portland Cement

$\text{SO}_x$  / cont'd

$E_u$ :

$$E_u = E_{\text{mineral source}} + E_{\text{fuel}}$$

$$E_u = 10.2 + 11.5 = 21.7 \text{ lb/ton cement}$$

This factor is uncontrolled however, it does take into account the sulfur oxide reaction with the alkaline dusts in the kiln.

$$\therefore E_u = 21.7 \text{ lb/ton cement}$$

$E_N$ :

Referring to Ref 201 pg 102 we see fuel requirements for six kiln systems. The long kilns are typical of present plants. The average value in the range for each system was obtained and then the average of all long kiln system was calculated

$$\text{Avg} = 6 \times 10^6 \frac{\text{BTU}}{\text{ton clinker}}$$

For the short kiln system (using average values in range)

$$\text{Avg} = 3.68 \times 10^6 \frac{\text{BTU}}{\text{ton clinker}}$$

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Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

$\text{SO}_x$  / cont'd

$E_N$ : We see that this may realize a heat saving  
 of

$$\frac{6 - 3.68}{6} \times 100 = 38.6\%$$

We assume that at least a 35% savings in heat requirements can be achieved for new plants

Ref 075 Table 8.6-1 Note @ 50% additional  $\text{SO}_2$  reduction when baghouse used for particulate control due to further alkaline reactions.

$$E_N = .5 (E_{\text{mineral}} + .65 (E_{\text{fuel}}))$$

$$E_N = .5 (10.2 + .65 (11.5))$$

$$E_N = 8.84 \text{ lb/TON cement}$$

$$\therefore E_N = 8.84 \text{ lb/TON cement}$$

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Calculations Done By J. Marrone Date: 12-5-74  
 Source Portland Cement

SO<sub>x</sub> / cont'd

$E_s$ : Using the average heat requirement determined above  $6 \times 10^6$  BTU/Ton clinker

Ref 058 pg 19 suggests that 5% of cement is Gypsum implying that it is 95% clinker.

$$\begin{aligned} \text{Heat Reg} &= \frac{6 \times 10^6 \text{ BTU}}{\text{Ton clinker}} \times \frac{.95 \text{ Ton clinker}}{\text{Ton cement}} \\ &= 5.7 \times 10^6 \text{ BTU/Ton cement} \end{aligned}$$

The typical kiln size, as calculated under  $E_s$  for particulates

$$= 1.0 \times 10^6 \frac{\text{BBL}}{\text{hr}} \times \frac{7r}{8400 \text{ hr}} \times \frac{\text{Ton}}{5.32 \text{ BBL}} = 22.37 \frac{\text{Ton cement}}{\text{hr}}$$

$$\frac{\text{BTU}}{\text{HR}} = 22.37 \frac{\text{Ton cement}}{\text{hr}} \times 5.7 \times 10^6 \frac{\text{BTU}}{\text{Ton cement}}$$

$$\text{Average } \frac{\text{BTU}}{\text{hr}} = 127.5 \times 10^6 \frac{\text{BTU}}{\text{hr}}$$

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Calculations Done By W. Marrone Date 12-5-74  
 Source Portland Cement

$SO_x$  / cont'd

$E_s$  : For those states with applicable regulations for  $SO_x$  we calculate a value of  $E_s^{(existing)}$  and  $(new)$  weighted according to capacity occurrence in each state.

$$E_s'^{(existing)} = \sum E_{S_i}^{(existing)} \times A_i$$

$$E_s'^{(new)} = \sum E_{S_i}^{(new)} \times A_i$$

For states with no regulations then the value of  $E_s$  is determined simply by

$$E_s''^{(new)} = \sum E_u^{fuel} \times A_i = E_u \times \sum A_i$$

$$E_s''^{(existing)} = \sum E_u^{fuel} \times A_i = E_u \times \sum A_i$$

The total allowable "state's emission level for new and existing "fuel burning sources" is then;

$$E_s^{(fuel)} = E_s' + E_s''$$

As noted above under  $E_u$  calculation a major portion of the  $SO_x$  emission is attributable to the mineral and therefore does not come under regulation

$$E_s^{(actual)} = E_s^{(mineral)} + E_s^{(fuel)}$$

$$\text{where } E_s^{(mineral)} = E_u^{(mineral)}$$

Portland CementSO<sub>x</sub> limitationbasis:  $127.5 \times 10^6$  BTU/HR

Existing	New
----------	-----

lb SO<sub>2</sub>/10<sup>6</sup> BTU

Alabama	1.2
Alaska	
Arizona	* *
Arkansas	* *
Colorado	.3 .3
California	
Conn.	
Delaware	
D.C.	
Florida	
Georgia	
Hawaii	3.05 3.05
Idaho	
Illinois	1.40 1.40
Indiana	1.20 1.20
Iowa	
Kansas	
Kentucky	2.0
Louisiana	
Maine	3.05 3.05
Maryland	1.5 1.5
Mass.	
Michigan	
Miss.	
Miss.	4.8 2.4
Missouri	2.3 2.3
Montana	1.0 1.0
Nebroska	
Nevada	
N.H. Hampshire	
N.J. Jersey	
N.Mexico	
New York	
N.Carolina	2.3 1.6
S.Dakota	
Ohio	2.9 1.0

	Existing lb SO <sub>2</sub> /10 <sup>6</sup> BTU	New
Oklahoma	1.75	
Oregon	1.5	
Penn.		
R.I.		
Carolina	2.7	2.7
Dakota	3.0	3.0
Tennessee	**	**
Texas	*	*
Utah	1.9	1.9
Vermont		
Virginia	2.6	2.6
Washington	**	**
N. Virginia		
Mississippi		
Wyoming		

\* specifies ground level conc not to be exceeded ( $\text{use } E_x = E_u$ )

\*\* specifies ppm limitation (not included in calculation)

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 12-5-74  
 Source Portland Cement

~~SO<sub>x</sub>~~ / cont'd

$$E_S: \text{ Existing Sources} \quad E_S' = \sum E_x \cdot A_i \quad < \quad E_S'' = E_u \cdot \sum A_i^{\text{Fuel}}$$

$$\begin{aligned} E_S' &= .01(3) + .005(3.05) + .039(1.4) + .043(1.2) + .004(3.05) \\ &\quad + .016(1.5) + .007(4.8) + .041(2.3) + .006(1.0) + .007(2.3) \\ &\quad + .040(2.9) + .012(2.7) + .007(3.0) + .006(1.9) + .015(2.6) \end{aligned}$$

$$E_S' = .5305 \frac{\text{lb SO}_2}{10^6 \text{ BTU}}$$

and with  $5.7 \times 10^6 \text{ BTU}$   
Ton cement

$$E_S' = .5305 \frac{\text{lb SO}_2}{10^6 \text{ BTU}} \times 5.7 \frac{\times 10^6 \text{ BTU}}{\text{Ton cement}} = 3.02 \frac{\text{lb SO}_2}{\text{Ton cement}}$$

now:

$$E_S'' = E_u \cdot \sum A_i^{\text{Fuel}} = 11.5 \frac{\text{lb}}{\text{Ton cement}} \times .707 = 8.13 \frac{\text{lb}}{\text{Ton cement}}$$

.035  $\times E_{\text{Avg}}$  for states not included in calc

$$E_S' + E_S'' + \text{Avg} \\ 3.02 + 8.13 + .035 E_A = E_{\text{Avg}}$$

$$11.15 = .965 E_A \Rightarrow E_A = 11.55 \frac{\text{lb}}{\text{Ton}}$$

$$E_S^{\text{(Fuel)}} = E_A = 11.55 \frac{\text{lb}}{\text{Ton cement}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 12-5-74  
 Source Portland Cement

SO<sub>x</sub>/ cont'd

$E_s$ :

$$E_s(\text{existing}) = E_s(\text{fuel}) + E_u(\text{mineral}) \\ = 11.55 + 10.2$$

∴

$$E_s(\text{existing}) = 21.75 \approx E_u$$

then

$$E_s(\text{existing}) = 21.7 \text{ lb/TON}$$

cement

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74  
 Source Portland Cement

$\text{SO}_x$  / cont'd

$$E_s: \quad \text{New Source} \quad E_s' = \sum E_{s,i} \times A_i \quad ; \quad E_s'' = E_u^{\text{Fuel}} \times \sum A_i$$

$$\begin{aligned} E_s' = & .019(1.2) + .01(3.0) + .005(3.05) + .039(1.4) + .043(1.2) + .008(2) \\ & + .004(3.05) + .016(1.5) + .007(2.4) + .041(2.3) + .006(1.0) \\ & + .007(1.6) + .04(1.0) + .018(1.75) + .008(1.5) + .012(2.7) \\ & + .007(3.0) + .006(1.9) + .015(2.6) \end{aligned}$$

$$E_s' = .5151 \frac{\text{lb SO}_2}{10^6 \text{ BTU}} \times \frac{5.7 \times 10^6 \text{ BTU}}{\text{Ton cement}} = 2.94 \frac{\text{lb}}{\text{Ton cement}}$$

and

$$E_s'' = E_u^{\text{Fuel}} \times \sum A_i = 11.5 \frac{\text{lb}}{\text{Ton cement}} \times .654 = 7.52 \frac{\text{lb}}{\text{Ton cement}}$$

.035  $\times E_{\text{Avg}}$  for states not included in calc

$$\begin{aligned} E_s' + E_s'' + E_{\text{Avg}}(.035) &= E_{\text{Avg}} \\ 2.94 + 7.52 + .035 E_{\text{Avg}} &= E_{\text{Avg}} \end{aligned}$$

$$10.46 = .965 E_{\text{Avg}} \quad E_{\text{Avg}} \approx 10.84 \frac{\text{lb}}{\text{Ton cement}}$$

$$E_s(\text{fuel}) = E_{\text{Avg}} = 10.84 \frac{\text{lb}}{\text{Ton cement}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 12-5-74

Source Portland Cement

$\text{SO}_x$  / cont'd

$$E_s : \quad E_s(\text{new}) = E_s(\text{fuel}) + E_u(\text{mineral}) \\ = 10.84 + 10.2$$

$$E_s \text{ new} = 21.04 \approx 21.0$$

$$E_s(\text{new}) = 21.0 \text{ lb/ton cement}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-6-74

Source Portland Cement

$\cancel{NO_x}$   
 $E_u:$

Ref 075 Table 8.6-1

Emission factor for uncontrolled wet process and dry process kiln is 2.6 lb/TON cement

$$E_u = 2.6 \text{ lb/TON}$$

cement

$E_N:$  Ref to pg 14 of emission calc for  $SO_x$  in which a 35% savings in heat requirements was stated as achievable at new cement plants. This savings in BTU/TON cement would imply a direct and proportional decrease in lb  $NO_x$ /TON cement

$$E_N = (1 - .35) \times 2.6 \frac{\text{lb}}{\text{TON}}$$

$$E_N = 1.69 \frac{\text{lb}}{\text{TON}}$$

cement

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 12-6-74

Source Portland Cement

$\text{NO}_x / E_s$ :

For  $\text{NO}_x$  emissions we will use the synthesized allowable emission rate developed by T. Hopper under "Boilers"

.22 lb/ $10^6$  BTU gas

.30 lb/ $10^6$  BTU oil

.73 lb/ $10^6$  BTU coal

using the fuel breakdown 71.06% coal, 28.86% oil, .08% gas we may calculate

$$E_{\text{allow}} = .7106(.73) + .2886(.30) + .0008(.22)$$

$$E_{\text{allow}} = .51874 + .08658 + .00018$$

$$E_{\text{allow}} = .6055 \text{ lb}/10^6 \text{ BTU}$$

and with the heat requirement of  $5.7 \times 10^6 \frac{\text{BTU}}{\text{TON cement}}$

$$E_s = .6055 \frac{\text{lb}}{10^6 \text{ BTU}} \times \frac{5.7 \times 10^6 \text{ BTU}}{\text{TON cement}}$$

$$E_s = 3.45 \text{ lb/TON cement}$$

since this value is greater than  $E_u$   $E_s$  assumed equal to  $E_u$

$$\therefore E_s = 2.6 \text{ lb/TON cement}$$

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 12-6-74  
 Source Portland Cement

### Summary of Emission Factors

lb /TON cement

Pollutant	$E_u$	$E_N$	$E_s$ (existing)	$E_s$ (new)
Particulate	301	.45	1.72.	.64
SO <sub>x</sub>	21.7	8.84	21.7	21.0
NO <sub>x</sub>	2.6	1.69	2.6	2.6

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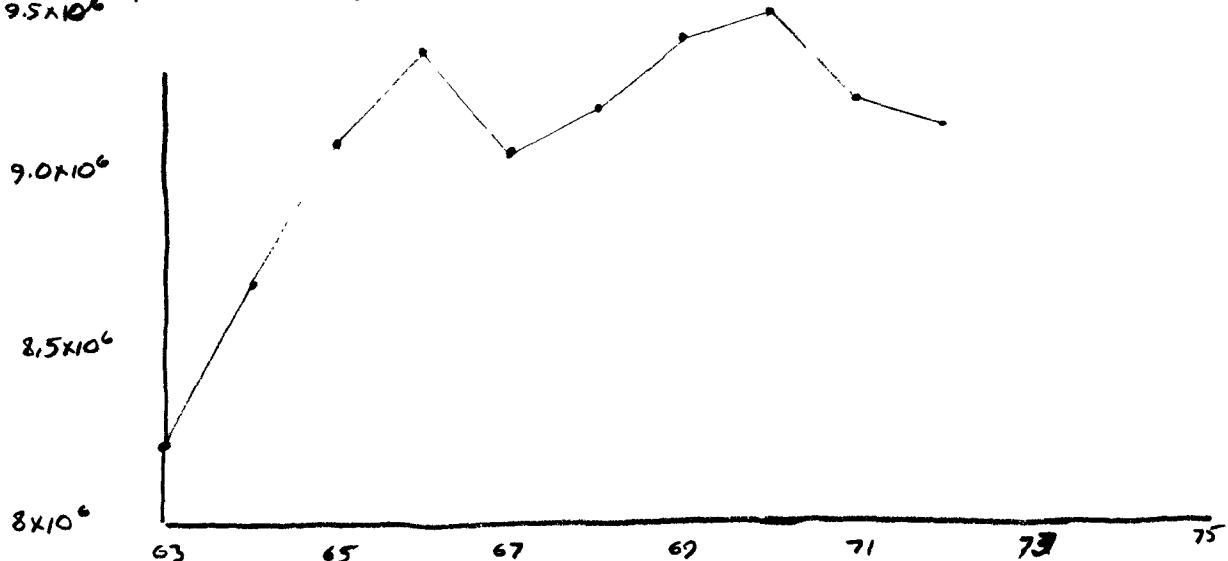
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Computation Sheet For Industrial Factors

Calculations Done By Hearce Date 12/21/74

Source Sand & Gravel Processing

Ref (215) p 1103 (1974) & '61, '63, '65, '67, '69, '71 yield the following production info



Growth during the period 1963 to 1970 was based on THE EXTENSIVE USE OF SAND & GRAVEL for the interstate highway construction network. THIS EFFORT HAS BEEN GEARING DOWN IN THE PAST SEVERAL YEARS TO THE POINT WHERE PRODUCTION MAY CONTINUE TO DECREASE. However, for the purposes of this study, we will assume

$$P_c = 0.0$$

1972 Production = 913,375,000 tons

No specific reference could be located with respect to fractional utilization. From ref (144) p 48, K for "stone, clay, & glass" = 80%. Presently, we will use this value for K.

$$K = 0.80$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 12/2/74  
 Source Sand & Gravel

$$A = \frac{913.375 \times 10^6}{0.8} = 1142 \times 10^6$$

$$A = 1142 \times 10^6 \text{ tons}$$

P<sub>B</sub>:

Ref (37) <sup>p30</sup> states an allowable depreciation of 10 yrs for equipment used in the mining of "sand, gravel, stone & clay"

Assuming twice the IRS allowable,

$$P_B = \frac{1}{2(10)} = 0.05$$

$$P_B = 0.05$$

Simple

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Computation Sheet For Emission Factors

Calculations Done By Haze Date 12/2/74

Source SAND & GRAVEL

Ref (75) p 8.19-1

$$EU = 0.1 \text{ #/ton}$$

Generally, collection devices are not used (Ref (47) p 219)

However, using best available technology, a baghouse could be employed (Ref (46) p 342). This Ref states an  $R \approx 100\%$ . We will assume <sup>these</sup> for the purpose of conservatism, 95% since the volume of material handled would cause eventual plugging & the operation would by-pass the baghouse during its cleanout

THIS ASSUMPTION IS  
 BORN OUT IN REF (47)  
 p 295 TAB 8-1 WHICH  
 STATES 94% & 96% FOR  
 SAND & GRAVEL PROCESSING  
 CONTROL EQUIPT

$$EN = (1 - .95)(.1) = 0.005$$

$$EN = 0.005$$

From Ref (215) 1974 p 1103 ff., the following State breakdowns existed in 1972

Cal. —  $117 \times 10^6$  tons

Mich. —  $\sim 59 \times 10^6$

Ill. —  $\sim 40 \times 10^6$

Wisc. —  $36.4 \times 10^6$

Minn. —  $36.7 \times 10^6$

Ohio —  $43.5 \times 10^6$

Texas —  $35.1 \times 10^6$

$$\frac{367.7}{913.4} = 40\%$$

The remaining 60% is distributed throughout the remaining states

$$\overline{367.7 \times 10^6}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/13/74

Source Sand & Gravel

Ref (215) p 110 3ft

# plants = 5384  
 in 1972

$$\text{Typ plant size} = \frac{(943.4 \times 10^6)}{(5384)} = 19.37 \text{ TPH}$$

$$19.37/.80 = 24.21 \text{ TPH}$$

" 38,733 #/hr

$$38,733/.80 = 48,416 \text{ PPH}$$

### % BREAKDOWN

CAL - 12.8%

MICH - 6.5%

ILL - 4.4%

WISC - 4.0%

MINN - 4.0%

Ohio - 4.8%

TEX - 3.8%

Others - 59.7%

From Refs (84), (148) & (15c) incl. gen'l process  
 weient curve

Allowable emissions (#/hr) are ...

CAC - 37.0

Minn - 29.5

Mich - 29.5

Ohio - 29.5

ILL - 12.1

TEX - 57.0

WISC - 22.4

Others - 28.1

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Computation Sheet For Emission Factors

Calculations Done By Henne Date 12/3/74

Source Sand & Gravel

$$\begin{aligned}
 E_s = f & \left[ (57.0)(.128) + (29.5)(.065) + (12.1)(.044) + (22.4)(.04) \right. \\
 & + (29.5)(.04) + (29.5)(.048) + (57.0)(.038) \\
 & \left. + (28.1)(.597) \right] \\
 = 3.456 & + 1.918 + .532 + .896 + 1.18 + 1.416 + 2.166 \\
 & + 16.776 \\
 = 28.34 & \text{ pph}
 \end{aligned}$$

$$E_s = \frac{28.34}{24.21} = 1.17 \text{ #ton}$$

The uncontrolled emission rate is less than  $E_s$  calculated

$$\therefore E_s = E_u = 0.1 \text{ #ton}$$

$$E_s = 0.1 \text{ #ton}$$

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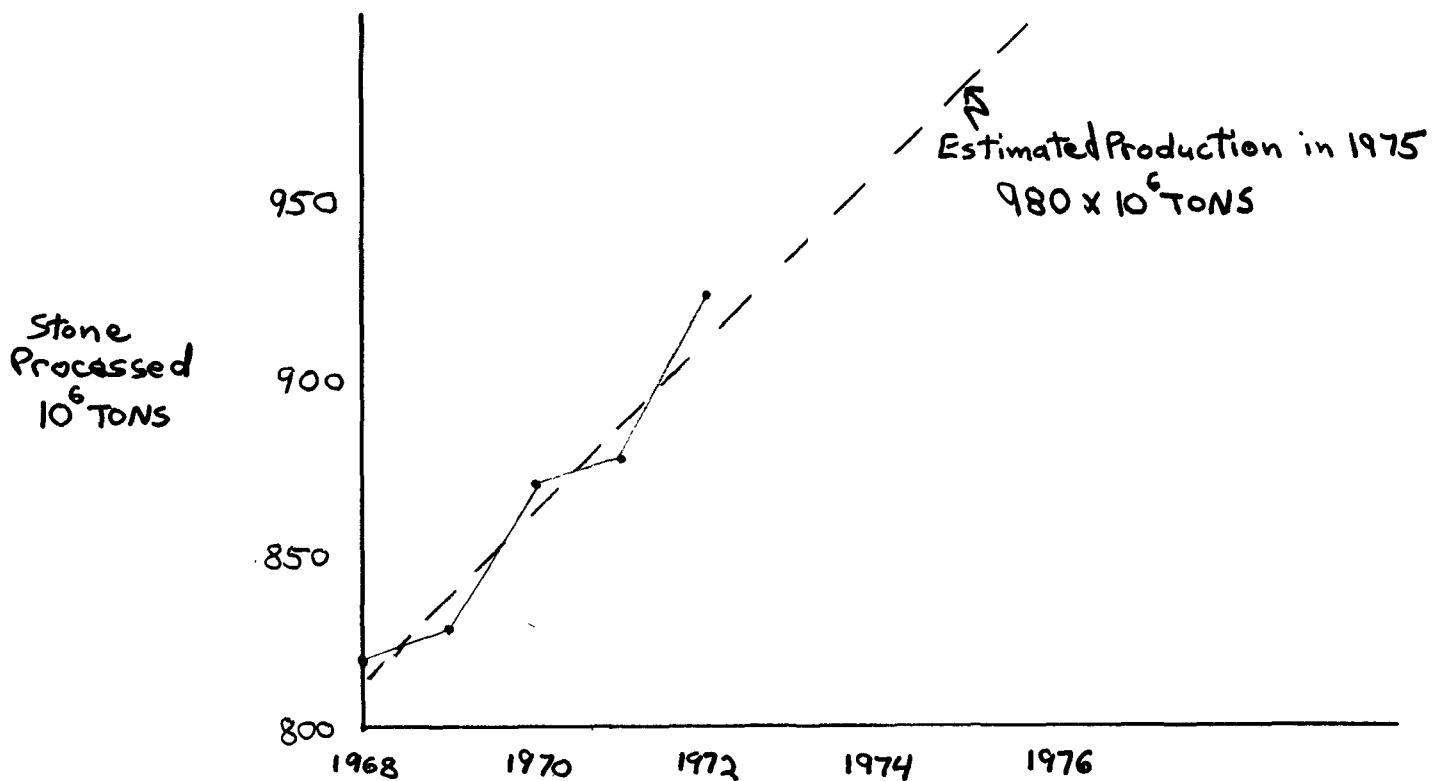
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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/27/74

source Stone Quarrying and Processing

Ref 215 yields the following production information:



These data points seem to indicate a simple growth rate for the Stone Quarry and Processing Industry. Future predictions of this industry are difficult because of the slow down of interstate highway construction in recent years. In order to minimize potential error we assume a simple growth rate for this reason also.

$$P_c = \frac{\text{Capacity in 1972} - \text{Capacity in 1968}}{(1972-1968) \text{ Capacity in 1975}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/27/74

Source Stone Quarrying and Processing

$$\text{Capacity in 1968} = \frac{\text{Production in 1968}}{K}$$

$$\text{Capacity in 1972} = \frac{\text{Production in 1972}}{K}$$

$$\text{Capacity in 1975} = \frac{\text{Estimated Production in 1972}}{K}$$

No specific reference could be located with respect to fractional utilization. From Ref. 144, p.48, K for "stone, clay, and glass" = 80%. Presently, we will assume this value for K.

$$K = 0.80$$

$$\text{Capacity in 1968} = \frac{820,000,000 \text{ TONS}}{.80} = \frac{1025 \times 10^6 \text{ TONS}}{\text{YR}}$$

$$\text{Capacity in 1972} = \frac{924,000,000 \text{ TONS}}{.80} = \frac{1155 \times 10^6 \text{ TONS}}{\text{YR}}$$

$$\text{Capacity in 1975} = \frac{980,000,000 \text{ TONS}}{.80} = \frac{1225 \times 10^6 \text{ TONS}}{\text{YR}}$$

$$P_c = \frac{\frac{1155 \times 10^6 \text{ TONS}}{\text{YR}} \frac{1025 \times 10^6 \text{ TONS}}{\text{YR}}}{(4)(\frac{980 \times 10^6 \text{ TONS}}{\text{YR}})} = \frac{\frac{130 \times 10^6 \text{ TONS}}{\text{YR}}}{(4)(\frac{980 \times 10^6 \text{ TONS}}{\text{YR}})} = .033$$

$$P_c = .033 \\ \text{Simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

Ref 37, p. 30 states an allowable depreciation of 10% for equipment used in the mining of "sand, gravel, stone & clay"

Assuming twice the IRS allowable,

$$P_B = \frac{1}{(2)(10)} = 0.05$$

$$P_B = 0.05 \\ \text{simple}$$

From the graph shown previously estimated production in 1975 is  $980 \times 10^6$  TONS.

$$A = \frac{\text{Production in 1975}}{K} = \frac{980 \times 10^6 \text{ TONS}}{.8} = 1225 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$A = 1225 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By K.Tower Date 12/30/74

Source Stone Quarrying & Processing

Ref 075, Table 8.20-1, p. 8.20-1 gives the following information for particulate emission factors for rock handling processes.

Type of Process	Uncontrolled Total lbs/TON
Primary Crushing	0.5
Secondary Crushing & Screening	1.5
Tertiary crushing & screening	6
Recrushing & screening	5
Fines Mill	6
Misc. Operations (Screening, conveying and handling)	2
Storage Pile Losses	10

Ref. 050, p.9 makes the following assumptions to arrive at a uncontrolled emission factor for the stone quarrying & processing industry.

1. Growth of production at 1.5% over 1971 base year.
2. All production is primary and secondary crushed and screened.
3. 75% of production is tertiary crushed and screened.
4. 20% of production is recrushed and screened
5. Storage pile losses are ignored
6. Growth in number of quarries at 3% over 1971 base year.

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying + Processing

$$E_U = 0.5 \frac{lb}{Ton} + 1.5 \frac{lb}{Ton} + (0.75)(6 \frac{lb}{Ton}) + (0.2)(5 \frac{lb}{Ton}) + 6 \frac{lb}{Ton} + 2 \frac{lb}{Ton} = 15.5 \frac{lb}{Ton}$$

$$E_U = 15.5 \frac{lb}{Ton}$$

rock processed

Ref 075, p. 8.20-1 states that efficiencies of 99% can be expected for stone quarry & processing emissions by using a fabric filter.

$$E_N = (15.5 \frac{lb}{Ton})(1.00 - .99) = (15.5 \frac{lb}{Ton})(.01) = .155 \frac{lb}{Ton}$$

$$E_N = .155 \frac{lb}{Ton}$$

rock processed

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

Ref 050, p. 4 gives the following information regarding number of quarries and plant capacity in 1970.

Yearly Capacity (Tons/YR)	*Hourly Capacity (lbs/Hour)	% of Total # of Quarries
Less than 24,999	Less than 24,999	36.4
25,000 to 49,999	25000 to 49,999	11.8
50,000 to 74,999	50000 to 74,999	7.7
75,000 to 99,999	75,000 to 99,999	5.9
100,000 to 199,999	100,000 to 199,999	13.5
200,000 to 299,999	200,000 to 299,999	6.1
300,000 to 399,999	300,000 to 399,999	4.9
400,000 to 499,999	400,000 to 499,999	3.5
500,000 to 599,999	500,000 to 599,999	2.2
600,000 to 699,999	600,000 to 699,999	1.6
700,000 to 799,999	700,000 to 799,999	1.3
800,000 to 899,999	800,000 to 899,999	1.1
900,000 and up	900,000 and up	4.0

\* lbs/hr values were obtained by assuming that each plant operated 250 day/yr 8 hrs/day, ref 236, p. VII-59

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

From the general process weight curve obtained from ref 084 and ref 148 we obtain the following calculation for  $E_s$ .

$$\begin{aligned}
 E_s = & (.364)(21 \frac{\text{lbs}}{\text{hr}}) + (.118)(34 \frac{\text{lbs}}{\text{hr}}) + (.077)(37.5 \frac{\text{lbs}}{\text{hr}}) + (.059)(40 \frac{\text{lbs}}{\text{hr}}) \\
 & + (.135)(47 \frac{\text{lbs}}{\text{hr}}) + (.051)(51 \frac{\text{lbs}}{\text{hr}}) + (.049)(56 \frac{\text{lbs}}{\text{hr}}) + (.035)(59 \frac{\text{lbs}}{\text{hr}}) \\
 & + (.022)(61 \frac{\text{lbs}}{\text{hr}}) + (.016)(62 \frac{\text{lbs}}{\text{hr}}) + (.013)(66 \frac{\text{lbs}}{\text{hr}}) + (.011)(68 \frac{\text{lbs}}{\text{hr}}) + \\
 & (.040)(70 \frac{\text{lbs}}{\text{hr}})^* = \quad \longrightarrow
 \end{aligned}$$

\* Ref 050, p.11.

$$\begin{aligned}
 & [7.64 + 4.01 + 2.89 + 2.36 + 6.35 + 3.11 + 2.74 + 2.07 \\
 & 1.34 + 0.99 + 0.86 + 0.75 + 2.80] = 37.91 \frac{\text{lbs}}{\text{hr}}
 \end{aligned}$$

$$E_s = \frac{(37.91 \frac{\text{lbs}}{\text{hr}})}{\left( \frac{\text{Avg. Plant TON}}{\text{Capacity hr}} \right)}$$

$$\begin{aligned}
 \text{Average Plant } \frac{\text{TON}}{\text{yr}} = & (25,000 \frac{\text{TONS}}{\text{yr}})(.364) + (50,000)(.118) + (75,000)(.077) + \\
 & (100,000)(.059) + (200,000)(.135) + (300,000)(.051) + (400,000)(.049) + \\
 & (500,000)(.035) + (600,000)(.022) + (700,000)(.016) + (800,000)(.013) + \\
 & (900,000)(.011) + (1,000,000)(.04)^* = 
 \end{aligned}$$

Ref 050, p.11

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

$$9100 + 5900 + 5775 + 5900 + 27,000 + 18,300 + \\ 19,600 + 17,500 + 13200 + 11,200 + 10,400 \\ 9900 + 40,000 = 193,775 \frac{\text{TONS}}{\text{YR}}$$

We make the assumption that an average plant operates 250 days/yr, 8  $\frac{\text{hrs}}{\text{day}}$ .

$$\text{Average Plant} \stackrel{\text{Capacity}}{\wedge} \frac{\text{TON}}{\text{HR}} = \frac{193,775 \frac{\text{TONS}}{\text{YR}}}{(250 \frac{\text{days}}{\text{YR}})(8 \frac{\text{hrs}}{\text{day}})} = 96.9 \frac{\text{TONS}}{\text{HR}}$$

This value of  $96.9 \frac{\text{TONS}}{\text{HR}}$  is substantiated by ref. 236, p. VII - 59 which states that typical plant capacities average  $100 \frac{\text{TON}}{\text{HR}}$ .

$$E_s = \frac{37.91 \frac{\text{lbs}}{\text{hr.}}}{100 \frac{\text{TONS}}{\text{HR}}} = .379 \frac{\text{lbs}}{\text{TON}}$$

$$E_s = .379 \frac{\text{lbs}}{\text{TON}}$$

Rock Processed

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 6/3/75

Source Mining & Milling of Lead

Ref (278) p 17

1970 Production = 571,767 TONS LEAD / yr

Using information from our study regarding primary lead smelters  
 (See "INDUSTRIAL FACTORS - PRIMARY LEAD")

$$P_C = 0$$

Our study indicated that 2 (of 4) producers <sup>of Pb</sup> operated @ 85%  
 of capacity & the remaining two operated @ 99%. We will assume  
 that the mining & milling operations function @ the avg of  
 these

$$K = \frac{.85 + .99}{2} = 0.92$$

$$K = 0.92$$

$$A = 0.572 \times 10^6 / .92 = 0.622 \times 10^6$$

$$A = 0.622 \times 10^6 \text{ tons Pb/yr}$$

Ref (37) p 30 Sec 10.0 Mining. The IES depreciation  
 guideline is 10 yrs. Assuming twice the average.

$$P_D = \frac{1}{2(10)} = 0.05$$

$$P_D = 0.05 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 6/5/75

Source Mining & Milling of Lead

Ref (278) p 16

$$E_U = 0.2 \text{ LB / TON of LEAD MINED}$$

Ref (280) Data from p 4-33, 34 would indicate that 0.2 is the uncontrolled level

Ref (280) p 4-35 indicates that controls could consist of H<sub>2</sub>O sprays; hooding, cyclones, wet scrubbers, & baghouses. Since this is a transfer of technology from rock crushing plants in gen'l, we will assume an average control efficiency of 50 %.

$$E_N = 0.1 \text{ LB / TON LEAD MINED} \neq E_{Unl}$$

Ref (278) p 17 indicates 20<sup>48</sup>/day of lead

$$20.0 = .2 (\text{TPD LEAD}) \quad \text{TPD LEAD} = 100$$

$$\text{Assuming } 16 \text{ hr/day op'n} \quad \text{TPH} = \frac{100}{16} = 6.25 \quad \text{TPH} = 12,500 \text{ PPH}$$

From (278) p 14 Avg% Pb = 0.048

$$\text{PWR} = 12500 / .048 = 260,417 \text{ PPH}$$

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Computation Sheet For Emission Factors

Calculations Done By Herrick Date 6/5/75  
 Source Mining + Milling Of LEAD

Ref (278) p.7

6 mines in Missouri & 1 in Idaho

From Ref (84) & (48) PWR curves for 260,000 pph rock

$$MO. = 53.5 \text{ lb/hr}$$

$$Idaho = 53.5 \text{ lb/hr}$$

@ 4.8% LEAD & assuming particulate control results in "de facto" lead control

$$ES_{pb} = \frac{(53.5)(.048)}{6.25} = 0.411 \text{ lb/run Pb}$$

Since this is > EU,  $ES \equiv EU$

$$EU_{pb} = 0.2 \text{ lb/run LEAD MINED}$$

Particulate

For 4.8% Lead

$$EU_p = .2/.048 = 4.17$$

$$EU_p = 4.17 \text{ lb/run LEAD}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 6/5/75

Source Mining & Milling of Lead

$$E_N = .5(4.17) = 2.09$$

$$E_{N_p} = 2.09 \text{ LB/TON LEAD}$$

$$E_{S_p} = E_{N_p}$$

$$E_{S_p} = 4.17 \text{ LB/TON LEAD}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/3/74

Source BRICK & RELATED CLAY PRODUCTS

THIS category includes the grinding, screening, blending, forming, drying, curing & firing of clay pipe, pottery & some types of refractory brick. IT DOES NOT INCLUDE CASTABLE REFRactories.

REF (9) p 309 TAB 14-1

1968 PRODUCTION =  $33.7 \times 10^6$  tons

From REF (8)  $P_c = 2.7\%$  simple

$$\therefore P_c = 0.027 \text{ simple}$$

$$1975 \text{ PRODUCTION} = (33.7 \times 10^6) [1 + 0.027]^7 = 38.56 \times 10^6 \text{ tons}$$

No direct information could be found regarding fractional utilization, K. However, we can estimate it from that of similar industries.

REF (14) p 48 indicates a K for "stone, clay & glass" = 80% for the period 1965-1973. We will assume this value

$$K = 0.80$$

$$A = \frac{38.56 \times 10^6}{0.80} = 35.7 \times 10^6$$

$$A = 35.7 \times 10^6 \text{ tons}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 12/3/74

Source Brick & Clay Products

for "other stone & clay products"

From Ref (37) p.34, the IRS allowable depreciation is 15 yrs. Assuming twice the allowable,

$$P_B = \frac{1}{2(15)} = 0.033$$

$P_B = 0.033$   
Simple

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOMER Date 12/3/74

Source Brick & Clay Products

### Particulates

REF (75) p 8.3-3 TAB 8.3-1

Raw material handling = 96 \*ton

Storage = 34 \*ton

### Curing & firing

REF (18) p 2-8 indicates

- (1) "COAL, OIL & GAS ARE ALL USED TO HEAT THE KILN, HOWEVER, GAS IS BY FAR THE MOST COMMONLY USED FUEL."
- (2) "PERIODIC KILNS ARE ALSO USED TO FIRE TILE, PIPE AND BRICK. BUT, THEY ARE NOT WIDELY USED ESPECIALLY IN MODERN PLANTS."

o We assume

- (1) 75% GAS
- 20% OIL
- 5% COAL
- (2) 75% TUNNEL KILNS
- 25% PERIODIC KILNS

} THESE ASSUMPTIONS DO NOT APPEAR TO BE CRITICAL SINCE PARTICULATE EMISSIONS FROM HANDLING AVERAGE ~100 TIMES GREATER THAN PARTICULATE COMBUSTION EMISSIONS

From REF (75) p 8.3-3 TAB 8.3-1

### Tunnel Kilns

GAS - .04	*	ton
OIL - .6	*	ton
COAL - 1.0A		

### Periodic Kilns

GAS - .11		
OIL - .9		
COAL - .5A		

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/3/74

Source Brick & Clay

$$E_{Up} = (.75) \left[ .04(.75) + (.6)(.2) + (1.0A)(.05) \right] + (.25) \left[ (.11)(.75) + (.9)(.2) + (.5A)(.05) \right]$$

96.0 + 34.0

↑ Assumes storage = Production

Assume Ash content (A) = 8.1% Ref ② p 4-4

$$E_{Up} = .75(63 + .12 + .41) + (.25)(.08 + .18 + .20) + 96 + 34 \\ = .42 + .11 + 96 + 34 = 130.5 \text{ #/ton}$$

$$E_{Up} = 130.5 \text{ #/ton}$$

Ref ⑧ p 5-2 TAB 5.1 INDICATES CONTROL = 99% for blending  
 STORAGE & GRINDING USING FABRIC FILTERS

$$\eta = \frac{313 - 3.1}{313} = 99\%$$

Ref ⑧ p 3-1 STATES  $\eta = 97\%$  for combustion particulates  
 employing A MEDIUM ENERGY SCRUBBER

$$\therefore E_N = (130)(.01) + (.5)(.03) = 1.3 + .015 = 1.315$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/13/74

Source Briek & Clay

$$E_{NP} = 1.32 \text{ #/ton briek, etc.}$$

Since briek & clay products mfg takes place in NEARLY ALL STATES & THERE ARE 851 plants doing so (ref(18) p 1-2 TAB 1-1)  
 we will use the general PWR curve

$$\frac{23.7 \times 10^6 \text{ TONS}}{(851)(870)} = 3.179 \text{ TPH PRODUCTION} = \text{typ plant size}$$

$$\frac{3.179}{.8} = 3.974 \text{ TPH CAPACITY} = \text{typ plant size}$$

$$\text{REF(18) p 2-3, 2-4 indicates a FEED/PRODUCT} = \frac{4890}{4170} = 1.173$$

$$\text{PWR} = 3.974(1.173) = 4.66 \text{ TPA} = 9323 \text{ #/HR}$$

From the gen'l PWR curve,

$$\text{Allowable} = 11.0 \text{ #/HR}$$

$$E_S = \frac{11.0}{3.97} = 2.77 \text{ #/ton}$$

$$E_{SP} = 2.77 \text{ #/ton product}$$

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Calculations Done By Hopper Date 12/3/74  
 Source Brick & Clay

It is conceivable that  $E_S$  could be det'd separately for the combustion aspect of the emissions.

REF ⑩ p 2-8, STATES  $(3-5) \times 10^6$  BTU per ton of  
 BRICK for tunnel kilns

$$\frac{0.5 \text{#/ton brick}}{4 \times 10^6 \text{ BTU/ton brick}} = 0.125 \text{#/10^6} \text{ which is less than the allowable for gas fuel alone}$$

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Computation Sheet For Emission Factors

Calculations Done By Hague Date 12/3/74  
 Source Brick clay

### SO<sub>x</sub>

SO<sub>x</sub> emissions are from the combustion process in the kilns.  
 Using the same assumptions as for particulates & the following  
 factors from REF(75) p8.3-3 TAB 8.3-1

<u>TUNNEL</u>	<u>Periodic</u>
GAS - NEG	GAS - NEG
OIL - 4.05	OIL - 5.95
COAL - 7.25	COAL - 12.05

$$\% \text{ Sulfur (S)}_{\text{oil}} = .265\% \text{ REF(97) p19 TAB 4.9 (arith. avg)}$$

$$\% \text{ Sulfur (S)}_{\text{coal}} = 2.00\% \text{ REF(22) p4.4 TAB 1.2}$$

$$E_{U_{SO_2}} = (.75) \left[ .75(0.0) + (.265)(4.0) + (.05)(7.2) + (2.00) \right]$$

$$+ (.25) \left[ (.75)(0.0) + (.265)(5.95) + (.05)(12.0) + (2.00) \right]$$

$$= (.75)(.212 + .72) + (.25)(.313 + 1.2) = .699 + .378$$

$$= 1.077 \text{ #/ton}$$

$$E_U = 1.077 \text{ #/ton Period}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/3/74

Source Brick & Clay Products

REF(18) p 3-1 STATES  $R = 60\%$  for  $SO_2$  using medium energy wet scrubber

$$E_{N_{SO_2}} = (1 - .60)(1.077) = 0.431$$

$$E_{N_{SO_2}} = 0.431 \text{ #/ton}$$

Previous calculations regarding "Boilers" done by Hopper for this project indicate allowable nationwide emission rate of  $1.589 \text{#/10}^6 \text{ BTU/hr}$  for units  $< 250 \times 10^6 \text{ BTU/hr}$

Again, using the value of  $4 \times 10^6 \text{ BTU/ton brick}$

$$E'_{SO_2} = \frac{1.077 \text{#/ton}}{4 \times 10^6 \text{#/ton}} = 0.269 \text{#/10}^6 \text{ BTU} \text{ which is less than the allowable.}$$

$$\therefore E_S = E_U = 1.077$$

$$E_{S_{SO_2}} = 1.077 \text{ #/ton product}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/31/74

Source Brick & Clay

### CARBON MONOXIDE

Assuming the same breakdowns as with the other pollutants,

FROM REF (75) P 8.3-3 TAB 8.3-1

<u>TUNNEL</u>	<u>PERIODIC</u>
GAS — .04	GAS — .11
OIL — NEG	OIL — NEG
COAL — 1.9	COAL — 3.2

} #/ton

$$\begin{aligned}
 E_{U_{CO}} &= .75 \left[ (.75)(.04) + 0 + .05(1.9) \right] + .25 \left[ (.75)(.11) + 0 + .05(3.2) \right] \\
 &= .75 (.03 + .095) + .25 (.083 + .16) = .094 + .061
 \end{aligned}$$

$E_{U_{CO}} = 0.155 \text{ #/ton product}$

Since no feasible controls (other than proper combustion MAINTENANCE) exist, we will set  $E_N = 0.0$  to determine the MAX hypothetical emissions impact to derive if control technology should be developed

$E_N = 0.0$

Since there are no regulations re: CO,  $E_S = E_U$

$(E_{S_{CO}} = 0.155 \text{ #/ton})$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/3/74  
 Source Brick & Clay Products

### Hydrocarbons

Assuming the same breakdowns as with the other pollutants  
 & from REF (75) p. 3-3 TAB 8.3-1

#### TUNNEL

GAS - .02

OIL - .1

COAL - .6

#### PERIODIC

GAS - .04

OIL - .1

COAL - .9

#/TON

$$\begin{aligned} E_{U_{HC}} &= .75 \left[ (.75)(.02) + (.2)(.1) + (.05)(.6) \right] + (.25) \left[ .75(.04) + (.2)(.1) + (.05)(.9) \right] \\ &= .75 [ .015 + .02 + .03 ] + (.25) [ .03 + .02 + .045 ] \\ &= .0488 + .0238 = .0726 \end{aligned}$$

$$E_{U_{HC}} = .0726 \text{ #/TON}$$

Assume  $E_N = 0.0$  for the same reasons as CO

$$E_{N_{HC}} = 0.0$$

Since there are no reg's,  $E_S = E_U$

$$E_{S_{HC}} = 0.0726 \text{ #/TON}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/3/74  
Source Brick & Clay

### NO<sub>x</sub>

Assuming the same breakdowns as with the other pollutants & from Ref (75) p 8.3-3 and 8.3-1

#### TUNNEL

GAS = .15  
OIL = 1.1  
COAL = .9

#### PERIODIC

GAS = .42  
OIL = 1.7  
COAL = 1.4

$$E_{U_{NO_x}} = .75 \left[ (.75)(.15) + (.2)(1.1) + (.05)(.9) \right] + .25 \left[ (.75)(.42) + (.20)(1.7) + (.05)(1.4) \right]$$

$$= .75(0.113 + 0.22 + 0.045) + .25(0.315 + 0.340 + 0.07)$$

$$= .2835 + .1813 = 0.465$$

$$E_{U_{NO_x}} = 0.465 \text{ #/ton}$$

- for residential heating

Ref (242) p 7-13, 7-16 indicate a reduction in NO<sub>x</sub> of ~ 50% by 1985.  
We will use this value & include the results in the E<sub>N</sub> = 0 category

$$E_{N1} = (1-.5)(.465) = 0.233$$

$$E_N = 0.233 \text{ #/ton}$$

Previous calculations regarding "Boilers" done by Hopper for THIS PROJECT INDICATE A NATIONWIDE ALLOWABLE EMISSION RATE of

$$\begin{array}{l} .22 \text{ - GAS} \\ .30 \text{ - OIL} \\ .73 \text{ - COAL} \end{array} \} \text{ #}/10^6 \text{ BTU}$$

Synthesizing,  $(.75)(.22) + (.2)(.3) + (.05)(.73) = .165 + .06 + .037$   
 $= .262$

Again, using the value of  $4 \times 10^6 \text{ BTU/ton brick}$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/4/74

Source Brick & Clay Products

$\frac{.465}{1 \times 10^{-6}} = 0.116 \text{ #}/10^6 \text{ BTU}$  Since this is less than the allowable, we will set  $E_S = E_U$

$$E_{S_{\text{max}}} = 0.465 \text{ #}/\text{ton product}$$

### Fluorides

From Ref (75) p 8.3-3 TAB 8.3-1

$$E_{U_F} = 1.0 \text{ #}/\text{ton} \quad (\text{for both kiln types})$$

From Ref (18)  $R = 70\%$  using A medium energy wet scrubber

$$E_N = 1.0(1 - .7) = 0.3 \text{ #}/\text{ton}$$

$$E_{N_F} = 0.3 \text{ #}/\text{ton product}$$

Ref (84) & (18) There are no regs applicable to F<sup>-</sup> emissions from brick & clay mfg

$$\therefore E_S = E_U$$

$$E_{S_{F^-}} = 1.0 \text{ #}/\text{ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/4/74,

Source Brick & Clay

$E_{III(d)}$

Since a wet scrubber can be retrofitted to an existing installation, we will assume  $E_{III(d)} = E_N$

$$\frac{E_{III(d)}}{F} = 0.3 \text{ # ton product}$$

## SUMMARY

	$E_U$	$E_N$	$E_S$	$E_{III(d)}$
PART	130.5	1.32	2.77	—
NOx	.465	<del>.233</del> 0.0	.465	—
SOx	1.077	.431	1.077	—
HC	.0726	0.0	.0726	—
F <sup>-</sup>	1.0	.30	1.0	.3
CO	.155	0.0	.155	—

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Computation Sheet For Industrial Factors

Calculations Done By Hornick Date 4/25/75  
 Source Calcium Carbide

This is an update of the 11/25/74 calculation sheet

Ref ⑤ p 724.5020A Jan '72

data indicate a decline in the production of calcium carbide. The following H from p 724.5020C of Ref ⑤ indicates why

The largest use for calcium carbide is for production of acetylene. Most Reppe chemicals and acetylenic alcohols are made from calcium carbide-derived acetylene. Some trichloroethylene and perchloroethylene are made from calcium carbide-derived acetylene; however, most trichloroethylene and perchloroethylene are now manufactured from ethylene or hydrocarbon-acetylene (e.g., acetylene manufactured by the partial oxidation of methane). At one time, all neoprene was manufactured from calcium carbide-derived acetylene, but now butadiene is the main raw material. Ethylene and hydrocarbon-acetylene have very nearly replaced all calcium carbide derived acetylene in vinyl acetate manufacture, and have replaced calcium carbide derived acetylene in vinyl chloride manufacture. Acrylic acid and esters manufacture is no longer based on calcium carbide-acetylene. Propylene has completely replaced calcium carbide-derived acetylene in acrylonitrile manufacture. One source believes that calcium carbide-derived acetylene may cease to be used for the manufacture of chemicals by 1973. (See the CEH ACETYLENE report for further information on chemical uses for acetylene.) The main non-chemical use for calcium carbide derived acetylene is in welding.

Calcium carbide is used in metallurgy for desulfurizing and deoxidizing. In Canada, it is used to produce calcium cyanamide. Calcium cyanamide is not produced in the United States, however. (See the CEH data sheet "Calcium Cyanamide - Imports" for further information.)

7/24.5020A

$$1966 \text{ Capacity} = 1.195 \times 10^6 \text{ tons}$$

$$1970 \text{ Capacity} = .963 \times 10^6 \text{ tons}$$

$$P_c = \sqrt[4]{\frac{.963}{1.195}} - 1.0 = -5.3\%$$

$$P_c = -0.053$$

$$A = (.963 \times 10^6) (1 - .053)^5 = 0.733 \times 10^6$$

$$A = 0.733 \times 10^6 \text{ TONS}\text{CALCIUM CARBIDE}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 1/28/75

Source Calcium Carbide

From Ref (37), p33, the IRS allowable depreciation is 11 yrs.  
 Assuming an obsolescence rate of twice this,

$$\text{Obs. Rate} = \frac{1}{22} = 0.045$$

Since  $P_g$  is greater than this, we can assume that no obsolete facilities are being replaced. IN FACT, it is probable THAT EXISTING plants would be shut down OR the productivity decreased.

$$P_B = 0$$

Ref (95) p 724.5020 A

$$1970 \text{ Capacity} = 963 \times 10^6 \text{ tons}$$

$$1970 \text{ Production} = 780 \times 10^6$$

$$K = 0.81$$

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Calculations Done By Hopper Date 4/28/75

Source Calcium Carbide

Since  $P_C$  is negative &  $P_B = 0$ , NSPS will apply only to emissions of designated pollutants from existing sources. Since there would appear to be no designated pollution emissions from the mfg. of calcium carbide, we will not develop any emission factors at this time.

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OBS  
CALCS

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 11/25/74

Source Calcium Carbide

REF 95 p 724.5020A JAN 72

DATA INDICATE A DEFINITE DECLINE IN THE PRODUCTION OF CALCIUM CARBIDE. THE FOLLOWING IT FROM P 724.5020C OF REF 95 INDICATES WHY

The largest use for calcium carbide is for production of acetylene. Most Reppe chemicals and acetylenic alcohols are made from calcium carbide-derived acetylene. Some trichloroethylene and perchloroethylene are made from calcium carbide-derived acetylene, however, most trichloroethylene and perchloroethylene are now manufactured from ethylene or hydrocarbon-acetylene (e.g., acetylene manufactured by the partial oxidation of methane). At one time, all neoprene was manufactured from calcium carbide-derived acetylene, but now butadiene is the main raw material. Ethylene and hydrocarbon-acetylene have very nearly replaced all calcium carbide-derived acetylene in vinyl acetate manufacture, and have replaced calcium carbide-derived acetylene in vinyl chloride manufacture. Acrylic acid and esters manufacture is no longer based on calcium carbide-acetylene. Propylene has completely replaced calcium carbide-derived acetylene in acrylonitrile manufacture. One source believes that calcium carbide-derived acetylene may cease to be used for the manufacture of chemicals by 1973. (See the CEH ACETYLENE report for further information on chemical uses for acetylene.) The main non-chemical use for calcium carbide-derived acetylene is in welding.

Calcium carbide is used in metallurgy for desulfurizing and deoxidizing. In Canada, it is used to produce calcium cyanamide; calcium cyanamide is not produced in the United States, however. (See the CEH data sheet "Calcium Cyanamid - Imports" for further information.)

∴ (P<sub>c</sub> < 0) (-6.7%)

Because of this decline in production, there would appear to be no economic incentive to replace OBSOLETE CAPACITY.

∴ P<sub>b</sub> = 0

This industry does not appear to be applicable for NSPS

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 12/4/74

Source CASTABLE REFRACERIES

Ref (15) p 1-1

1971 Production = 261,835 tons

Same ref, page

$$P_c = 0.043 \text{ compound}$$

$$\begin{aligned} 1975 \text{ Production} &= (261,835)(1 + .043)^4 \\ &= 309,860 \text{ tons} \end{aligned}$$

Ref (144) p 48 indicates a fractional utilization of 80% for "stone, clay & glass." Since no specific information could be located for Castable Refractories in particular, we will assume this value to be applicable.

$$K = 0.80$$

$$A = \frac{309,860}{.80} =$$

$$A = 387,325 \text{ tons}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 10/4/74  
 Source Ceramic Refactories

From Ref (37) p34, the IRS allowable depreciation for "other stone, & clay products" which includes "ceramic insulating materials" is 15 years. Assuming twice the allowance,

$$P_D = \frac{1}{(2)(15)} = 0.033$$

$$\boxed{P_D = 0.033 \text{ simple}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppers Date 12/14/74

Source Castable Refactories

PARTICULARS

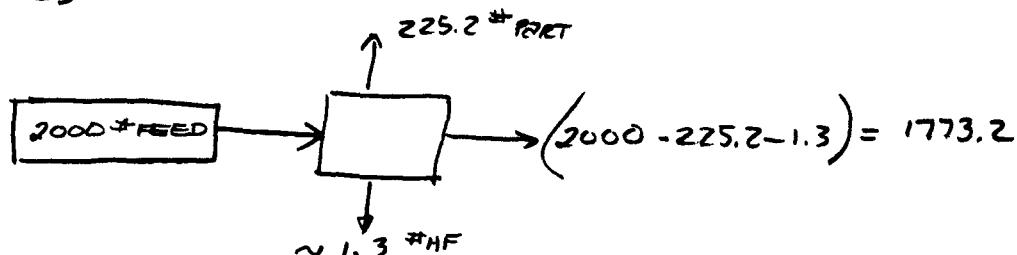
From Ref (75) p 8.5-1 TAB 8.5-1

Dryer — 30  
 Crusher — 120  
 Mixing — 50  
 Curing — .2  
 Molding — 25

1.3 # HF /<sub>TON</sub>  
<sub>MELT</sub>

225.2 #/ton of FEED

Since castable refractory mfg is accomplished by melting a feed stock & pouring this melt into molds, the feed/product ratio could be approximated as follows



$$\text{FEED/PRODUCT} = \frac{2000}{1773.2} = 1.128$$

So

$$E_U = 225.2 \#/\text{ton FEED} \times 1.128 \frac{\text{TON FEED}}{\text{TON PRODUCT}}$$

$$E_U = 254 \#/\text{ton PRODUCT}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/4/74  
 Source Castable Refactories

Ref (75) indicates the following controlled emission factors & devices  
 p 8.5-1  
 TAB 8.5-1

Dryer - 0.3 #/ton w/ Baghouse  
 Crusher - 7.0 #/ton w/ Scrubber  
 Melting - 0.8 #/ton w/ Baghouse  
 Curing NO  
 Molding - 0.3 #/ton w/ Baghouse

$$\overline{8.4 \text{ #/TON} \times 1.128 = 9.48}$$

This corresponds to an overall N of

$$N = \frac{254 - 9.48}{254} = 96.3\%$$

$$E_N = 9.48 \text{ #/TON PRODUCT}$$

EN HAS  
been REDEFINED.  
THIS VALUE IS  
INCORRECT. See p 4 of  
THESE CALCULATIONS

### E<sub>s</sub> DETERMINATION

REF (15) p 1-1 states 67 plants mfg 261,835 (1.01)

$$\text{TYP PLANT SIZE} = \frac{(261,835)(1.01)}{(67)(8760)} = \frac{\text{TONS}}{\text{TPH}} = 0.451 \text{ TPH}$$

$$\frac{0.451}{0.8} \times 1.128 = PWR = 0.636 \text{ TPH} \leq 1272 \text{ #/HR}$$

Ref (15) pg 2 ff gives the name, location & % share of industry for each plant mfg refractories (all). Assuming the

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/5/74

Source Castable Refractories

same breakdown for castable refractories; considering only those whose share was greater than 1%, we determine the following:

Missouri - 8.76%

Georgia - 7.31%

Pa - 5.47%

Ohio - 4.90

All others - 73.56%

Using ref (84), (148) & gen'l pw curve, the Allowable emissions are....

Mo - 3.0

GA - 3.0

Pa - f(SCFM)

Ohio - 3.0

Others - 3.05

$$E_s = f(3.0 \text{ #/hr})$$

$$E_s = \frac{3.0}{(.451)(.8)} = 5.32 \text{ #/ton}$$

This value is less than  $E_N$ , the emission factor representing best level of control. For the case, the process weight reg's are more stringent than the best control can afford. This is understandable in light of the fact that the opposite set of circumstances has been found to exist for many plants.

However, the controlled emissions from the crushing op'n has been determined to be 7#/ton using a scrubber.

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/5/74  
 Source Casmate Refactories

This corresponds to an efficiency of

$$R = \frac{120 - 7}{120} = 94\%$$

Ref (15) p 8.5-1 TAB 8.5-1 indicates that use of a cyclone could reduce emissions to 45#/ton. This device could be used in series with a scrubber to obtain the following result

$$R = .94 = \frac{45 - x}{45}$$

$$x = 2.7 \text{#/ton}$$

We feel that an controlled emission factor of 2.7#/ton could be obtained. Therefore, EN will be redefined

$$EN = (.3 + 2.7 + .8 + .3)(1.128) = 4.62 \text{#/ton}$$

$$\therefore EN = 4.62 \text{#/ton}$$

PRODUCT

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/15/74  
 Source Ceramic Refactories

Fluorides

Ref (75) p 8.5-1 TAB 8.5-1

$$E_{UHF} = 1.3 \text{ #/ton of melt}$$

Since melt  $\propto$  product

$$E_{NHF} = 1.3 \text{ #/ton product}$$

Ref (15) indicates fluoride control of 95% using  
 p 3-1,2 venturi scrubbers

$$E_N = 1.3 (1-.95)$$

$$E_{NHF} = 0.065 \text{ #/ton product}$$

There are no specific regs governing fluoride emissions from ceramic refractory plants

$$\therefore E_S = E_U$$

$$E_{UF} = 1.3 \text{ #/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 12/5/74

Source Coke Refineries

Since vented gasses can generally be retrofitted to existing installations, we will assume  $E_{M1} = E_N$

$$E_{M1(H)} = 0.065 \text{ #/ton}$$

HF

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/4/74  
 Source Ceramic Clay

Ref (49) p 309 TAB 1A-1

1968 Production =  $7.87 \times 10^6$  tons

This is based on

- (1) POTTERY & STONWARE - 514,000 tons
- (2) FLOOR + WALL TILE - 573,000 tons
- (3) FILTERS, CATALYST, CHEMIS, ETC - 3,781,000 tons
- (4) FILLERS - 3,001,000 tons

$$\checkmark \\ 7.87 \times 10^6 \text{ tons}$$

Ref (93) p 145 TAB 9-1 states for the year 1963

- (1) 511,166
  - (2) 434,493
  - (3) 2,166,452
  - (4) 3,435,605
- $$\Rightarrow 5.55 \times 10^6 \text{ tons}$$

Assume simple growth

$$\frac{7.87 - 5.55}{5 \text{ yrs}} = 0.464 \times 10^6 \text{ tons/yr}$$

$$\text{Production 1975} = 7.87 \times 10^6 + 7(0.464 \times 10^6) = 11.1 \times 10^6$$

$$P_c = \frac{464}{11.1} = 0.042$$

$$P_c = 0.042$$

SIMPLE

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Computation Sheet For Industrial Factors

Calculations Done By Home Date 12/4/74

Source Ceramic Clay

Ref (144) p48 indicates a K for "stone, clay & glass" = 80%

$$K = 0.80$$

$$A = \frac{11.1 \times 10^6}{.80} = 13.88 \times 10^6$$

$$A = 13.88 \times 10^6 \text{ tons}$$

From Ref (37) p 34, the IRS allowable depreciation for "other stone & clay products" is 15 yrs. Assuming twice the allowable

$$P_B = \frac{1}{2(15)} = 0.033$$

$$P_B = 0.033$$

Simple

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 12/4/74  
Source Ceramic Clay

### Particulars

Ref (75) p 8.7-1 TAB 8.7-1 indicates

Drying - 70 #/ton  
Grinding - 76 #/ton  
Storage - 34 #/ton } per unit input

Ref (47) p 125 states that

All material is dried  
60% of material is ground

We will assume Quarry Handled = Quarry Stock

$$\therefore E_U = 70 + .6(76) + 34 = 149.6 \frac{\#}{\text{TON INPUT}}$$

No direct information could be found regarding the FEED/PRODUCT RATIO. We will, therefore, use that data for BRICK & RELATED CLAY PRODUCTS MFG - 1.173

$$E_U = 149.6 \frac{\#}{\text{TON INPUT}} \times 1.173 \frac{\text{TON INPUT}}{\text{TON OUTPUT}} = 175.5 \frac{\#}{\text{TON}}$$

$$E_U = 175.5 \frac{\#}{\text{TON PRODUCT}}$$

Ref (75) p 8.7-1 indicates a control efficiency = 90% can be attained using a cyclone & scrubber. However, we feel that a transfer of technology from Brick & Clay mfg is feasible. This would employ a cyclone followed by a fabric filter. Ref (18) p 5-2 TAB 5-1 indicates control = 99%

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Computation Sheet For Emission Factors

Calculations Done By Hause Date 12/4/74  
 Source Ceramic Clay

for blending, storage & grinding

$$\therefore E_N = 175.5 (1 - .99) = 1.755$$

$$E_{N_p} = 1.755 \text{ #/ton product}$$

Since we have no direct information on typical plant size, we will assume the same as brick & related clay products mfg. This should be a valid judgement since the materials, operations & market are quite similar.

TYP SIZE  $\approx$  4 TPH Capacity

Applying a feed/product ratio of 1.173

$$PWR \approx 4.7 \text{ TPH} \approx 9400 \text{ #/hr}$$

Since we do not have the geographical distribution of plants & plant sizes, we will use the generalized process weight rate curve.

Ref (64) + (148)

$$\text{Allowable} = 11.0 \text{ #/hr}$$

$$E_S = \frac{11.0}{4.0} = 2.75 \text{ #/ton}$$

$$E_{S_p} = 2.75 \text{ #/ton product}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/4/74

Source Ceramic Clay

### NO<sub>x</sub>

No published information on NO<sub>x</sub> emissions could be located. However, a great deal of similarity exists between ceramic clay mfg. & brick & clay mfg. The same raw mat's (kaolinite + montmorillonite) are kiln-dried in similar type kilns. We will assume, therefore, until more accurate info is det'd, that the emission factors for NO<sub>x</sub> emissions from ceramic clay are the same as for brick + related clay.

$$E_{U\text{NO}_x} = 0.465 \text{ #/ton}$$

$$E_{N\text{NO}_x} = 0.233 \text{ #/ton}$$

$$E_{S\text{NO}_x} = 0.465 \text{ #/ton}$$

### Fluorides

For the same reasons as mentioned above we will assume fluoride emissions to be the same as as for brick + clay mfg

$$E_{U\text{F}^-} = 1.0 \text{ #/ton}$$

$$E_{N\text{F}^-} = 0.30 \text{ #/ton}$$

$$E_{S\text{F}^-} = 1.0 \text{ #/ton}$$

$$E_{\text{MDF}^-} = 0.3 \text{ #/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/4/74  
 Source Ceramic Clay

### Acid Mist

No direct information on emissions of Acid mist could be found. However, Steen (Ref 217) p 138 states an HCl emission of over 300 \*ton of HCl are "large fused silica furnace".

Ref 18 p 2-8 indicates that brick firing kilns are typically 50 - 250 TPD. Assuming the large plant production applies,

$$EV = \frac{200(24)}{250} = 19.2 \frac{\# \text{ HCl}}{\text{ton product}}$$

$$EV_{HCl} = 19.2 \frac{\# \text{ ton product}}{\text{ton product}}$$

Ref 217 p 138 indicates control by wet scrubbing. A transfer of technology from HCl production, which also uses wet scrubbing to control acid mist emissions shows that an R = 96.7% can be obtained.

See Ref 192 p 13

Calculation sheet for "Hydrochloric Acid" done by Hopper for this project

$$EN = 19.2(1-.967) = 0.634 \frac{\# \text{ ton}}{\text{ton}} = EN_{\text{acid mist}}$$

Since there are no regulations governing acid mist emissions,  $E_S = EV$

$$(E_S = 19.2 \frac{\# \text{ ton}}{\text{ton}})$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/4/74  
 Source Ceramic Clay

$E_{III(d)}$

Wet scrubbers can readily be retrofit to existing installations.

$$\therefore E_{III(d)} = E_N$$

$$E_{III(d)} = 0.634 \text{ # ton}$$

Summary

	$E_U$	$E_N$	$E_S$	$E_{III(d)}$
Part.	175.5	1.755	2.75	—
NO <sub>x</sub>	.465	0.233	.465	—
F <sub>T</sub>	1.0	.30	1.0	.30
Acid Mist	19.2	.634	19.2	.634

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/7/75

Source Clay Sintering

Very little information could be located regarding industrial factors for this industry. In fact, no production information could be found. We will, therefore, estimate a value & relate the value to some known facts to determine if the value appears reasonable.

Ref (222) p 7-41 indicates that a typical plant could produce 420 tons/day of product

This same ref indicates "While the processes for sintering fly ash & clay are generally similar...."

We will assume, until better info is available that the number of clay sintering plants & fly ash sintering plants are equal.

Ref (236) p VIII-32 indicates that there are 5 fly ash sintering plants.

$$(5)(350)(420) = 0.74 \times 10^6 \text{ tons of product}$$

↑  
Assumption

We will assume this to be 1975 capacity

$$A = 0.74 \times 10^6 \text{ tons}$$

product

In order to determine if this # appears reasonable, we will make the following analysis:

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Computation Sheet For Industrial Factors

Calculations Done By Hansen Date 1/7/75

Source Clay Sintering

From Ref 25, in 1972,  $28.6 \times 10^6$  tons of clay were handled

$$\% \text{ Sintered} \approx \frac{.74}{28.6} = 2.6\%$$

If the % were much higher than this, one would expect more discussion in the literature. This value may even be too high.

We will assume that  $K$ ,  $P_C$ ,  $P_B$  are identical to the brick & related clay product industry (see "Industrial Factors - Brick & Related Clay Products")

$$K = 0.80$$

$$P_C = 0.027 \quad \text{simple}$$

$$P_B = 0.033 \quad \text{simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/27/74  
 Source Clay Sintering

Ref (222) p 7-39 indicates

$$\begin{aligned} EU &= 40 \text{ lb/ton} && (\text{CLAY MIXED WITH COKE}) \\ EU &= 12 \text{ lb/ton} && (\text{NATURAL CLAY}) \end{aligned}$$

If we assume a 50/50 usage rate

$$EU = \frac{40+12}{2} = 26$$

$$E_{UP} = 26 \text{ lb/TON PRODUCT}$$

If we assume (as we did with fly ash sintering) that the use of a baghouse or ESP can reduce emissions by 99.9%

$$EN = (1 - .999)(26) = 0.026 \text{ lb/TON PRODUCT} = E_{NP}$$

From Ref (215) we found that clay comes from 47 states; however, the majority (30-35%) comes from Georgia (10.4%), Texas (8.7%), Ohio (6.9%), N.C. (~5%). If we assume that the clay sintering plants are located proportionately in these 4 states & the feed/product ratio is as follows:

Ref (222) p 7-41

$$F/P = 560/420 = 1.333$$

$$F/P = \frac{35/26}{AVG} = 1.35$$

Then using Refs (84) + (48)

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/7/75

Source Clay Sintering

$$\text{for } \frac{420}{24} (2000)(1.34) = \text{PWR} = 46,900 \text{ lb/hr}$$

Georgia - 34.2  $\text{lb}/\text{hr}$

Texas - 62.5  $\text{lb}/\text{hr}$

Ohio - 34.2  $\text{lb}/\text{hr}$

N.C. - 34.2  $\text{lb}/\text{hr}$

$$E_{Sp} = f \left[ \frac{10.4}{31} (34.2) + \left( \frac{8.7}{31} \right) (62.5) + \left( \frac{6.9}{31} \right) (34.2) + \left( \frac{5}{31} \right) (34.2) \right] \\ = f (11.47 + 17.54 + 13.13) = f (42.1)$$

$$E_3 = \frac{42.1 \text{ lb/hr} (24)}{420} = 2.41 \text{ lb/ton product}$$

$$E_{Sp} = 2.41 \text{ lb/ton product}$$

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Computation Sheet For. Industrial Factors

Calculations Done By Homer Date 1/7/75.

Source Fly Ash Sintering

REF (252) ?

$$1972 \text{ Production} = 7.576 \times 10^6 \text{ TONS}$$

REF (236) p VII-32

5 plants in the U.S. 200 TPH, 24 hrs/day, 7 days/wk

$$\text{Capacity} = (5)(200)(8760) = 8.76 \times 10^6$$

$$K = \frac{7.576}{8.76} = 0.86$$

$$K = 0.86$$

We will assume that the growth of fly ash sintering will parallel that of large utility boilers from which the raw mat'l comes. From our analysis of fossil-fueled boilers (see "INDUSTRIAL FACTORS - BOILERS p 15),

$$P_c = 0.055c$$

$$A = (8.76 \times 10^6)(1 + 0.055)^3 = 10.29 \times 10^6$$

$$A = 10.29 \times 10^6 \text{ tons}$$

$P_c$  of these makes indicates a feed/product ratio of 1.34

So

$$A = 10.29 \times 10^6 / 1.34 \\ = 7.68 \times 10^6$$

From Ref. (37) p 36, the IES allowable depreciation for other stone & clay products is 15 yrs. Assuming twice the allowable,

$$P_d = \frac{1}{(2)(15)} = .033$$

$$P_d = 0.033$$

simple

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/7/75  
 Source Fly Ash Sintering

Ref (75) p 8.8-2 TAB 8.8-1

$$E_{UP} = 110 \text{ lb/ton}$$

Ref 236 p VII-32 states that existing plants use either a baghouse or ESP due to fine particulate emission. No control  $\eta$  is stated. We will assume that an  $\eta = 99.9\%$  can be achieved.

$$E_{NP} = (1 - \eta)(110) = .11 \text{ lb/ton}$$

$$E_{NP} = .11 \text{ lb/ton}$$

Ref (236) p VII-32 indicates a typical throughput rate of 200 ton  
 $200(2000) = 400,000 \text{ lb/hr}$

From the same Ref., full scale plants are located in the following states, NY, Pa, Mich

There are 5 plants in the U.S. but we will assume that 33% of the capacity exists in each of the three abovementioned plants.

From Ref's (84) & (148) for a PWR =  $400,000 \text{ lb/hr}$

NY. 62.5 lb/hr

Pa. Ref = f (scfm)

Ref (236) p VII-32 scfm avg = 15,000 scfm  
 $\therefore R_g = 0.04 \text{ gr/scf}$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 1/7/74

Source Fly Ash Sintering

$$\frac{(.04 \text{ lb/scf})(15,000 \text{ scf/min})(60 \text{ min/hr})}{7000 \text{ lb/ton}} = 5.14 \text{ lb/hr}$$

It would appear  
that this reg. cannot  
be met in this case.  
Assume = to the avg  
of NY & Mich

Michigan

58.0 lb/hr

$$62.5 + 58.0 / 2 = 60.2 \text{ lb/hr}$$

Ref (222) p 7-41

A.  $\frac{\text{FEED}}{\text{PRODUCT}} = \frac{560}{420} = 1.333$

B.  $F/P = \frac{35/26}{\overline{Ave}} = 1.35$

$$E_S = \frac{60.2 \text{ lb/hr}(1.34)}{200} = 0.40 \text{ lb/ton}$$

$E_{Sp} = 0.40 \text{ lb/ton product}$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/17/74

Source Coal Cleaning: Thermal Drying

K:

Ref. 010 p. 3-5

$$\text{Production in 1969} = 67.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

Ref. 010 p. 3-6

192 Thermal Drying Units (1969)

Ref. 010 p. 8-3

119 Coal Cleaning Plants with Thermal Drying (1969)

Ref. 010 p. 8-14

$150 \frac{\text{TONS}}{\text{HR}}$ , Capacity for typical thermal dryer (1969)

$$\text{Plant Production} = \frac{67.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{119 \text{ plants}} = .56 \times 10^6 \frac{\text{TONS}}{\text{YR}} / \text{Plant}$$

$$\text{Capacity} = \left( \frac{150 \frac{\text{TONS}}{\text{HR}}}{\text{Dryer}} \right) \left( \frac{192 \text{ Dryers}}{119 \text{ Plant}} \right) \left( 24 \frac{\text{HRS.}}{\text{DAY}} \right) \left( 250 \frac{\text{DAYS}}{\text{YR}} \right) = 1.45 \times 10^6 \frac{\text{TONS}}{\text{YR}} / \text{PLANT}$$

$$K = \frac{.56 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{1.45 \times 10^6 \frac{\text{TONS}}{\text{YR}}} = .39$$

This value does not seem reasonable, unless it is assumed that every thermal drying plant has .7 thermal dryers idle on the average. For this reason we assumed that  $24 \frac{\text{hrs}}{\text{day}}$  was an unrealistic assumption and that two eight hour shifts / day (16 hrs/day) was more reasonable.

$$\text{Therefore } K = (.39) \left( \frac{24}{16} \right) = .59$$

$$K = .59$$

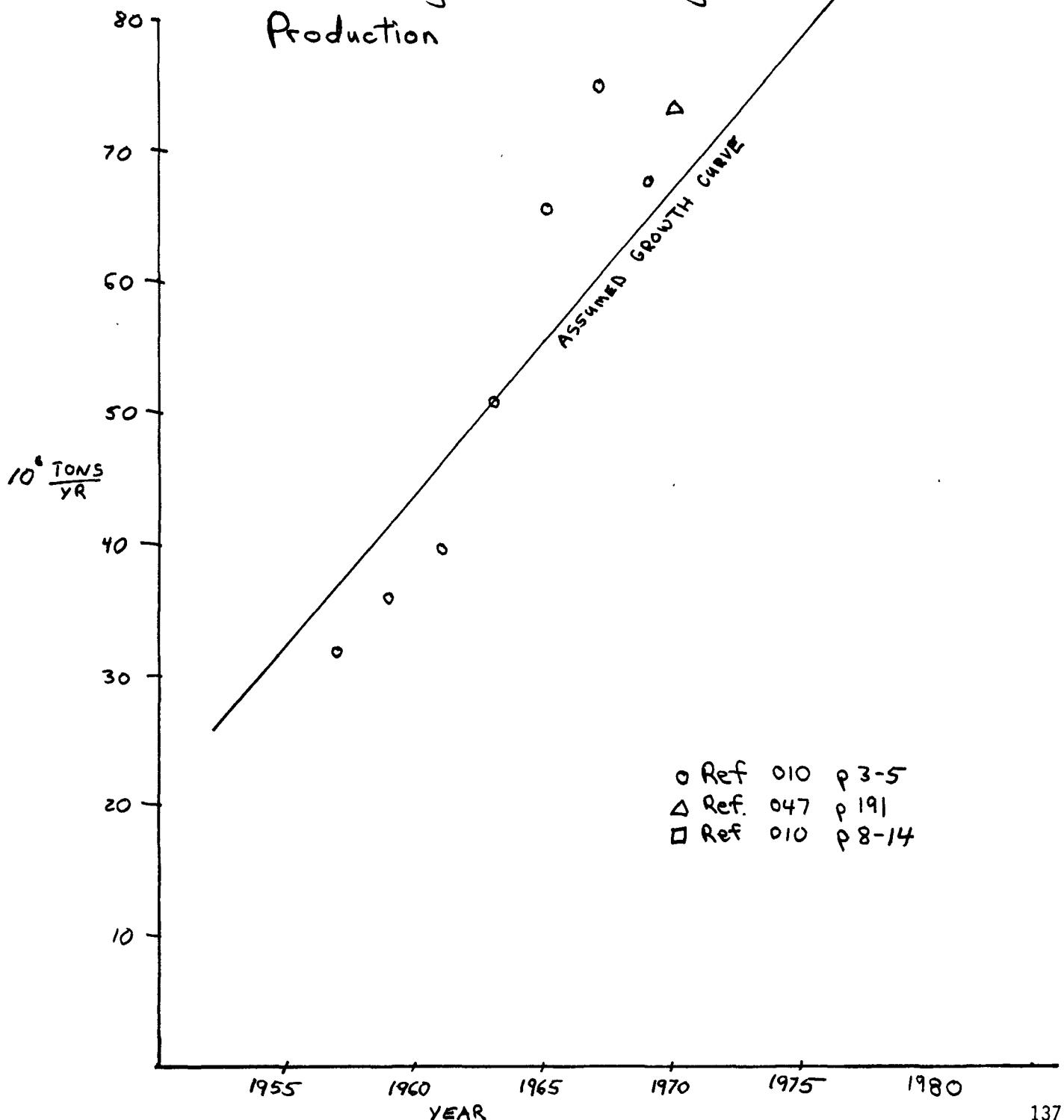
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Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 12/18/74

Source Coal Cleaning : Thermal Drying



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Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 12/19/74

Source Coal Cleaning: Thermal Drying

Extrapolating from the attached graph, production of thermally dried coal in 1975 will be  $78.5 \times 10^6$  TONS  
YR

$$A = \frac{78.5 \times 10^6 \text{ TONS}}{.59} = 133.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$A = 133 \times 10^6 \frac{\text{TONS OF THERMALLY DRIED COAL}}{\text{YR}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

$P_C$  Ref 010 lists the production growth of coal cleaning by thermal drying. The attached graph shows the production curve from 1955 to 1980. Simple growth is assumed. Based on an estimated production in 1975 of  $78.5 \times 10^6$  TONS we estimate a 2.9% growth rate.

From the year 1965 + 1975 there is an increase of approximately  $23 \times 10^6$  TONS OF COAL THERMALLY DRIED.

$$\frac{23 \times 10^6 \text{ TONS}}{10 \text{ yrs}} = 2.3 \times 10^6 \frac{\text{TONS}}{\text{yr}}$$

$$P_C = \frac{2.3 \times 10^6 \frac{\text{TONS}}{\text{yr}}}{78.5 \times 10^6 \frac{\text{TONS}}{1975}} = .029$$

$P_C = .029$   
simply

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Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 12/17/74

Source Coal Cleaning: Thermal Drying

$P_B$ :

Ref 037 Section 10.0

This category describes the asset guideline period for equipment used in the mining and quarrying of metallic and non-metallic minerals and the milling beneficiation and other primary preparation of such materials.

Asset Guideline Period = 10 yrs.

$P_B \text{ est} \rightarrow 2 \times \text{IRS} = 20 \text{ yrs}$

100% depreciation = 5% simple  
 $\frac{100\%}{20 \text{ yrs.}}$

$P_B = .050 \text{ simple}$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

### Particulates

From Ref 010 p. 3-5 we determined the relative percentage of the three main types of thermal dryers

Fluidized Bed	- .61
Multilouvre	- .15
Flash	- .24

Rotary, Screen, Vertical Tray & Cascade were all assumed to be flash type dryers.

Ref 075 Table 8.9-1, p.8.9-1 gives the following uncontrolled emission factors.

Type of Dryer	Uncontrolled Emissions lb/TON
Fluidized Bed	20
Flash	16
Multilouvre	25

$E_u$ :

Fluidized Bed	$(20 \text{ lb/TON})(.61) = 12.20 \text{ lb/TON}$
Flash	$(16 \text{ lb/TON})(.24) = 3.84 \text{ lb/TON}$
Multilouvre	$(25 \text{ lb/TON})(.15) = \frac{3.74 \text{ lb/TON}}{19.78 \text{ lb/TON}}$

$E_u = 19.8 \text{ lb/TON}$   
of coal dried

Ref 075 Table 8.9-1, p.8.9-1 specifies a 99-99.9% control of thermal dryers with the use of a wet scrubber following cyclones. We assumed a 99.5% efficiency

$$E_N = .005 \times E_u = .005 \times 19.8 \text{ lb/TON} \\ = .099 \text{ lb/TON}$$

$E_N = .099 \text{ lb/TON}$   
of coal dried

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Computation Sheet For Emission Factors

Calculations Done By K.Tower Date 12/20/74  
 Source Coal Cleaning: Thermal Drying

$E_N$  (con'd) Ref 237, p. 2 gives the recommended <sup>new source</sup> Federal Standard for emissions for thermal dryers.

$$E_{\text{allowable}} = .031 \frac{\text{g}}{\text{dscf}}$$

$$E_N = \frac{(.031 \frac{\text{g}}{\text{scf}})(22,400 \frac{\text{scf}}{\text{ton}})^*}{7000 \frac{\text{g}}{\text{lb}}} = .099 \frac{1 \text{bs emissions}}{\text{ton coal dried}}$$

\* Ref 010, p. 3-8

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

$\text{SO}_x$ : We assumed that the total  $\text{SO}_x$  emissions were the result of the fuel burned to operate the dryers

Ref 043 p. 219

$$230.8 \frac{\text{BTU reg'd}}{\text{lb coal dried}}$$

Ref 075 Table 1.1-2, p. 1.1-3

$$385 \frac{\text{lbs S}}{\text{ton coal burned}} \text{ for } 10-100 \times 10^6 \frac{\text{BTU}}{\text{HR}} \text{ Dryers}$$

Ref 010 p. 8-14

$$\text{Average thermal dryer now in operation } 150 \frac{\text{TONS}}{\text{HR}} \\ (230.8 \frac{\text{BTU}}{\text{lb coal}}) \left( 150 \frac{\text{TONS}}{\text{HR}} \right) \left( 2000 \frac{\text{lbs}}{\text{TON}} \right) = 69.2 \times 10^6 \frac{\text{BTU}}{\text{HR}}$$

$$\text{This verifies } 385 \frac{\text{lbs SO}_2}{\text{ton coal burned}}$$

Ref 022 p. 4-4 Table 4-2

$$\text{Average \% S in coal} = 2\%$$

$$\therefore \frac{\text{lbs SO}_2}{\text{ton coal burned}} = 76 \quad \text{We assumed all the S is converted to SO}_2$$

Ref 022 Table 4-1, p 4-2

$$26.2 \times 10^6 \frac{\text{BTU}}{\text{TON COAL BURNED}}$$

$$\frac{\left( 230.8 \frac{\text{BTU}}{\text{lb COAL DRIED}} \right) \left( 2000 \frac{\text{lbs}}{\text{TON COAL DRIED}} \right) \left( 76 \frac{\text{lbs SO}_2}{\text{TON COAL BURNED}} \right)}{\left( 26.2 \times 10^6 \frac{\text{BTU}}{\text{TON COAL BURNED}} \right)} = 1.34 \frac{\text{lbs SO}_2}{\text{TON COAL DRIED}}$$

$$E_u = 1.34 \frac{\text{lbs SO}_2}{\text{TON COAL DRIED}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

### SO<sub>x</sub> (cont'd)

Ref 101, p 9-3 shows that coal with a sulfur content as low as 0.5% can be obtained. An economic study should be made to determine the best control mechanism. We assumed the most feasible method to control sulfur emissions would be to reduce the average S content of the coal used for fuel to 0.5% S.

$$\begin{aligned}
 E_N &= \left( \frac{0.5}{2.0} \right) (E_u) \\
 &= \left( \frac{0.5}{2.0} \right) \left( 1.34 \frac{\text{lbs SO}_x}{\text{TON COAL DRIED}} \right) \\
 &= 0.33 \frac{\text{lbs SO}_x}{\text{TON COAL DRIED}}
 \end{aligned}$$

$$E_N = 0.33 \frac{\text{lbs SO}_x}{\text{TON COAL DRIED}}$$

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Computation Sheet For Emission Factors

Calculations Done By K.Tower Date 12/19/74  
source Coal Cleaning: Thermal Drying

$E_s$ :

Ref O10 p 8-5 Table 9

State	Annual Tonnage of Coal Dried (Thermally) [1969]	% of Total	# of Thermal Dryers, 1969
Illinois	10.7	15.9	39
Ohio	4.2	6.3	13
Pennsylvania	4.6	6.9	11
Virginia	10.1	15.1	19
West Virginia	30.8	45.9	82
		90.1	

\* Ref O10, p 8-4 Tables

As shown these 5 states constituted 90.1% of all the coal thermally dried in 1969. We are basing  $E_s$  on just these five states.

$$\text{Illinois } \frac{(10.7 \times 10^6 \frac{\text{TONS}}{\text{YR}}) (2000 \frac{\text{lbs}}{\text{Ton}})}{(39 \text{ plants}) (4000 \frac{\text{hrs}}{\text{yr}})} = 137,179 \frac{\text{lbs}}{\text{hr}} \text{ Production Plant}$$

$$\frac{137,000 \frac{\text{lbs}}{\text{YR}}}{.59} \times 1.0 \frac{\text{lb feed}}{\text{lb prod.}} = 232,203 \frac{\text{lbs coal/dried}}{\text{hr}} \text{ INPUT CAPACITY}$$

$$(69 \frac{\text{Tons}}{\text{HR}}) (2000 \frac{\text{lb}}{\text{Ton}}) = 137,179 \frac{\text{lbs}}{\text{hr}}$$

We ASSUMED THE FEED TO PRODUCT RATIO (F/P) TO BE EQUAL TO 1.0  
 $E_s$  regulations for state are taken from Ref. O84 & Ref 148

For Illinois  $232,000 \frac{\text{lbs}}{\text{hr}}$  Input Capacity,  $32 \frac{\text{lbs}}{\text{hr}}$  emission allowed

$$E_{s, \text{ILL.}} = \left( \frac{32 \frac{\text{lbs}}{\text{hr}}}{69 \frac{\text{Tons}}{\text{HR}}} \right) (.159) = .074 \frac{\text{lbs emissions}}{\text{TON COAL DRIED}}$$

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Calculations Done By K. Tower Date 12/19/74  
 Source Coal Cleaning: Thermal Drying

$E_s$  (con'd)

PT Ohio  $4.2 \times 10^6 \frac{\text{TONS}}{\text{YR}}$

$$\frac{(13 \text{ Plants})(4000 \frac{\text{HRS}}{\text{YR}})}{} = 80.8 \frac{\text{TONS}}{\text{HR}} / \text{PLANT}$$

$$(80.8 \frac{\text{TONS}}{\text{HR}}) \left( 2000 \frac{\text{lbs}}{\text{TON}} \right) = 161,600 \frac{\text{lbs}}{\text{HR}} \quad \text{Average Plant Production}$$

$$\frac{(161,600 \frac{\text{lbs}}{\text{HR}}) \left( 1.0 \frac{\text{lb Feed}}{\text{lb Product}} \right)}{.59} = 273,898 \frac{\text{lb coal dried}}{\text{hr}} \quad \text{INPUT CAPACITY}$$

$E_{\text{allowable}}$  in Ohio for  $274,000 \frac{\text{lbs}}{\text{hr}}$  Input Capacity =  $55 \frac{\text{lbs}}{\text{hr}}$ .  
 (Ref 084 and Ref 148)

$$E_{s_{\text{OHIO}}} = \frac{\left( 55 \frac{\text{lbs}}{\text{ton}} \right)}{\left( 81 \frac{\text{TONS}}{\text{HR}} \right)} \left( .063 \right) = .043 \frac{\text{lbs emissions}}{\text{TON COAL DRIED}}$$

Pennsylvania

Assume  $E_s = E_{s_{\text{average}}}$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/19/74

Source Coal Cleaning: Thermal Drying

$E_s$  (cont'd):

$$\text{PT Virginia } \frac{10.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{(19 \text{ Plants})(4000 \frac{\text{HRS}}{\text{YR}})} = 132.9 \frac{\text{TONS}}{\text{HR}} / \text{PLANT}$$

$$(132.9 \frac{\text{TONS}}{\text{HR}}) (2000 \frac{\text{lbs}}{\text{TON}}) = 265,800 \frac{\text{lbs}}{\text{HR}} \text{ Average Plant Production}$$

$$\frac{(265,800 \frac{\text{lbs}}{\text{HR}})(1.0 \frac{\text{lb Feed}}{\text{lb Product}})}{.59} = 450,508 \frac{\text{lbs coal dried}}{\text{hr}} \text{ INPUT CAPACITY}$$

$E_{\text{available}}$  in Virginia for 450,508  $\frac{\text{lb}}{\text{hr}}$  Input Capacity = 61  $\frac{\text{lb}}{\text{hr}}$  Allowable  
(Ref 084 and Ref 148)

$$E_{s_{\text{Virginia}}} = \left( \frac{61 \frac{\text{lb}}{\text{HR}}}{199 \frac{\text{TONS}}{\text{HR}}} \right) (.151) = .046 \frac{\text{lbs emissions}}{\text{TON coal dried}}$$

$$\text{West Virginia } \frac{30.8 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{(82 \text{ plants})(4000 \frac{\text{HRS}}{\text{YR}})} = 93.9 \frac{\text{TONS}}{\text{HR}} / \text{Plants}$$

$$(93.9 \frac{\text{TONS}}{\text{HR}}) (2000 \frac{\text{lbs}}{\text{TON}}) = 187,800 \frac{\text{lbs}}{\text{HR}} \text{ Average Plant Production}$$

$$\frac{93.9 \frac{\text{TONS}}{\text{HR}}}{.59} = 159.2 \frac{\text{TONS}}{\text{HR}} \text{ Average Plant Capacity}$$

Ref 010, p 3-8 states for an average dryer there is 22,400 standard cubic feet of dry air per ton of coal.

$$\frac{(159.2 \frac{\text{TONS}}{\text{HR}})(22,400 \frac{\text{SCF}}{\text{TON}})}{(60 \frac{\text{min}}{\text{HR}})} = 59,435 \text{ SCFM for typical plant}$$

$$E_{\text{allowable Existing Sources}} = 0.12 \text{ grains/SCF for Dryers} \leq 120,000 \frac{\text{SCF}}{\text{MIN}}$$

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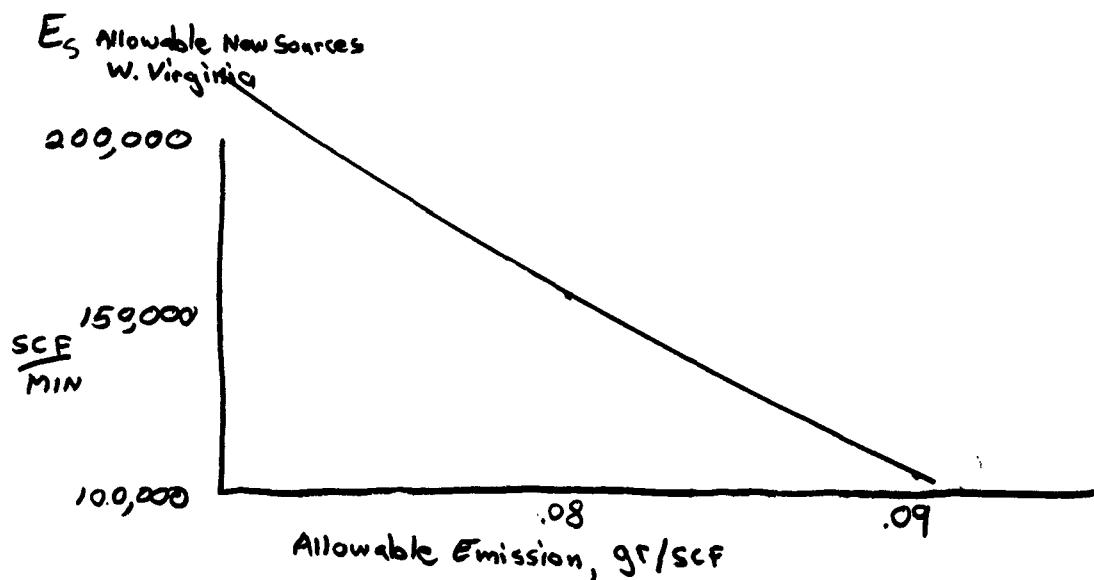
Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/19/74

Source Coal Cleaning: Thermal Drying

$$\frac{E_s \text{ (cond)}}{PT} = \frac{(0.12 \frac{\text{gr}}{\text{SCF}})(2000 \frac{\text{lbs}}{\text{TON}})(22,400 \frac{\text{SCF}}{\text{TON}})}{(14 \times 10^6 \frac{\text{gr}}{\text{ton}})} = .38 \frac{\text{lbs}}{\text{ton coal dried}}$$

$$E_s \text{ existing} = (.38 \frac{\text{lbs}}{\text{TON}})(.459) = .174 \frac{\text{lbs}}{\text{TON}}$$



Ref 010, 8-14 New Dry Capacity Will Be  $400 \frac{\text{TON}}{\text{HR}}$

$$\frac{(400 \frac{\text{TONS}}{\text{HR}})(22,400 \frac{\text{SCF}}{\text{TON}})}{(60 \frac{\text{min}}{\text{HR}})} = 149,333 \text{ SCFM For Typical NEW PLANT}$$

$$E_{\text{ALLOWABLE New Source}} = .0815 \frac{\text{gr}}{\text{SCF}}$$

$$E_s \text{ new source} = \frac{(.0815 \frac{\text{gr}}{\text{SCF}})(2000 \frac{\text{lbs}}{\text{TON}})(22,400 \frac{\text{SCF}}{\text{TON}})}{14 \times 10^6 \frac{\text{gr}}{\text{ton}}} = .261 \frac{\text{lbs}}{\text{ton}}$$

$$148 E_s \text{ new source} = (.261)(.459) = .120 \frac{\text{lbs}}{\text{TON}}$$

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Calculations Done By K. Tower Date 12/19/74

source Coal Cleaning: Thermal Drying

$$\bar{E}_s \text{ (cond)} = E_s^{\text{New Source}} \text{ W. Virginia} = \left( .26 \frac{\text{lbs}}{\text{ton}} \right) \times (.459) = .119 \frac{\text{lbs}}{\text{ton}} \quad E_s^{\text{New Source}} = .119 \frac{\text{lbs}}{\text{ton}}$$

but ILL, OHIO, Virg. & W. Virg.

We make the assumption that all states with thermal dryers have an  $E_s$  equal to the average. percentage of

$$E_s_{\text{Existing}} = E_s_{\text{ILL}} + E_s_{\text{OHIO}} + E_s_{\text{Virg.}} + E_s_{\text{W. Virg.}} + E_s_{\text{Existing}} (.168)$$

$$E_s_{\text{Existing}} = \frac{.074 \frac{\text{lbs}}{\text{TON}} + .043 \frac{\text{lbs}}{\text{TON}} + .046 \frac{\text{lbs}}{\text{TON}} + .174 \frac{\text{lbs}}{\text{TON}}}{1 - .168} = .405 \frac{\text{lbs}}{\text{TON}}$$

$$E_s_{\text{Existing Sources}} = .41 \frac{\text{lbs PT}}{\text{TON COAL DRIED}}$$

$$E_s_{\text{New}} = E_s_{\text{ILL}} + E_s_{\text{OHIO}} + E_s_{\text{Virg.}} + E_s_{\text{W. Virg.}} + E_s_{\text{Existing}} (.168)$$

$$E_s_{\text{New}} = \frac{.074 \frac{\text{lbs}}{\text{TON}} + .043 \frac{\text{lbs}}{\text{TON}} + .046 \frac{\text{lbs}}{\text{TON}} + .120 \frac{\text{lbs}}{\text{TON}}}{1 - .168} = .340 \frac{\text{lbs}}{\text{TON}}$$

$$E_s_{\text{New Sources}} = .34 \frac{\text{lbs IT}}{\text{TON COAL DRIED}}$$

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Computation Sheet For Emission Factors

Calculations Done By K.Tower Date 12/20/74

Source Coal Cleaning: Thermal Drying

E <sub>s</sub> <sub>SO<sub>2</sub></sub> State	Ref 084 & Ref 148		#% of Total Tonnage Dried 1969
	Allowable SO <sub>2</sub> #SO <sub>2</sub> /10 <sup>6</sup> BTU	Allowable SO <sub>2</sub> #SO <sub>2</sub> /Ton Coal Dried	
Colorado	.3	.14	.01
Illinois	1.8 <sub>existing</sub> , 1.2 <sub>new</sub>	.83 <sub>existing</sub> , .55 <sub>new</sub>	.16
Indiana	1.2	.55	.03
Kentucky	3.2	1.48	.05
N. Dakota	3.0	1.39	.00
Ohio	2.9 <sub>existing</sub> , 1.0 <sub>new</sub>	1.34 <sub>existing</sub> , .46 <sub>new</sub>	.06
Pennsylvania	.46	.21	.07
Utah	1.53	.71	.01
Virginia	Ground Level		.15
W. Virginia	1.53	.71	.46

\* Ref 010, p 8-5

# SO<sub>2</sub>/TON COAL DRIED was obtained by multiplying  
#SO<sub>2</sub>/10<sup>6</sup>BTU by the factor 230 BTU  
lb Coal x 2000 lbs  
TON. Ref. 043, p 219.

$$E_{s_{existing}} = (01)E_{s_{col}} + (16)E_{s_{ill}} + (03)E_{s_{ind}} + (05)E_{s_{kent}} + (00)E_{s_{ndak}} + (06)E_{s_{ohio}} + (07)E_{s_{penn}} + (01)(E_{s_{utah}}) + (.15)E_{s_{existing}} + (.46)E_{s_{w.virg.}}$$

We assumed E<sub>s</sub><sub>virg</sub> = E<sub>s</sub><sub>EXISTING</sub>

$$E_{s_{existing}} = .0014 + .133 + .017 + .074 + .000 + .080 + .015 + .007 + .15 E_{s_{existing}} + .327$$

$$E_{s_{existing}} = \frac{.654}{1-.15} = .769 \frac{\text{lbs SO}_2}{\text{Ton Coal Dried}}$$

$$E_{s_{existing}} = .77 \frac{\text{lbs SO}_2}{\text{Ton Coal Dried}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/20/74

Source Coal Cleaning: Thermal Drying

$E_{S_{SO_2}}$  (con'd)

$$E_{S_{SO_2}} = (.01)E_{S_{Calo.}} + (.16)E_{S_{NEW}} + (.03)E_{S_{IND}} + (.05)E_{S_{Kent.}} + (.00)E_{S_{N.Pa.C.}} + (.06)E_{S_{OHIO}} + (.07)E_{S_{Penn.}} + \\ (.01)E_{S_{Utah}} + (.15)E_{S_{New}} + (.46)E_{S_{W.Virg.}}$$

$$E_{S_{NEW}} = .001 + .088 + .017 + .074 + .000 + .028 + .015 + .007 + (.15)E_{S_{NEW}} + .327$$

$$E_{S_{NEW}} = \frac{.557}{1-.15} = .655 \frac{\text{lbs}}{\text{TON}}$$

$$E_{S_{\substack{\text{New} \\ \text{Sources}}}} = .66 \frac{\text{lbs } SO_2}{\text{TON COAL DRIED}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 12/17/74

Source Fiberglass Mfg.

<sup>4 processes</sup>  
 Because of different emissions, this industry must be broken up into two categories

- (a) TEXTILE Products
- (b) Wool Products

From Ref 228 p 42 TAB 8.2

ESTIMATED 1975 PRODUCTION

$$(a) \text{ TEXTILE products} = 725 \times 10^6 \text{ LBS} = 0.363 \times 10^6 \text{ TONS}$$

$$(b) \text{ Wool products} = 1518 \times 10^6 \text{ LBS} = 0.759 \times 10^6 \text{ TONS}$$

From Ref 228 p 1

$$K = 0.70$$

TEXTILE  
+  
WOOL

← Assume to be the same for TEXTILE & WOOL

$$A_{\text{TEXTILE}} = 0.363 \times 10^6 / 0.70 =$$

$$A_{\text{TEXTILE}} = 0.519 \times 10^6 \text{ TONS}$$

$$A_{\text{WOOL}} = 0.759 \times 10^6 / .70 = 1.084 \times 10^6$$

$$A_{\text{WOOL}} = 1.084 \times 10^6 \text{ tons}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 12/17/74

Source Fiberglass Mfg

From Ref (228) p 39

$$P_C_{\text{TEXTILE}} = 0.122 \text{ CMFD}$$

$$P_C_{\text{wool}} = 0.042 \text{ CMFD}$$

Ref (228) p 37 Depreciation period is quoted @ 8 years  
 Assume, that realistically twice this value would hold

$$\therefore P_B = \frac{100\%}{16 \text{ yrs}} = 6.25\%$$

$$P_B_{\substack{\text{TEXTILE} \\ \text{wool}}} = 0.0625 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/17/74

Source Fiberglass

PARTICULATES

Ref (228) p 22 TAB 5.1 gives UNCONTROLLED emission factors for each process type as average values

$$E_{UP_{TEXTILE}} = 84 \text{ #/ton product}$$

$$E_{UP_{WOOL}} = 96 \text{ #/ton product}$$

For Wool Process

Ref (228) discusses controls from A new (1971) O-C-F plant which "INCORPORATES THE LATEST EMISSION CONTROL MEASURES"

O-C-F will be replacing (eventually) ALL reverberatory furnaces with ELECTRIC MELT FURNACES. WE WILL ASSUME THAT ALL NEW & replacement furnaces are of this type. Ref (228) p 24

$$\therefore E_{FURNACE} = 1.1 \text{ #/ton product}$$

$$E_{Furnace} = f(88\% r) \text{ "By changing process conditions, using a scrubber and a baffled denhouse..."} \quad \text{Ref (228) p 28}$$

$$E_{Furnace} = 57.6 (1 - .88) = 6.91 \text{ #/ton product}$$

$$E_{Oven} = f(97\% r) \text{ "treated by incineration"} \quad \text{Ref (228) p 28}$$

$$E_{Oven} = (1 - .97)(9.0) = 0.27 \text{ #/ton product}$$

$$E_{Water} = f(85\% r) \text{ "controlled by water scrubbing"} \quad \text{Ref (228) p 28}$$

$$E_{Water} = (1 - .85)(2.4) = 0.36 \text{ #/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Hause Date 12/13/74

Source Fiberglass

$$E_{N_{\text{WOOL}}} = 8.64 \frac{\#}{\text{ton}} \text{ PRODUCT}$$

Note: Ref 228 p19 This reference (& others) indicate that control of PARTICULATE EMISSIONS from the forming line is difficult. ∴ additional R+D control efforts would be req'd in this area.

### Fur Textile Process

Ref 228 p 29ff

OCF is conducting an R+D program to develop AN ELECTRIC FURNACE FOR TEXTILE FIBER PLANTS. WE WILL ASSUME THAT BY 1985, THIS EFFORT WILL BE SUCCESSFUL

$$E_{N_{\text{FURNACE}}} = 1.1 \frac{\#}{\text{ton}}$$

Presently, no controls are used on the forming & curing lines & roasting does not apply to this process. We will, however, assume a transfer of technology from wool plants by employing the same type control devices & efficiencies.

$$E_{N_{\text{FORMING}}} = 1.6 (1-.88) = 0.192$$

$$E_{N_{\text{CURING}}} = 5.6 (1-.97) = 0.168$$

$$E_{N_{\text{TEXTILE}}} = 1.46 \frac{\#}{\text{ton}} \text{ PRODUCT}$$

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Computation Sheet For Emission Factors

Calculations Done By Hooper Date 12/18/74  
 Source Fiberglass

Es PARTICULATE

IN 1972 THERE WERE 32 mfg plants in the U.S. REF 228  
 P 40,41. P 42A INDICATES for 1972

$$\text{Wool Production} = 1343 \times 10^6 \text{ LBS}$$

$$\text{Textile Production} = 493 \times 10^6 \text{ LBS}$$

Assuming that the typical wool plant is equal in size to the textile plant

$$\frac{(1343 + 493) \times 10^6}{(32)(8760)} = 6550 \text{ LB/HR (Production)}$$

$$\text{Cap.} = \frac{6550}{0.7} = 9357 \text{ LB/HR} = 1.68 \text{ TPH}$$

Ref 228 P 40+41 gives the # of employees in each plant in each state. Since we do not have production or capacity breakdowns, we will assume plant size proportional to the # of employees

TOTAL EMPLOYEES = 20,377

STATE	%	S.C.	14.5
CALIF.	(6.4)	Tenn	6.9
GA.	1.3	Tex	3.7
IND.	3.3	W. Va.	1.8
KANSAS	9.9		
N.J.	8.3		
N.Y.	0.1		
N.C.	(16.7)		
OHIO	(18.3)		
Pa	(5.8)		
RI	2.9		

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Computation Sheet For Emission Factors

Calculations Done By \_\_\_\_\_ Date \_\_\_\_\_  
 Source Fiberglass

8 STATES CONTRIBUTE 87% of the production. We  
 will EVALUATE  $E_{sp}$  FOR THESE 8 STATES

From Refs (84), (148) & (56) the allowable emissions are

CAL - 9.59 #/hr

Pa - assume as the avg

KANSAS - 11.4

SC. - 11.4

N.J. - 30.0

TENN - 9.4

N.C. - 11.4

Ohio - 11.4

$$E_{sp} = [(0.064)(9.59) + (0.099)(11.4) + (0.083)(30) + (0.167)(11.4) + (0.183)(11.4) + (0.145)(11.4) + (0.069)(9.4)] + (E_{sp})(.19)$$

$$\begin{aligned} E_s &= 0.614 + 1.129 + 2.49 + 1.904 + 2.086 + 1.653 + .649 + .19 E_s \\ &= 10.525 + .19 E_s \end{aligned}$$

$$E_{sp} = 12.99 \text{ #/hr}$$

$$E_{sp, wool} = \frac{12.99}{4.68} = 2.78$$

$$E_{sp, wool} = 2.78 \text{ #/hr}$$

$$E_{sp, textile} = 2.78 \text{ #/hr}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 2/8/74  
 Source Fiberglass

The  $E_S$  for wool process cannot be attained with BACT

$$\therefore E_S = E_N$$

$$E_{S_{WOOL}} = 8.64 \text{ #/ton product}$$

HOWEVER,  $E_N$  for TEXTILE process is more stringent than  $E_S$

$$\therefore E_{S_{TEXTILE}} = 2.78 \text{ #/ton product}$$

### Summary of Particulate Emission Factors

	$E_U$	$E_N$	$E_S$
<u>TEXTILE</u>	84.0	1.46	2.78
<u>Wool</u>	96.0	8.64	8.64

### Emission factors for $SO_2$

REF 75 p 8.11-3 TAB 8.11-1 gives emission factors for  $SO_2$

Since we do not know the % breakdown between regenerative & recuperative ovens, assume 50/50 split

$$E_{U_{SO_2}} = (29.6 + 2.7)/2 = 16.2$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/18/74

Source FIBERGLASS

$$EU_{SO_2} = 16.2 \text{ #/ton PRODUCT}$$

Assume eq. inc breakdown for wool process

$$EU_{SO_2} = \frac{10.0 + 9.5 + .04}{3} = 6.51$$

$$EU_{SO_2} = 6.51 \text{ #/ton PRODUCT}$$

As for particulates, the industry is going to electric furnaces.  
 From Ref(55) p 8.11-3 TAB 8.11-1, EUfor electric furnaces  
 for wool processing is 0.04 #/ton. So.

$$EU_{SO_2} = 0.04 \text{ #/ton PRODUCT}$$

Assume that by 1985 R+D efforts for electric furnaces for  
 textile processing is successful & the emission factor is the  
 same as for wool.

$$EU_{SO_2} = 0.04 \text{ #/ton PRODUCT}$$

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Computation Sheet For Emission Factors

Calculations Done By H. P. Lee Date 12/18/74  
 Source Fiberglass

Only IL, IND & NJ have gen'l process SO<sub>2</sub> reg. There are no fiberglass plants in IL & IND & ~ 8.3% of capacity is located in N.J.

THE NJ REG IS 2000 ppm

From Ref(28) p Appendix

FURNACE AIRFLOW IS BETWEEN 4000 & 8000 SCFM

Assuming 6000 SCFM,

$$\left( \frac{.002 \text{ FT}^3 \text{ SO}_2}{\text{FT}^3 \text{ gas}} \right) \left( \frac{6000 \text{ FT}^3 \text{ gas}}{\text{min}} \right) \left( 60 \frac{\text{min}}{\text{hr}} \right) \left( 492^\circ \text{F} \right) \left( 64 \frac{\# \text{ SO}_2}{\# \text{ mole}} \right) = \frac{\# \text{ SO}_2}{\text{TON PRODUCT}}$$

$$(530^\circ \text{F}) \left( \frac{359 \text{ FT}^3 \text{ SO}_2}{\# \text{ mole}} \right) \left( 4.68 \frac{\text{ton product}}{\text{hr}} \right) = \frac{\# \text{ SO}_2}{\text{TON PRODUCT}}$$

" 25.5

Since this is greater than EU for either process,  
 then  $E_{SO_2} = EU$

$$E_{SO_2} = 16.2 \frac{\#}{\text{ton product}}$$

TEXTILE

$$E_{SO_2} = 6.51 \frac{\#}{\text{ton product}}$$

WOOL

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Computation Sheet For Emission Factors

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 Source Fiberglass

### Summary of SO<sub>2</sub> Emission Factors

	<u>E<sub>U</sub></u>	<u>E<sub>N</sub></u>	<u>E<sub>S</sub></u>
TEXTILE	16.2	0.04	16.2
WOOL	6.51	0.04	6.51

### Emission Factors for NO<sub>x</sub>

Ref 75 p 8.11-3 TAB 8.11-1 gives emission factors for NO<sub>x</sub>. Since we do not know the % breakdown between regenerative & recuperative ovens, assume 50/50 split

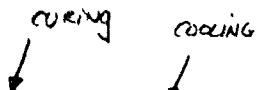
$$E_{U\text{NO}_x \text{ TEXTILE}} = \frac{9.2 + 29.2}{2} = 12.7 \text{#/ton} + 2.6 \text{#/ton} \quad (\text{FROM CURING OVEN})$$

$$E_{U\text{NO}_x \text{ TEXTILE}} = 15.3 \text{#/ton PRODUCT}$$

Assume equal breakdown for wool process

$$E_{U\text{NO}_x \text{ WOOL}} = \frac{5.0 + 1.7 + .27}{3} = 2.32 \text{#/ton} + 1.1 \text{#/ton} + 0.2$$

$$E_{U\text{NO}_x \text{ WOOL}} = 3.62 \text{#/ton PRODUCT}$$



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Calculations Done By HOPPER Date 12/18/74

Source Fiberglass

As was the case for particulate & SO<sub>x</sub>, the industry is changing to electric furnaces. From Ref(75) p.8.11-3 TAB 8.11-1, E<sub>U</sub> for electric furnaces is 0.27 #/ton. So... 0.27 + 1.1 + 2

$$E_{N\text{ NO}_x} = 1.57 \text{#/ton PRODUCT}$$

Assume that by 1985, R+D efforts for electric furnaces for textile processing is successful & the emission factor is the same as for wool.

$$\text{Then } 0.27 + 2.6 = 2.87$$

$$E_{N\text{ NO}_x} = 2.87 \text{#/ton PRODUCT}$$

Since there are no regs. applicable to NO<sub>x</sub> emissions from fiberglass plants E<sub>S</sub> = E<sub>U</sub>

$$E_S = 3.62 \text{#/ton PRODUCT}$$

$$E_{S\text{ NO}_x} = 15.3 \text{#/ton PRODUCT}$$

### Summary (NO<sub>x</sub>)

	<u>E<sub>U</sub></u>	<u>E<sub>N</sub></u>	<u>E<sub>S</sub></u>
<u>TEXTILE</u>	15.3	2.87	15.3
<u>Wool</u>	3.62	1.57	3.62

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Source Fiberglass

## Carbon Monoxide

NOXIDE We will follow with the same assumptions used to calculate the emission factors for parti., NO<sub>x</sub> + SO<sub>x</sub>

REF(75) p 8.11-3 TAB 8.11-1

$$E_{U_{CO}} = \frac{1.1 + .9}{3} = 2.0 + 1.5$$

Curing

$$\text{EU}_\text{CO}_\text{TEXTILE} = 3.5 \text{ #/ton product}$$

$$E_{UCO} = \frac{.25 + .25 + .05}{3} = 0.183 + 1.7 + 0.2$$

$$E_{U_{CO}} = 2.08 \quad \#/\text{TON PRODUCT}$$

Same page & Ref using electric furnaces,  $E_N = .05 + 1.7 + .2$

$$E_{N_{CO}} = 1.95 \text{ #ton product}$$

$$E_{N_{\text{ex}}} = .05 + 1.5 = 1.55$$

$$E_{NCO} = 1.55 \text{ } ^\circ/\text{per cent}$$

Since there are no regs applicable to CO emissions,  $E_S = E_U$

$$E_{\text{SiO}_2} = 3.5 \text{ *} / \text{ton product}$$

$$E_{Sc0} = 2.08 \text{ eV} / \text{run product}$$

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### Summary (CO)

	<u>EU</u>	<u>EN</u>	<u>ES</u>
Textile	3.5	1.55	3.5
Wool	2.08	1.95	2.08

### Hydrocarbon Emission Factors

From Ref (75) p 8.11-3 TAB 8.11-1

$$E_{U_{HC}} = 0.09 + 3.3 = 3.39$$

$$E_{U_{HC}} = 3.39 \text{#/ton produced}$$

curing & cooling

It would appear that there are no H/C emissions from textile processing.

Since the wool curing process would be controlled by INCINERATION TO ELIMINATE PARTICULATES, H/C emissions would ALSO BE ELIMINATED. THE % WAS STATED @ 97%.

$$E_{N_{HC}} = (1-0.97)(3.39) = 0.102 \text{#/ton}$$

$$E_{N_{HC}} = 0.102 \text{#/ton produced}$$

Since there are no regs applicable to these H/C emissions,  $E_S = EU$

$$E_{S_{HC}} = 3.39 \text{#/ton}$$

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Source Fiberglass

### Fluorides

We will follow with the same assumptions used to calculate the emission factors for Part, NO<sub>x</sub> & SO<sub>x</sub> & CO

Ref (75) p 8.11-3 TAB 8.11-1

$$E_{UF^-}_{\text{TEXTILE}} = \frac{3.8 + 12.5}{2} = 8.15$$

$$E_{UF^-}_{\text{TEXTILE}} = 8.15 \text{ #/ton produced}$$

$$E_{UF^-}_{\text{wool}} = \frac{0.12 + .11 + .02}{3} = 0.08 \text{ #/ton}$$

$$E_{UF^-}_{\text{wool}} = 0.08 \text{ #/ton}$$

As was mentioned previously, the industry is switching to electric furnaces. Assuming that R+D efforts to develop electric furnaces for textile processing are successful by 1985 & the emission factor is the same as for wool processing

$$E_{NF^-}_{\text{TEXTILE}} = 0.02 \text{ #/ton } )$$

$$E_{NF^-}_{\text{wool}} = 0.02 \text{ #/ton}$$

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 Source Fiberglass

Since there are no specific fluoride reg's,  $E_S = E_U$

$$E_{S_F^-} = 8.15 \text{ #/ton}$$

TEXTILE

$$E_{S_F^-} = 0.08 \text{ #/ton}$$

WOOL

$E_{III(d)}$

The use of electric furnaces is not a feasible "retrofit" technique. There has been no demonstrated control technology for F<sup>-</sup> control from furnaces in the fiberglass industry. However, Ref (234) p 3-224 indicates wet scrubbing could be used for fluoride emissions from GLASS furnaces with an efficiency of 99%. we will assume this transfer of technology to be feasible.

$$E_{III(d)F^-} = (1-.99)(8.15) = 0.082 \text{ #/ton}$$

TEXTILE

$$E_{III(d)F^-} = 0.082 \text{ #/ton}$$

PRODUCED

$$E_{III(d)F^-} = (1-.99)(.08) = 0.001$$

WOOL

$$E_{III(d)F^-} = 0.001 \text{ #/TON}$$

PRODUCED

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Source Fiberglass

## Summary (Fluorides)

	<u>E<sub>U</sub></u>	<u>E<sub>N</sub></u>	<u>E<sub>S</sub></u>	<u>E<sub>Ind</sub></u>
TEXTILE	8.15	0.02	8.15	0.082
Wool	0.08	0.02	0.08	0.001

Summaries can be found on the following pages: 5, 8, 9, 11, 14

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Computation Sheet For Industrial Factors

Calculations Done By Hoyer Date 12/19/74

Source FRIT Mfg

REF (234) p 3-231

Fluorospar Use in 1968 = 7800 tons

Ref (234) p 3-232,3 indicates the relationship (typical) between fluorospar & frit manufactured

$$\frac{215 \text{ #F/TON CaF}_2}{3.15 \text{ #F/TON FRIT}} = 68.25 \quad \frac{\text{TON FRIT}}{\text{TON CaF}_2}$$

$$7800 \text{ tons CaF}_2 \times 68.25 \frac{\text{TON FRIT}}{\text{TON CaF}_2} = 0.532 \times 10^6 \text{ TONS FRIT}$$

" 1968 Production

No direct information could be found regarding fractional utilization, K. However, we can estimate it from that of similar industries. Ref (144) p 48 indicates a K for "stone, clay & glass" = 80% for the period 1965 - 1973. We will assume this value.

$$K = 0.80$$

Again, no specific information could be located regarding growth rate. We will, therefore, assume the growth to be similar to that experienced by similar industries.

Brick, & Related Clay Products — 2.7% s

Ceramic Clay — 4.2% s

Castable Refractories - 4.3% s

See Specific Calculation Sheets for the development of these

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 Source FRT

growth rates

$$P_{C_{AVG}} = \frac{2.7 + 4.2 + 4.3}{3} = 3.7$$

$$(P_C = 0.037) \text{ simple}$$

$$A = \frac{(0.532 \times 10^6)(1 + [7][0.037])}{.8} = 0.837 \times 10^6$$

$$A = 0.837 \times 10^6 \text{ tons}$$

Ref (37) p34 indicates that the IRS allowable depreciation for "other stone & clay products" which includes "ceramic insulating materials" is 15 years. We will assume this to be representative. So, using once the allowable,

$$P_B = \frac{1}{(2)(15)} = 0.033$$

$$P_B = 0.033 \text{ simple}$$

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 Source Feit Mfg.

Ref (15) p 8.12-2 TAB 8.12-1

Uncontrolled

$$\text{PARTICULATE EMISSION} = 16 \text{ #/TON MAT'L PROCESSED}$$

Ref (234) p 3-233 indicates that 890 LBS of feit are mfg from 990 LBS of feedstock

$$E_{UP} = 16 \text{ #/TON INPUT} \times \frac{990 \text{ TON INPUT}}{890 \text{ TON OUTPUT}} = 17.8$$

$$E_{UP} = 17.8 \text{ #/TON FEIT}$$

Ref (55) p 8.12-2 TAB 8.12-1 indicates that high AP venturi scrubbers can reduce particulate by 67%. Ref (46) p 788 indicates that a baghouse could also be used however, no % is stated. We feel that an efficiency of at least 90% could be attained with a properly designed unit.

$$E_{NP} = 17.8 (1 - .9) = 1.78$$

$$E_{NP} = 1.78 \text{ #/TON FEIT}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date \_\_\_\_\_

Source Frit \_\_\_\_\_

From Ref (23) p 3-233 A typical furnace handling 1000# of RAW MAT'L / HR WAS SELECTED. This size would appear TO BE TYPICAL ALSO BASED ON INFORMATION IN Ref (46) p 783 WHICH INDICATES SIZES BETWEEN 100 & 3000 LBS.

Since the geographical distribution of capacity is unknown we will use the general PWR curve as developed from Ref (24) + (48)

$$PWR = 1000 \text{#/hr}$$

$$\text{Allowable} = 2.58 \text{#/hr}$$

$$ES_p = \frac{2.58(2000)}{890} = 5.80 \text{#/ton Frit}$$

$$ES_p = 5.80 \text{#/ton Frit}$$

### Fusenes

Ref (75) p 8.12-2 TAB 8.12-1

$$EV_{F-} = f\left(5 \text{#/ton MAT'L PROCESSED}\right)$$

As with particulates,

$$5 \times \frac{990}{890} = 5.56 \text{#/ton Frit} = EV_{F-}$$

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 Source Frit

High ΔP wet scrubbing will reduce fluorides by 94%

$$E_N = 5.56(1-.94) = 0.334$$

$$\therefore E_{N_F^-} = 0.334 \text{ #/ton}_{\text{Frit}}$$

There are no applicable regulations for fluoride emissions

$$\therefore E_S = E_N$$

$$E_{S_F^-} = 5.56 \text{ #/ton}_{\text{Frit}}$$

$E_{III(d)}$  A wet scrubber can be retrofitted, in most cases, to an existing installation.

$$\therefore E_{III(d)} = E_N$$

$$(E_{III(d)} = 0.334 \text{ #/ton}_{\text{Frit}})$$

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Source Frit

### TRACE METALS

No mention of trace metal emissions was located. However, we can generate a factor from the material flow balance sheet on P 3-232, 293 of Ref 234

From the 996 lbs of raw material input (day)

- (a) 300 # of borax ( $\text{Na}_2\text{B}_4\text{O}_7$ )
- (b) 1 # of CoO
- (c) 4 # of MnO
- (d) 1 # of NiO

$$\frac{\text{B}_4}{\text{Na}_2\text{B}_4\text{O}_7} = \frac{4(10.8)}{2(11) + 4(10.8) + 7(16)} = \frac{43.2}{22 + 43.2 + 112} = .244$$

$$300(.244) = 73.2 \text{ # Boron}$$

$$\frac{\text{Co}}{\text{CoO}} = \frac{27}{27+16} = .628$$

$$(1)(.628) = .628 \text{ Cobalt}$$

$$\frac{\text{Mn}}{\text{MnO}} = \frac{25}{25+16} = .610$$

$$(1)(.610) = .610 \text{ # Mn}$$

$$\frac{\text{Ni}}{\text{NiO}} = \frac{28}{28+16} = .636$$

$$(1)(.636) = .636 \text{ # Ni}$$

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 Source FRIT

$$\frac{73.2 + .428 + 2.44 + .636}{996} = \frac{76.904}{996} = .0772$$

If we assume that the particulate emission contains this % of trace metals, then

$$E_{U_{TM}} = 17.8(0.0772) = 1.374 \text{ #/ton FRIT}$$

$$E_{U_{TM}} = 1.374 \text{ #/ton FRIT}$$

If we assume that the baghouse efficiency applies equally to trace metals, then

$$E_{N_{TM}} = 1.374(1-\alpha) = 0.082$$

$$E_{N_{TM}} = 0.082 \text{ #/ton FRIT}$$

There are no regs for trace metals.  $\therefore E_S = E_U$

$$E_S = 1.374 \text{ #/ton FRIT}$$

If we assume that the efficiency of a wet scrubber ✓  
 for particulates

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Source FRIT

can remove TM's with equal efficiency, then

$$E_{(NET)} = 0.082 \frac{\#}{\text{ton FRIT}}$$

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Computation Sheet For Industrial Factors

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Source Glass Mfg.

Ref (16) p 1-1 There are nearly 700 different compositions of glass.

p 1-2 Soda-lime glasses account for 90% of the glass tonnage.

The mfg of opal glass is the major glass industry source of fluoride emission (REF (16) p 2-18)

We will, therefore, consider for this study

- ① SODA-lime glass
- ② OPAL GLASS

### Soda-Lime Glass

Ref (16) p 1-3 states that

$$1967 \text{ Production} = 25 \times 10^6 \text{ tons}$$

$$\text{Soda-lime glass} = (0.9)(25 \times 10^6) = 22.5 \times 10^6 \text{ tons}$$

Ref (16) P 1-5 TAB 1-S shows an overall growth in the industry of 2.8% (simple)

$$P_c = 0.028 \quad \text{simple}$$

$$1975 \text{ Production} = (22.5 \times 10^6) [1 + (8)(0.028)] = 27.54 \times 10^6$$

Ref (16) p 48 TAB 1-S indicates a K for "Stone, Clay & Glass" to be 0.80 based on the Avg between 1965 and 1973

$$K = 0.80$$

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 Source Glass Mfg

$$A = \frac{2754 \times 10^6}{0.80} = 34.43 \times 10^6$$

$$A_{\text{SODA-LIME CLASS}} = 34.43 \times 10^6 \text{ tons}$$

Since no specific ref. could be found for  $P_B$ , we will assume twice the IRS allowable depreciation for a similar industry - "other stone & clay products". Ref (37) p 34 gives 10% allowable AS 15 yrs.

$$P_B = \frac{1}{(2)(15)} = 0.033$$

$$P_B = 0.033 \text{ simple}$$

### OPAL GLASS

Ref (34) p 3-219 TAB 3-73 indicates that in 1968, 34,500 tons of  $\text{CaF}_2$  were used to make opal glass. Same Ref, p 3-218 shows that 4950 tons of glass are produced from (among other constituents) 560 tons  $\text{CaF}_2$

$$\frac{1968 \text{ Production}}{\text{OPAL GLASS}} = \left(34,500\right) \left(\frac{4950}{560}\right) = 0.305 \times 10^6 \text{ tons}$$

Since no specific info could be located regarding  $K$ ,  $P_C$  &  $P_B$  for opal glass mfg, we will assume them to be the same as for soda-lime glass

$$K = 0.80$$

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Source Glass Mfg.

$$P_C = 0.028 \text{ simple}$$

$$P_B = 0.033 \text{ simple}$$

$$A_{OPAL} = (0.305 \times 10^6) [1 + (7)(0.028)] \div 0.80 = 0.456 \times 10^6$$

$$A_{OPAL} = 0.456 \times 10^6 \text{ tons}$$

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 Source Glass Mfg

### Soda-Lime Glass

Ref(15) p 8.13-1 TAD 8.13-1

$$E_{UP} = 2 \text{ lb/ton glass}$$

The application of control devices in this industry is just developing (Ref(16) p 3-1). P 3-4 (same ref) notes that a 99% + efficiency can be attained with fabric filters. Assuming 99%

$$E_{NP} = (1 - .99)(2) = 0.02$$

$$E_{NP} = 0.02 \text{ lb/ton glass}$$

Ref(16) p 1-3 states that in 1967, establishment shipped 68,000 tons of glass /yr

Assuming 330 days of operation @ 24 hrs/day

$$\frac{68,000(2000)}{(330)(24)} = 17,172 \text{ lb/hr production}$$

If we assume a feed/product ratio as mentioned on p 3-218 of Ref(24)  
 "factors" & A K = 0.80

$$PWR = \frac{(17172)(5480 - 90)}{(0.80)(4950)} = 23,373 \text{ lb/hr}$$

Since we do not know the geographical distribution of the 369 (Ref(16) p 1-3)

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Source Glass Mfg

establishments, we will use the gen'l PWR curve generated from  
Ref's (89) & (148)

$$\text{Allowable} = 20.3 \text{ lb/hr}$$

$$\frac{\text{Production} = 17,172}{\text{Rate } (.8/2000)} = 10.73 \text{ TPH}$$

$$E.S.P_{SO_2} = 20.3 / 10.73 = 1.89 \text{ lb/ton GLASS}$$

$$E.S.P_{SO_2} = 1.89 \text{ lb/ton GLASS}$$

Ref (75) p 8.13-1 TAB 8.13-1 gives a fluoride emission factor of 4 x .2 F lb/ton. Ingen'F emissions from soda-lime glass mfg are small.

Ref (16) p 2-10 indicates an effluent fluoride content of 1.9 - 2.2 ppm which we assume this to be negligible.

The same ref, page, shows NO<sub>x</sub> emissions of 340 (flint/glass) + 40 (analog glass) ppmv. We must convert those values to lb/hr using other data found on p 2-10 of Ref (16).

$$\frac{(.029 \frac{\text{lb}}{\text{SCFM}})(60)}{(7000 \frac{\text{ge}}{\text{LB}})(2.1)} \cdot (\text{INVERT}) = \text{SCFM} = 84.7$$

$$\frac{(340 \times 10^{-6} \frac{\text{ft}^3 \text{NO}_x}{\text{lb}})(8448 \frac{\text{ft}^3 \text{ge}}{\text{min}})(60 \frac{\text{min}}{\text{hr}})(46 \frac{\# \text{NO}_x}{\text{lb NO}_x \text{ NO}_x})}{387 \frac{\text{ft}^3 \text{NO}_x}{\text{lb NO}_x}} = 20.48 \frac{\text{lb NO}_x}{\text{hr}}$$

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Source Glass Mfg

If we assume that our typical plant size is applicable (no mention of production rate was given),  $17,172 \frac{\text{LB}}{\text{HR}} = 8.568 \text{ TPH}$

$$E_{NO_x} = \frac{20.48 \frac{\text{LB}}{\text{HR}}}{8.568 \frac{\text{ton}}{\text{HR}}} = 2.39 \text{ % ton for flint glass furnace}$$

Now for amber glass furnace

$$\frac{(7000)(5.4)}{(.041)(60)} = 5000 = 15,366$$

$$(640 \times 10^{-4})(15366)(60)(48) / 387 = 70.14 \frac{\text{LB}}{\text{HR}}$$

$$E_{NO_x} = \frac{70.14}{8.568} = 8.186 \text{ % ton for amber glass furnace}$$

We will assume the avg

$$E_{NO_x} = \frac{2.39 + 8.186}{2} = 5.29$$

$$E_{NO_x} = 5.29 \frac{\text{LB/ton}}{\text{glass}}$$

Ref (42) p 9-1 states that control efforts for kilns, furnaces etc. are just beginning & anticipated levels of NO<sub>x</sub> reduction have not yet been formulated. As we have done in the past, we will set  $\Delta E = 0.0$  to define the maximum hypothetical impact that could exist under 100% control. This will aid in a prioritization for control techniques R+D efforts.

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Source Glass Mfg

$$E_{N\text{O}_x} = 0.0 \frac{\text{lb}}{\text{ton glass}}$$

The avg NO<sub>x</sub> control level for the U.S. is 0.218 lb/10<sup>6</sup> BTU for gas fired units < 250x10<sup>6</sup> BTU/HR (Avg of info from Ref ④ + ⑪ - See "EMISSION FACTORS - BOILERS"). For oil the value is 0.3 lb/10<sup>6</sup> BTU  
 Ref ⑥ p 772-774 gives heat input req'ts for N.G. fired regenerative furnace.

Using a value of 6 ft<sup>2</sup>/ton glass per day

↓ 8.568x24 tons of glass/day, 16 hrs/day

$$(6)(16)(8.568) = 823 \text{ ft}^2 \Rightarrow 7500 \frac{\text{ft}^3}{\text{ton glass}} \text{ of NG.}$$

From Fig 591 p 774  
 Ref ⑥

@ 1050 BTU/ft<sup>3</sup> Ref ⑦ p 1.1-1

$$\left( 7500 \frac{\text{ft}^3}{\text{ton glass}} \right) \left( 1050 \frac{\text{BTU}}{\text{ft}^3} \right) = 7.875 \times 10^6 \frac{\text{BTU}}{\text{ton glass}}$$

Assuming a fuel use of 50/50 oil/gas

$$\left( 7.875 \times 10^6 \right) \left( \frac{0.218 + .3}{2} \right) 10^{-6} = 2.04 \frac{\text{lb}}{\text{ton glass}} = E_S$$

$$E_{S\text{NO}_x} = 2.04 \frac{\text{lb}}{\text{ton glass}}$$

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 Source Glass Mfg

SO<sub>x</sub> An analysis, similar to NO<sub>x</sub> can be conducted

Using the same Ref's & pages A5 NO<sub>x</sub>

$$\frac{(10^{-6})(250+17)(8448)(60)(64)}{387} \xrightarrow{\text{assume all SO}_2} = 22.38 \frac{\text{lb SO}_x}{\text{HR}}$$

$$E_{SO_x \text{ soda-lime}} = \frac{22.38}{8.568} = 2.61 \frac{\text{lb}}{\text{ton glass}} (\text{flint glass})$$

$$\frac{(315+15)(10^{-6})(15366)(60)(64)}{1387)(8.568)} = 5.872 \frac{\text{lb}}{\text{ton glass}} (\text{amber glass})$$

We will assume the avg

$$\frac{5.872 + 2.61}{2} = 4.24$$

$$E_{SO_x \text{ soda-lime}} = 4.24 \frac{\text{lb}}{\text{ton glass}}$$

For the same reason as for NO<sub>x</sub>

$$E_{NO_x \text{ soda-lime}} = 0.0$$

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 Source Glass Mfg

The avg SO<sub>x</sub> content level for oil in the U.S. is 1.589 "B/ton<sub>BRU</sub>

There are no specific reg's for gas, however, one would not expect a state to permit more than that for oil.

$$(7.875 \times 10^6)(1.589)(10^{-6}) = 12.51 \text{ "B/ton}$$

Since this is > than EU,  $E_S = E_U$

$$E_{S_{SO_x}} = 4.24 \text{ "B/ton glass}$$

### OPAL GLASS

It will be assumed that particulate emissions from an opal glass furnace are equal to that from a soda-lime glass furnace plus the particulate fluoride that is emitted.

Ref (22) p 3-218 states fluoride emissions of  $\frac{0.6 \text{ (cc/m)}^3}{4.95 \text{ ton}} = 0.242 \text{ "}$

$$E_{Up} = 2.24 = 2.24 \text{ "B/ton}$$

$$E_{Up} = 2.24 \text{ "B/ton glass}$$

← includes soluble fluorides

from soda-lime glass

As was the case for particulates,  $A = 99\%$  using filters. Assuming 99%,

$$E_N = (1 - .99)(2.24) = 0.0224$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/16/75  
 Source Glass Mfg

$$E_{NP} = 0.0224 \text{ lb/ton}$$

OPAL  
GLASS

Ref (234) p 3-217 states that there are 5 opal glass plants each having a capacity of between 60 & 70 TPD  
 Assuming the avg of 65 & 16 hrs/day

$$\frac{(65)(2000)}{16} = 8125 \text{ % of output capacity}$$

Using a feed/product ratio as per p 1 of those refs,

$$PWR = \frac{(8125)(5480-90)}{4950} = 884.7 \text{ t/hr}$$

Using the generalized PWR curve, from Refs (84) & (148)  
 The allowable is 10.6  $\text{lb/hr}$

$$E_S = \frac{(10.6)(2000)}{8125} = 2.61 \text{ lb/ton}$$

Since this is > than  $E_{NP}$ ,  $E_S = E_{NP}$

$$E_{SP} = 2.24 \text{ lb/ton}$$

OPAL  
GLASS

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Calculations Done By Homer Date 1/16/75

Source Glass Mfg.

### Opal Glass

#### FLUORIDES

Ref(234) p 3-218 gives the uncontrolled fluoride emission factor of  $\frac{(54.0 + 0.6)(200)}{4950} = 22.06 \text{ lb/ton glass}$

54.0 (gaseous)

0.6 (solid)

$$E_{UF^-} = 22.1 \text{ lb/ton glass}$$

The only collection device that would reduce the gaseous HF is a wet scrubber (Ref(234) p 3-220) with an 80% N (same page)

$$E_N = (1 - .8)(22.1) = 4.42 \text{ lb/ton glass}$$

$$E_{N^-} = 4.42 \text{ lb/ton glass}$$

Since there are no regs governing HF emissions & since particulate control would cause a "defect" control of solid fluorides

$$E_{SF^-} = 22.1 \text{ lb/ton glass}$$

Since a wet scrubber could, in most cases, be retrofit to an existing installation, we assume  $E_{NDF^-} = E_N$

$$E_{NDF^-} = 4.42 \text{ lb/ton glass}$$

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Calculations Done By Hopper Date 1/16/75

Source Glass Mfg

We will assume that emissions of  $\text{NO}_x$  &  $\text{SO}_x$  will be the same as for soda-lime glass mfg since the furnaces and temperatures are similar.

### $\text{NO}_x$

$$E_U = 5.29 \text{ lb/ton GLASS}$$

NO<sub>x</sub>  
OPAL  
GLASS

$$E_{N_{\text{NO}_x}} = 0.0$$

CAL GLASS

$$E_{S_{\text{NO}_x}} = 2.04 \text{ lb/ton GLASS}$$

OPAL GLASS

### $\text{SO}_x$

$$E_{U_{\text{SO}_x}} = 4.24 \text{ lb/ton GLASS}$$

OPAL GLASS

$$E_{N_{\text{SO}_x}} = 0.0$$

CAL GLASS

$$E_{S_{\text{SO}_x}} = 4.24 \text{ lb/ton GLASS}$$

OPAL GLASS

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Calculations Done By HOPPER Date 1/16/75  
 Source Glass Mfg

SUMMARY:	SODA-LIME GLASS			OPAL GLASS			
	EU	EN	Es	EU	EN	Es	Enid
Pt	2.0	0.02	1.89	2.24*	.0224*	2.24	—
F <sup>-</sup>	—	—	—	22.1	4.42	22.1	4.42
NO <sub>x</sub>	5.29	0.0	2.04	5.29	0.0	2.04	—
SO <sub>x</sub>	4.24	0.0	4.24	4.24	0.0	4.24	—

\* INCLUDES solid fluorides

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 11/25/74

Source Gypsum

REF (144) p 5-38

PRODUCTION =  $12.592 \times 10^6$  TONS  
 1973

From Ref (95) p 214.3020 6/69

THE GROWTH TREND FOR CALCINED GYPSUM APPEARS TO BE RELATIVELY FLAT. THE MANY UPS & DOWNS ARE PROBABLY DUE TO TRENDS IN THE HOUSING INDUSTRY - THE MAJOR USER OF THE PRODUCT.

THE "AVG" GROWTH WILL BE DET'D FROM DATA (REF95) BETWEEN 1950 & 1968. THE GROWTH TREND OVER THIS LONG PERIOD IS PROBABLY MORE REPRESENTATIVE THAN THAT DET'D FROM TWO CONSECUTIVE YEARS

Assume simple growth:

$$\begin{aligned} 1950 &= 7.4 \times 10^6 \text{ TONS} \\ 1968 &= 8.7 \times 10^6 \text{ TONS} \end{aligned}$$

$$\left( \frac{8.7 - 7.4}{18} \right) (10^6) = .072 \text{ X } 10^6 \text{ TPY}$$

$$\begin{aligned} 1975 \text{ Production} &= 12.592 \times 10^6 + 2(.072 \times 10^6) \\ &= 12.736 \times 10^6 \text{ TONS} \end{aligned}$$

No direct information could be found relative to FRACTIONAL UTILIZATION RATE

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 11/25/74

Source Gypsum

From REF (144) p 48, K for "STONE, CLAY, AND  
 glass" = 80% for the period '65 → '73.  
 We will assume this value for gypsum

$$A = \frac{12.736 \times 10^6}{.80} = 15.92 \times 10^6$$

$$K = 0.80$$

$$A = 15.92 \times 10^6 \text{ tons}$$

$$P_c = \frac{0.072}{12.736} = 0.0057$$

$$P_c = 0.0057$$

simple

REF (37) p 34

IRS ALLOWABLE  
 DEPRECIATION } = 20 yrs  
 FOR "CEMENT" }

IRS ALLOWABLE  
 DEPRECIATION } = 15 yrs  
 FOR "OTHER STONE  
 AND CLAY PRODUCTS" }

$$\text{Assume } P_B = \frac{1}{2(\text{AVG})} = \frac{1}{2(17)} = .0294 = P_B$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 11/25/74

Source Gypsum

### PROCESSES

REF (75) TAB 8.14-1

$$\begin{array}{rcl}
 \text{Raw mat'l DRYER} & = & 40 \text{ #/ton} \\
 \text{PRIMARY GRINDER} & = & 1 \text{ "} \\
 \text{CALCINER} & = & 90 \text{ "} \\
 \text{CONVEYING} & = & .7 \text{ "} \\
 \hline
 & & 131.7 \text{ #/ton}
 \end{array}$$

$$E_U = 131.7 \text{ #/TON MAT'L PROCESSED}$$

REF (75) TAB 8.14-1 INDICATES  $E_N = 0.2 + .001 + .1 + .001$   
 USING A FABRIC FILTER  $= .302 \text{ #/ton}$

$$\therefore E_N = 0.302 \text{ #/TON MAT'L PROCESSED}$$

REF (152) 79 PLANTS IN 1971

$$\text{CAPACITY in } 1971 = \frac{(12.592 \times 10^6) - 2(0.072 \times 10^6)}{0.80} = 15.56 \times 10^6 \text{ tons}$$

$$\text{TYPICAL PLANT SIZE} = \frac{15.56 \times 10^6 \text{ tons}}{79(8760)} = 22.48 \text{ tons/Hr}$$

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Calculations Done By Hooper Date 11/25/74  
 Source Gypsum

$$22.48 \times 2000 = 44,960 \text{ ppd}$$

Ref (152) p.3 names 10 states representing a cross-section of the areas mfg. gypsum

Cal.	Mich
Fla.	N.J.
Georg.	N.Y.
Ind.	OKLA.
Iowa	TEX.

From Ref (84) + (148) + (156)

Fla - 23.0 ppd	Mich - 33.0 ppd	Calif - 30.2
Georg - 33.0 ppd	N.J. - 30.0 ppd	
Ind - 33.0 ppd	N.Y. - 29.5 ppd	
Iowa - 33.0 ppd	OKLA - 33.0	
	TEX - 62.0	

Assuming equal distribution:

$$\text{ALLOWABLE} = 33.97 \text{ #/HR}$$

$$E_S = \frac{33.97}{22.48} = 1.51 \text{ #/TON}$$

$$E_{S_{PART}} = 1.51 \text{ #/TON}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 12/20/74  
 Source Lime

Ref(21) p728ff 1972 Production =  $20.33 \times 10^6$  tons TOTAL

Ref(49) p244 TAB 12-1 gives breakdown between ROTARY  
 KILNS & VERTICAL KILNS for 1968

$$\text{ROTARY} = 16.2/18 = 90\%$$

$$\text{VERTICAL} = 1.8/18 = 10\%$$

Ref(50) p1 gives anticipated growth rates of 5.1%, 4.87  
 & 5.1%. We will assume an average = 5% compound.

$$P_c = 0.05$$

compound

Ref(42) p122 TAB 15

This table gives the relationship between added capacity &  
 increased production. From this we can determine K.

$$\Delta \text{Capacity} = 128 + 157 + 185 + 213 = 683 \times 10^3 \text{ tons}$$

1972-1975

$$\Delta \text{Production} = 1150 - 536 = 614 \times 10^3 \text{ tons}$$

1972-1975

$$K = \frac{614}{683} = 0.90$$

$$K = 0.90$$

$$A = (20.33 \times 10^6) (1.05)^3 / 0.90 = 26.15 \times 10^6 \text{ tons}$$

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Calculations Done By Hoppe Date 12/20/74

Source Lime

$$A = 26.15 \times 10^6 \text{ tons}$$

Ref(37) p 30 "Mining" - IRS Allowable - 10 yrs

Ref(37) p 33 "MANUFACTURE OF CHEMICALS AND ALLIED PRODUCTS.....ORGANIC AND INORGANIC CHEMICALS - 11 yrs

Assume  $2 \times 10$  yrs to be representative

$$P_B = \frac{100\%}{20 \text{ yrs}} = 5\%$$

$$P_B = 0.05 \quad \text{simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/20/74  
 Source Lime

Ref (49) p244 TAB 12-1

$$E_{U_p}^{\text{ROTARY}} = 180 \text{ #/ton LIME}$$

$$E_{U_p}^{\text{VERTICAL}} = 7 \text{ #/ton LIME}$$

We previously calculated

- (a) 90% processed in rotary kilns
- (b) 10% processed in vertical kilns

Synthesizing

$$E_{U_p} = 180(.9) + 7(.1) = 162 + .7 = 162.7$$

$$E_{U_p} = 162.7 \text{ #/ton LIME}$$

\*

Also

24  $\text{#}/\text{ton}$  rock crushed from the crushing & screening operation

Ref (50) p 4 indicates that  $28 \times 10^6$  tons of rock were crushed to make  $19 \times 10^6$  tons of lime

$$(24 \text{ #/ton CRUSHED}) \times \left( \frac{28 \times 10^6 \text{ ton crushed}}{19 \times 10^6 \text{ ton lime}} \right) = 35.4 \text{ #/ton lime *}$$

Also, 5  $\text{#}/\text{ton}$  for materials handling

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/19/74  
 Source Lime

$$\Sigma E_{ij} = 162.7 + 35.4 + 5 = 203$$

$$E_{ip} = 203 \text{ lb/ton lime}$$

Ref (49) p 249 & Ref (192) p 195ff indicate that bag filters can be employed in all areas to control particulate emissions by 99.99%. We feel that 99.9% would represent a more realistic value.

$$E_N = (1 - .999)(203) = 0.203$$

$$E_{N_p} = 0.203 \text{ lb/ton lime}$$

$E_S$

Ref (215) p 728ff indicates 186 lime plants in 1972

Ref (49) p 253 indicates the typical kiln capacity is about 200 tons/day

Assuming 330 days/yr operation @  $K = 0.90$

$$\frac{\text{Yearly Production from}}{1 \text{ kiln}} = \left( 200 \frac{\text{tons}}{\text{day}} \right) \left( 330 \frac{\text{days}}{\text{yr}} \right) (0.90) = 0.0594 \times 10^6 \frac{\text{tons}}{\text{yr} \cdot \text{kiln}}$$

$$1972 \text{ Production} = 10.33 \times 10^6 \text{ tons/yr}$$

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 Source Lime

$$\# \text{ kilns} = \frac{20.33}{.0594} \cdot 342 \quad \text{or} \quad \frac{342}{.186} = 1.8 \text{ per plant}$$

So,

$$\frac{200 \text{ tons}}{24 \text{ hrs/day}} = 8.33 \text{ TPH} = 16,666 \text{ LB/HR OUTPUT CAPACITY}$$

The calcining of limestone proceeds as follows



$$\frac{\text{INPUT}}{\text{OUTPUT}} = \frac{20+12+48}{20+16} = \frac{80}{36} = 2.222 = \text{Feed/Product}$$

$$\text{PWR} = 16,666 \times 2.222 \approx 37,000 \text{ LB/HR}$$

From Ref(215) we get the following breakdown in lime production figures for quicklime

(20%)	Ohio	$- 3.488 \times 10^6$		
(15.3%)	MO	$- 2.7 \times 10^6$	(Estimate)	
(11.4%)	Penn	$- 2.015 \times 10^6$		
(5.83%)	Tex	$- 1.032 \times 10^6$		
(9.10%)	Mich	$- 1.610 \times 10^6$		
(5.0%)	Ill	$- 0.890 \times 10^6$		
		$\underline{11.74}$		
			$\frac{11.74}{17.687} = 66\%$	
			↑	
			Ref(215)p 728	

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/20/74  
 Source Line

From Ref (84), (42) & the gen'l PWR curve

Ohio - 29.0

Mo. - 29.0

$$\text{Penn} = A = .76 \left[ \frac{F}{W} \right]^{.42} = (.76) \left[ (200)(18.5) \right]^{.42} = .76(32.52) = 24 \frac{\text{lb}}{\text{HR}}$$

Tex - 55.0

Mich - 25.4 ← A specific reg exists as a function of 98.5% effc.  
 $\therefore E_{\text{smich}} = (1 - .985)(203) = 3.05$

Ill - 12.0

$$3.05 \frac{\text{t}}{\text{ton}} \times 8.33 \frac{\text{ton}}{\text{hr}} = 25.4$$

All Others - 27.7

$$\begin{aligned} E_{sp} &= f \left[ (29.0)(.20) + (29.0)(.153) + (55)(.058) + (25.4)(.091) \right. \\ &\quad \left. + (12.0)(.05) + (24.0)(.114) + (27.7)(.334) \right] \\ &= f \left[ 5.8 + 4.44 + 3.19 + 2.31 + .60 + 2.74 + 9.25 \right] \\ &= 28.33 \frac{\text{lb}}{\text{hr}} \end{aligned}$$

$$E_{sp} = \frac{28.33 \frac{\text{lb}}{\text{hr}}}{8.33 \frac{\text{ton}}{\text{hr}}} = 3.40$$

$$E_{sp} = 3.40 \frac{\text{lb}}{\text{ton hr}}$$

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Computation Sheet For Emission Factors

Calculations Done By Harper Date 12/20/74  
 Source Lime

SO<sub>x</sub>

Since no emission factors could be located, it is necessary to develop one.

From Ref (42) p200, the % fuel use breakdown is

60% COAL  
 28% NAT.GAS  
 6% COAL+GAS  
 6% #6 OIL (RESIDUAL)

Heat input req'ts Ref (42) p126

for High Calcium Quicklime  $(1.5 + 2.8) \times 10^6 \text{ BTU/ton lime} = 4.3 \times 10^6$   
 for Dolomitic Quicklime  $(1.25 + 2.6) \times 10^6 \text{ BTU/ton lime} = 3.85 \times 10^6$

Assume a linear AUS =  $4.1 \times 10^6 \text{ BTU/ton lime}$   $\frac{4.1 \times 300}{29} = 34 \text{ MM BTU/HR}$

From Ref (45) p 1.1-3 TAB 1.1-2

SO<sub>2</sub> EMISSIONS  
FROM  
BITUMINOUS COAL =  $38S \left( < 10 \text{ MM BTU/HR} \right) * / \text{ton coal burned}$

From Ref (45)  
 p 1.3-2 TAB 1.3-1  $SO_x \text{ from } RES. OIL = (152 + 2)S * / 1000 \text{ gal}$

$SO_x \text{ from NAT GAS} = 0.6 \frac{\text{LB}}{10^6 \text{ FT}^3}$

If fuel was 100% COAL

$$E_{U_{SO_2}} = \frac{\left( 4.1 \times 10^6 \frac{\text{BTU}}{\text{ton lime}} \right) (38S) * \frac{\text{ton}}{\text{ton coal}}}{\text{BTU/ton coal}}$$

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Calculations Done By Hoppe Date 12/20/74  
 Source Lime

From Ref (22) p4-2 TAB 4-1

$$HV_{COAL} = 26,2 \times 10^6 \frac{BTU}{TON_{COAL}}$$

$$\% S_{COAL} = 27$$

So,

$$EV'_{SO_2}_{COAL} = \frac{(4.1 \times 10^6)(.38)(.27)}{26,2 \times 10^6} = 11.9 \frac{LB/TON}{LIME} *$$

I.f fuel is 100% GAS

$$EV'_{SO_2}_{GAS} = \frac{(4.1 \times 10^6)(.6 \times 10^{-6})}{1050} = 2.34 \frac{LB/TON}{LIME} *$$

↑  
Ref(75) p1.4-1

If fuel is 100% Res. oil.

$$\% S = 1.5\% \quad \text{Ref(22) p4-4 TAB 4-2}$$

$$HV = 6384 \times 10^6 \frac{BTU}{10^3 BBL}$$

11

$$\frac{6384 \times 10^6}{1000 BBL} \times \frac{1 BBL}{42 gal} = \frac{152 \times 10^6 BTU}{1000 gal}$$

$$EV'_{SO_2}_{R.O.} = \frac{(4.1 \times 10^6)(154)(1.5)}{152 \times 10^6} = 6.23 \frac{LB/TON}{LIME} *$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/20/74  
 Source Lime

Synthesis

$$EU_{SO_2} = (11.9)(.6 + .03) + (2.34)(.28 + .03) + (6.23)(.06) \times 10^{-3}$$

$$= 7.497 + .00725 + .3738 = 7.87 \text{ #/ton lime}$$

However, Ref (75)

p 8.6-3 TAB 8.6-1 states that the emission factor for a cement kiln for  $SO_2$  is 6.8 S #/ton (coal). This reduction from 38 S is due to the alkaline clasts which are also present in lime kilns. This corresponds to a % reduction of

$$\frac{38 - 6.8}{38} = 82\%$$

If we assume a similar reduction, then

$$EU = (1 - .82)(7.87) = 1.417$$

$$EU_{SO_2} = 1.42 \text{ #/ton lime}$$

The big filter specified for the control of particulate will also control  $SO_2$  due to the cake buildup on the bags of alkaline clasts.

Ref (75) p 8.6-3 indicates that an  $SO_2$  removal efficiency  $\approx 50\%$  could be expected @ the filter of a cement kiln. We will assume the same %.

$$EN_{SO_2} = (1 - .5)(1.42) = 0.71$$

$$EN_{SO_2} = 0.71 \text{ #/ton lime}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/23/74  
 Source Lime

$E_{SO_2}$

$$\frac{1.42 \frac{\# SO_2}{TON LINE}}{4.1 \times 10^6 \frac{BTU}{TON LINE}} = 0.35 \frac{\#}{10^6 BTU}$$

From Ref (84) + (148)

This value is less than, or at best, equal to the State reg's for SO<sub>2</sub> (Ohio, Mo, Mich, Penn, Ill, Texas)

$$\therefore E_{SO_2} = E_U$$

$$E_{SO_2} = 1.42 \frac{\#}{TON LINE}$$

NO<sub>x</sub> As was the case with SO<sub>x</sub>, it is necessary to develop an NO<sub>x</sub> emission factor

From Ref (75) p 1.1-3 TAB 1.1-2

$$\frac{NO_x \text{ EMISSIONS}}{\text{from bit coal}} = 6 \frac{\#}{TON COAL}$$

Ref (75) p 1.3-2 TAB 1.3-1

$$NO_x = 60 \frac{\#}{1000 gal. (AUS)}$$

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Calculations Done By Hopper Date 12/23/74

Source Lime  
 Ref(75) P

$$\text{NO}_x = 120 \frac{\#}{10^6 \text{ ft}^3}$$

If fuel was 100% coal

$$E_{NO_x} = \frac{(4.1 \times 10^6 \frac{\text{Btu}}{\text{ton}})(6 \frac{\#/\text{ton}}{\text{coal}})}{26.2 \times 10^6 \frac{\text{Btu}}{\text{ton coal}}} = 0.939 \frac{\#/\text{ton}}{\text{lime}} (\text{coal}) *$$

If fuel was 100% gas

$$E_{NO_x} = \frac{(4.1 \times 10^6)(120) \times 10^{-6}}{1050} = 0.469 \frac{\#/\text{ton}}{\text{lime}} (\text{gas}) *$$

If fuel was 100% res. oil

$$E_{NO_x} = \frac{4.1 \times 10^6 (60)}{152 \times 10^6} = 1.618 \frac{\#/\text{ton}}{\text{lime}} (\text{oil}) *$$

Synthesizing,

$$E_{NO_x} = (.63)(.939) + (.31)(.469) + (.06)(1.618) \\ = .592 + .145 + .097 = 0.834$$

$$E_{NO_x} = 0.834 \frac{\#/\text{ton}}{\text{lime}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoffer Date 12/23/74  
 Source Lime

Ref (242) p 9-1 indicates that no control methods have been demonstrated for NO<sub>x</sub> emissions from industrial process combustion equipment. This Ref is dated 10/74 & is, i.e., very recent.

However, p 7-13, 7-16 indicates that by 1985, a reduction of ~50% should be achieved for residential heaters. Assuming the potential for a transfer of technology, we will use this value & present the results in the EU = 0.0 etc categories.

$$EN_{NO_x} = (1-0.5)(0.834) = 0.417$$

$$EN_{NO_x} = 0.417$$

The NO<sub>x</sub> regs for most sources are the same

0.2	* / 10 <sup>6</sup> BTU	gas
0.3	"	oil
0.7	"	coal

Synthesis

$$(0.2)(0.7) + (0.3)(0.2) + (0.7)(0.3) = 0.141 + 0.062 + 0.210 = 0.413 \text{ * / 10}^6 \text{ BTU}$$

$$\left( \frac{0.413}{10^6 \text{ BTU}} \right) \left( 4.1 \times 10^6 \frac{\text{BTU}}{\text{TON}_\text{Lime}} \right) = 2.136 \text{ * / ton}_\text{Lime}$$

Since this is > EN<sub>NO<sub>x</sub></sub>, E<sub>s</sub> = EU

$$E_{NO_x} = 0.834 \text{ * / ton}_\text{Lime}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/23/74  
Source Lime

## Summary

	<u>E<sub>U</sub></u>	<u>E<sub>N</sub></u>	<u>E<sub>S</sub></u>
PART	.203	.203	3.40
NO <sub>x</sub>	.834	0.417	.834
SO <sub>x</sub>	1.42	.71	1.42

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 11/27/74

Source Minecast Wool

No direct values of production in TONS could be located. REF (158) (MC 72 P - 32E-5) indicates production in terms of tons, square feet & board feet depending on the end use. They also quote the value (\$MM) of the product. We will attempt to get the TOTAL industry production in TONS using this value data assuming that the value is directly proportional to the weight.

In 1972, There were 331,300 tons of loose fiber valued @ \$37.2  $\times 10^6$  DOLLARS

Total value of the industry was  $729.6 \times 10^6$

$$\frac{331,300}{37.2} = \frac{x}{729.6} \quad x = 6.50 \times 10^6 \text{ tons}$$

Since a majority of the info regarding production breakdowns for various products is not stated, no cross check can be made using product densities & footage produced.

A similar calculation can be made for the year 1972.  
 Using the same reference

$$\frac{261,900}{19.2} \cdot \frac{x}{425} \quad x = 5.797 \times 10^6 \text{ tons}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 11/27/74

Source Mineral Wool

Assume simple growth, since we have made such an assumption. This will minimize the potential compounding of errors.

$$\frac{(6.5 - 5.8) \times 10^6}{5} = 0.14 \times 10^6 \text{ TONS/4R}$$

$$6.5 + 3(0.14) = 6.92 \times 10^6 = 1975 \text{ Production}$$

$$P_c = \frac{0.14}{6.92} = 2.0\%$$

$$P_c = .02 \text{ simple}$$

No specific Ref was made as to fractional utilization. From Ref 144 p 48, K for "stone, clay & glass" = 80% for the period '65-'73. Also, the avg value of K for chemicals during that period was 83%. We will assume a K = 82% for the mfg. of mineral wool.

$$K = 0.82$$

$$A = \frac{6.92 \times 10^6 \text{ tons}}{.82} = 8.439 \times 10^6$$

$$A = 8.439 \times 10^6 \text{ tons}$$

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Computation Sheet For Industrial Factors

Calculations Done By Horne Date 11/27/74

Source Mineral Wool

Po: REF (37) p34

IRS Allowable depreciation = 20 yrs  
for "cement"

IRS Allowable depreciation  
for "other stone & clay products" = 15 yrs

$$\text{Assume } P_0 = \frac{1}{2(15)} = \frac{1}{2(17)} = .0294$$

$$P_0 = .0294$$

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 11/25/74  
 Source Mineral Wool

PARTICULARS

Ref (75) p 8.16-2 TAB 8.16-1

UNCONTROLLED EMISSIONS:

22 #/ton FROM CUPOLA  
 17 #/ton FROM BLOWCHAMBER  
 4 #/ton FROM CURING OVENS  
 2 #/ton FROM COOLER

We assume that all mineral wool is made in cupolas -  
 NOT REVERBATORY FURNACES. Ref (46) p 342 indicates that this is  
 a valid judgement.

The origin of the above emission factors was Ref (46)  
 A check indicates agreement except for the blowchamber.

From Ref (46) p 345 TAB 100

$$E_{U_1} = \frac{(9.20)(200)}{3525} = 5.22$$

$$E_{U_2} = \frac{(7.11)(200)}{3625} = 3.92$$

$$E_{U_3} = \frac{(8.3)(200)}{4120} = \frac{4.03}{4.39} = \text{AVG}$$

$$E_{U_{\text{TOTAL}}} = 22 + 4.4 + 4 + 2 = 32.4$$

$$E_U = 32.4 \text{ #/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 11/25/74  
 Source Minecart Woods

Ref (46) p 347 indicates control of cupola particulate emissions with a baghouse. Page 348 indicates an  $R = 97\%$

$$E_{N_{cu}} = 22(1 - .97) = 0.66 \text{ %} *$$

Ref (46) p 349 indicates control of blowchamber particulate emissions with a centrifugal scrubber, followed by an ESP. The overall  $R = 68\%$ .

$$E_{N_{bl.}} = 4.4(1 - .68) = 1.41$$

$$E_{N_{bl.}} = 1.41 \text{ %} *$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 11/25/74  
 Source Mineral Wool

Ref (46) p 345 indicates  $\eta = 81\%$  for particulates from the curing oven by employing a wet scrubber followed by an ESP.

$$E_{N_{curing\ oven}} = 4(1-.81) = 0.76 \text{ #/ton}$$

Assume the use of a wet scrubber with an  $R = 60\%$ .  
 (transfer of technology from the blowchamber - Ref (55) p 8.16-2 TAB 8.16-1)

$$E_{N_{cooler}} = 2(1-.60) = 0.8 \text{ #/ton}$$

$$\sum E_N = 0.66 + 1.41 + .76 + .8 = 3.63 \text{ #/ton}$$

$$E_N = 3.63 \text{ #/ton}$$

Ref (46) p 344 ① PWR for cupola  $\approx 4200 \text{ #/hr} = 2.1 \text{ TPH}$

② PWR for blowchamber  $\approx 4000 \text{ #/hr} = 2.0 \text{ TPH}$

③ PWR for curing oven  $\approx 5000 \text{ #/hr} = 2.5 \text{ TPH}$

From RSF (158) p 2  
 MCTZ(P)-32-E-5

The following breakdown is  
 det'd on the basis of # of employees  
 in the industry in 1972.

$$\text{Ohio} = 3.4/14.3 = 23.8\%$$

$$\text{TEXAS} = .7/14.3 = 4.9\%$$

$$\text{INDIANA} = 1.7/14.3 = 11.9\%$$

$$\text{Alab.} = .2/14.3 = 1.4\%$$

$$\text{New Jersey} = 1.5/14.3 = 10.5\%$$

$$\text{ILL.} = .1/14.3 = 0.7\%$$

$$\text{ALL OTHER} = 46.8\%$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 11/28/74  
 Source Mineral Wool

From REF (84), (48), 156

$$\text{Typ. PWR} \approx 2.1 + 2.0 + 2.5/3 = 2.2 \text{ TPH} = 4400 \text{ #/HR}$$

$$\begin{array}{lll} \text{Ohio} = 6.9 \text{ #/HR} & \text{TEX} = 6.7 \text{ #/HR} & \text{Alab.} = 5.9 \\ \text{IND} = 6.9 \text{ #/HR} & \text{ILL} = 3.9 \text{ #/HR} & \\ \text{N.J.} = 28 \text{ #/HR} & \text{All other} = 7.6 \text{ #/HR} & \end{array}$$

$$\begin{aligned} E_S = f & \left[ (.238)(6.9) + (.119)(6.9) + (.105)(28) + (.049)(6.7) \right. \\ & \left. + (.014)(5.9) + (.007)(3.9) + (.468)(7.6) \right] \\ = 1.6422 & + .8211 + 2.94 + .3283 + .0826 + .0273 \\ & + 3.5568 \\ = 9.3983 & \end{aligned}$$

$$E_S = 9.3983/2.2 = 4.272$$

$$E_{S_p} = 4.27 \text{ #/ton}$$

Sulfur Oxides are also emitted from cupolas

$$(E_{SO_2}) = 0.02 \text{ #/ton} \quad \text{Ref (75) p 8.16-2 TAB 8.16-1}$$

Assume  $E_N = 0.0$  since no feasible control has been demonstrated. This would defin the max hypothetical

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 11/27/74

Source Mineless Wool

$$\text{EN}_{\text{SO}_2} = 0.0$$

There are no state control regs.

$$\therefore E_S = E_U = 0.02$$

$$E_S_{\text{SO}_2} = 0.02 \text{ #/ton}$$

CO

REF ④6 p 344 TAB 98 indicates CO emissions of 0.9% from cupolas (very limited data)  
 we will assume % by volume

$$E_U = \frac{(.009)(4550 \frac{\text{ft}^3}{\text{min}})(28 \frac{\#}{\text{mole}})(2000 \frac{\#}{\text{ton}})(60 \frac{\text{min}}{\text{hr}})}{(359 \frac{\text{ft}^3}{\text{mole}})(\frac{530}{460})(3525 \frac{\#}{\text{hr}})} = 94.4 \text{ #/ton}$$

$$E_U_{\text{CO}} = 94.4 \text{ #/ton}$$

Assume  $\bar{E}_N = 0.0$  since no feasible control has been demonstrated. This will result in the max hypothetical impact if controls were applied

$$\bar{E}_N_{\text{CO}} = 0.0$$

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Computation Sheet For Emission Factors

Calculations Done By Hoyer Date 12/2/74

Source Mineral Wool

There are no state emission regulations

$$\therefore E_{SCO} = EU_{CO} = 94.4 \text{ #/ton}$$

$$E_{SCO} = 94.4 \text{ #/ton}$$

NO<sub>x</sub>

Ref (46) p 346 tab 101 indicates NO<sub>x</sub> emissions from the heating over equal to .6 & .15 #/HR for units with a PWR of 5180 #/HR & 3500 #/HR respectively

$$EU'_{NO_x} = \frac{0.6(200)}{5180} = 0.232 \text{ #/ton}$$

$$EU^2_{NO_x} = \frac{(0.15)(200)}{3500} = 0.086 \text{ #/ton}$$

.159 = AVG

Assuming the avg,

$$EU_{NO_x} = 0.16 \text{ #/ton}$$

Ref (242) p 7-13, 7-16 indicates that by 1985, NO<sub>x</sub> emissions from residential heating can be reduced by ~50%. We will assume a similar reduction & include the results in the EN<sub>NOx</sub> category.

$$EN = (1-0.5)(0.16) = 0.08$$

$$EN = 0.08 \text{ #/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/2/74  
 Source Mineral Wool

The emission of  $\text{NO}_x$  would be from the combustion process. Since reg's are written on a  $\frac{\text{#}}{10^6 \text{ BTU}}$  basis, it is necessary to convert our results for comparison purposes.

Consequently,

$$\frac{Q_{\text{air}} + Q_{\text{wool}}}{\eta_{\text{heat transfer}}} = Q_{\text{input}} \text{ by fuel}$$

From Ref 101, p 346 and 101

$$Q_{\text{air}} = (8000 \frac{\text{BTU}}{\text{min}})(60 \frac{\text{min}}{\text{hr}})(.075) \frac{\text{#}}{\text{BTU}} \left( \frac{530}{460} \right) (.24)(200 - 70)$$

↑  
Ref 101  
p 3-131  
TAB 3-179

$$Q_{\text{air}} = 1.294 \times 10^6 \frac{\text{BTU}}{\text{HR}}$$

$$Q_{\text{wool}} = (5180)(.157)(200 - 70) = 0.106 \times 10^6 \frac{\text{BTU}}{\text{HR}}$$

↑ Assume  
Ref 101

p 3-133  
TAB 3-200

$$Q_{\text{input}} = \frac{(1.294 + .106)/10^6}{0.80} = 1.75 \times 10^6 \frac{\text{BTU}}{\text{HR}}$$

↑ Assume

$$\text{EMISSION} = \frac{0.6 \frac{\text{#}}{\text{HR}}}{1.75 \times 10^6 \frac{\text{BTU}}{\text{HR}}} = 0.34 \frac{\text{#}}{10^6 \text{ BTU}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/2/74  
 Source Mineral Ovens

$$Q_{air} = (4870)(60)(.075)\left(\frac{550}{460}\right)(.24)(270-70) = 1.212 \times 10^6 \text{ BTU/HR}$$

$$Q_{voc} = (3500)(.157)(270-70) = .1099 \times 10^6 \text{ BTU}$$

$$\text{Emission} = \frac{.15 (.80)}{(1.322 \times 10^6)} = .0908 \text{ #}/10^6 \text{ BTU}$$

$$\text{The Ave} = 0.215 \text{ #}/10^6 \text{ BTU}$$

From Ref (84), the allowable for....

$$\begin{array}{l} \text{Gas} = .2 \\ \text{Oil} = .3 \\ \text{Solid} = .7 \end{array} \} \text{ #}/10^6 \text{ BTU}$$

For the cases evaluated here, we do not know the fuel type.  
 Generally speaking, some ovens would use oil & others gas. Since  
 a synthesized value would fall somewhere between .2 & .3,  
 we will assume  $E_S = E_U$

$$E_{S_{NO_x}} = 0.16 \text{ #}/\text{ton}$$

### Hydrocarbons

The following info is taken from Ref (46) ✓ 342 ff

TABS 100, 101, 102

SOURCE	EMISSION*	SCFM	PWC
BLOWHANGER	.0036 %	11,100	3.75
OVEN	1.90 #/HR	—	5.3
oven	2.20 #/HR	—	3.0
cooker	.0009 %	1850	3525

Assumed to be  
 $\text{HCHO}$

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Calculations Done By Homer Date 12/2/74  
 Source Mineral Wool

$$E_{U_{HC}} = \frac{(.000036)(11,100)(30)(2000)(60)(460)}{(359)(530)(3525)} = 0.987 \text{ #/ton} *$$

$$E_{U_{HC}} = \frac{(1.90)(2000)}{5180} = .734 \text{ #/ton}$$

$$E_{U_{HC}} = \frac{(2.20)(2000)}{3500} = 1.257 \text{ #/ton}$$

$$\overline{0.996} = \text{AVG} *$$

$$E_{U_{cooler}} = \frac{(9 \times 10^{-4})(1850)(30)(2000)(60)(460)}{(359)(530)(3525)} = .041 \text{ #/ton}$$

$$\Sigma = 0.987 + .996 + .041 = 2.02$$

$$E_U = 2.02 \text{ #/ton}$$

Control of oven emissions using cat. A/B  $\Rightarrow$

$$\eta = \frac{1.90 - .9}{1.90} = 53\%$$

Using direct flame A/B,

$$\eta = \frac{2.20 - .94}{2.20} = 57\%$$

No demonstrated control has been shown for the blancher or the cooler. Assume that 57% control can also be achieved for those units using a direct-flame A/B.

$$E_N = 2.02(1 - .57)$$

$$E_N = 0.869 \text{ #/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/2/74  
 Source Minecart Ultras

There are no Sulfate rays

$$\therefore E_S = E_U - 2.02$$

$$E_S = 2.02 \text{ #/ton}$$

### Summary

PART	E <sub>U</sub>	E <sub>N</sub>	E <sub>S</sub>
SO <sub>2</sub>	.02	0.0	.02
NO <sub>2</sub>	0.16	0.08	.16
CO	94.4	0.0	94.4
HC	2.02	.87	2.02

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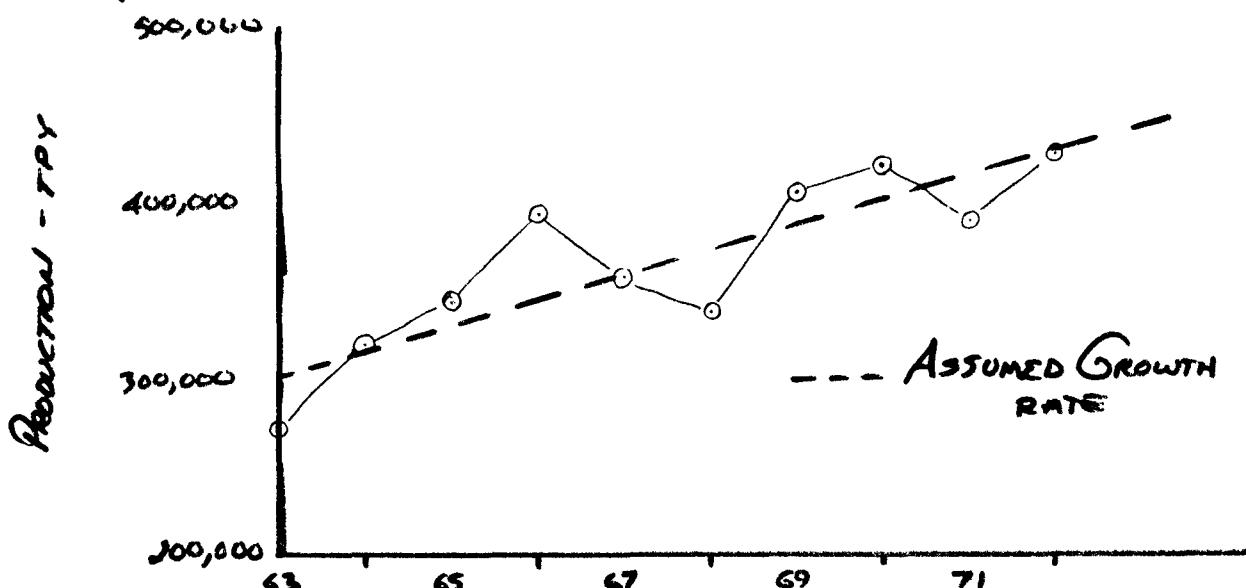
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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 11/26/74  
 Source Perlite

REF 215 1972 472,000 tons of EXPANDED PERLITE  
 PRODUCED

From REF 215 1963, 65, 67, 69, 71, 72 we obtained the  
 following DATA



$$\frac{472,000 - 300,000}{9} = 19,111 \text{ TPY}$$

$$1975 \text{ Production} = 472,000 + 3(19,111) = 529,333 \text{ tons}$$

No specific REF was made as to fractional utilization

From REF 14 p48 K for "stone, clay & glass" = 8%  
 for the periods '65 - '73. Also, the avg value of K for

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Computation Sheet For Industrial Factors

Calculations Done By Horne Date 11/26/74  
 Source Perlite

Chemicals during that period was 83%.

We will assume a  $K = 82\%$  to be representative of the perlite mfg. industry

$$K = 0.82$$

$$A = \frac{529,333}{.82} = 0.645528 \times 10^6 \text{ tons}$$

$$A = 0.6455 \times 10^6 \text{ tons}$$

$$P_C = \frac{19111}{529,333} = 0.036$$

$$P_C = 0.036$$

simple

$P_0$ : REF (37) p 3d; IRS allowable depreciation } = 20 yrs  
 FOR "CEMENT"

IRS ALLOWABLE DEPRECIATION }  
 FOR "OTHER STONE AND CLAY PRODUCTS" } = 15 yrs

$$\text{Assume } P_0 = \frac{1}{2(\text{AVG})} = \frac{1}{2(1)} - .0294 = P_B$$

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 11/25/74

Source Perlite

REF (75)

p 8.17-1  
TAB. 8.17-1

$$E_U = 21 \# \text{ton of charge}$$

From REF (75), SAME PAGE  $\eta_{\text{baghouse}} = 96\%$

$$E_N = 21(1 - .96) = 0.84$$

$$E_N = 0.84 \# \text{ton of charge}$$

ES:

REF (16) p 350

"SEVERAL PERLITE ORE DEPOSITS ARE IN CALIFORNIA AND OTHER DEPOSITS ARE IN SIX OF THE ROCKY MOUNTAIN STATES."

REF (215) IN 1972 There were 84 plants in 30 states  
 p 905 ff

#1 ILLINOIS - UNPUBLISHED (ASSUME 35,000)

2 PENN. 29,790 TONS

3 CAL. 21,221 TONS

4 TEX. 21,210 TONS

5 FLA. 18,249 TONS

6 IND 16,331 TONS

$$\Rightarrow 141,801 / 427,000 = 33\%$$

REMAINING PRODUCTION IN 24 STATES

↗ 1972 DATA from REF 215 p 905 ff

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 11/26/74

Source Petelite

$$\frac{427,000}{.82} = 1972 \text{ CAPACITY} = 520,732 \text{ tons}$$

$$\frac{520,732}{(84)(8760)} = 0.7077 \text{ TPH} = 1415 \text{ ppm}$$

ILL = 8.2%

PENN = 6.3%

CAL = 5.0%

TEX = 5.0%

FLA = 4.3%

IND = 3.8%

ALL OTHERS = 67.4%

From Ref (84) + (148) + Genl PWR curve, ALLOWABLE EMISSIONS ARE . . .

ILL = 2.1

PENN = RELATES TO .04 GR/SCF; ASSUME AS PART OF GENL PWR

CAL = 3.42 (REF 156)

TEX = 2.2

FLA = 2.75

IND = 3.20

OTHERS = 3.25

$$E_s = f(.082)(2.1) + (.05)(3.2) + (.05)(2.2) + (.043)(2.75) + (.038)(3.20) \\ + (737)(3.25) = \\ .1722 + .16 + .11 + .1183 + .1216 + 2.3953 = 3.0774 \text{ #/HR}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 11/27/74

Source PERLITE

$$E_S = \frac{3.0774}{.7077} = 4.348 \text{ #/ton}$$

$$\bar{E}_S_{\text{perlite}} = 4.35 \text{ #/ton perlite}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marvone Date 8-14-74

Source Phosphate Rock Processing

In the processing of phosphate rock, four operations are used prior to fertilizer manuf or export. of rock

- a) drying
- b) grinding
- c) material handling
- d) calcining

- ① Ref 040 Table VIII -1 indicates that the production for each of these operations is not the same.
- ② Ref 047 p 146 states "in Florida, where approx 75% of phosphate rock is produced,"
- ③ Ref 040 p II-1 indicates that Western rock contains organic matter and Carbonate which is removed by Calcination.

We will handle each of the processes separately excepting that we will assume material handling emissions will occur during drying operation or at least all material entering dryer will be handled so as to be considered under the same production quantity as drying.

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing (Drying and Handling)

### K: Ref 040 Table VIII - 1

Drying production and capacity info are given for 1970 and 1980.

The calculated  $K_{70} = .88$  and  $K_{80} = .86$  are obtained by,

$$K_{70} = \frac{16}{18} = .88 \quad K_{80} = \frac{15.2}{17.6} = .86$$

The average of these two value is  $K = .87$   
 which we will use for 1975 and assume to be constant for 1975-1985 period

$$K = .87$$

### A:

Referring to the attached graph, compiled from the data in Ref 040 Table VIII - 1 we estimate the 1975 production for rock drying as  $12.6 \times 10^6$  Tons/ of  $P_2O_5$  and the capacity as;

$$\text{Capacity}_{75} = \frac{12.6 \times 10^6}{.87}$$

$$= 14.5 \times 10^6 \text{ Tons as } P_2O_5$$

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Calculations Done By W. Marone Date 8-14-74

Source Phosphate Rock Processing (Drying & Handling)

A: cont'd

Ref 071 Table 4 pg 28 range at  $P_2O_5$  content of Florida pebbled rock  $31.2 \rightarrow 35.3\%$  by wt

Table 5 pg 29 Typical analysis 33%  $P_2O_5$  in rock

We will use the mid value in the range of % of Table 4 or the typical value of Table 5 which is 33%  $P_2O_5$  in the rock. This is not exactly typical of all phosphate rock, which will vary throughout the country, however since Ref 047 p146 estimates that 75% of the rock processed comes from Florida we feel this number of 33% as suitably representative.

Converting the production and capacity in terms of  $P_2O_5$  to total rock is performed as follows;

$$\text{Production rock} = \frac{\text{Prod } P_2O_5}{.33} = \frac{12.6 \times 10^6}{.33} = 38.2 \times 10^6 \frac{\text{Ton}}{\text{yr}}$$

$$\text{Capacity rock} = \frac{\text{Capacity } P_2O_5}{.33} = \frac{14.5 \times 10^6}{.33} = 43.9 \times 10^6 \frac{\text{Ton}}{\text{yr}}$$

$$\therefore A = 43.9 \times 10^6 \frac{\text{Ton}}{\text{yr}} \text{ phosphate rock}$$

Dry & Hand

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Computation Sheet For Industrial Factors

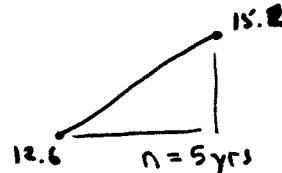
Calculations Done By W. Marzzone Date 8-14-74

Source Phosphate Rock Processing (Drying and Handling)

$P_c$ : The growth of the rock <sup>drying</sup> processing portion of this industry is estimated from the data on Table VII - 1 of Ret 040 which we have plotted conveniently on an attached graph. The slope of the production curve will be taken as the simple growth rate and applied to 1975 as a base year.

$$1980 \text{ prod} = 15.2 \times 10^6 \text{ Ton P}_{2O_5}$$

$$1975 \text{ prod} = 12.6 \times 10^6 \text{ Ton P}_{2O_5}$$



$$P_c = \frac{15.2 - 12.6}{5} \div 12.6 = .041$$

$$\therefore P_c = .041 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By William Marrone Date 8-14-74

Source Phosphate Rock Processing (Grinding)

K: Referring to the attached graph which was developed from data in Table VIII-1 Ret 040 we see that the value of K in 1975  $\approx .93$  and in 1980  $\approx .96$ . Comparing these to  $K_{70} = .88$  we gather that this portion of the industry is growing to its capacity. Lacking definitive data from other sources on K we will estimate that the average K between 1975 and 1980 will be applicable for the period 1975 to 1980

$$K_{avg} = \frac{.93 + .96}{2} \approx .94$$

∴

$$K = .94$$

A: The production in terms of  $P_2O_5$  from grinding is obtained from the attached graph;

$$P_{75} = 8 \times 10^6 \frac{\text{Ton}}{\text{yr}} \text{ as } P_2O_5$$

applying the 33%  $P_2O_5$  by wt factor arrived at previously for rock drying we may calculate the 1975 ~~production~~ of rock through grinding

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 8-14-74

Source Phosphate Rock Processing (Grinding)

A: cont'd

$$\frac{1975 \text{ Prod}}{\text{Rock}} = \frac{1975 \text{ Prod } P_{05}}{.33} = \frac{8 \times 10^6}{.33} = 24.2 \times 10^6 \frac{\text{Ton}}{\text{Yr}}$$

Now, using the value of  $K = .94$  we obtain the 1975 production capacity

$$A = \frac{24.2 \times 10^6}{.94} = 25.7 \times 10^6 \frac{\text{Ton}}{\text{Yr}} \text{ rock}$$

$$\therefore A = 25.7 \times 10^6 \frac{\text{Ton}}{\text{Yr}} \text{ of rock}$$

Grinding

$P_c$ : The growth in rock grinding is estimated similarly as in the case of rock drying. Referring to the attached graph, the simple growth above 1975 base year is calc as:

$$P_c = \frac{9.7 - 8.0}{5} \div 8.0 = .043$$

$$\therefore P_c = .043 \text{ simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing (Calcinining)

K: The data obtained from Ref 040 Table VIII-1 indicates a growth in capacity slightly greater than production for the period 1970-1980. We will assume, lacking other information, that the utilization during the period 1975-1985 will be best approximated by the value of 1980  $K = .9$

$$\therefore K = .9$$

A: The 1975 Production in terms of  $P_2O_5$  through calcining is  $.8 \times 10^6 \frac{\text{Ton}}{\text{Yr}}$  (from attached graph).

The  $P_2O_5$  content of the calcined rock is approximated from Table 6 pg 30 of Ref 077

$$\begin{aligned} P_2O_5 \text{ T/O} &= 520 \\ \text{Total T/O} &= 1502 \end{aligned} \quad \left. \begin{array}{l} \text{after calcination} \\ \hline \end{array} \right.$$

$$\frac{520}{1502} = .346 \quad \text{or } 34.6\%$$

$$\text{Prod Rock 1975} = \frac{.8 \times 10^6}{.346} = 2.3 \times 10^6 \frac{\text{Ton}}{\text{Yr}}$$

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Computation Sheet For Industrial Factors

Calculations Done By R. Massone Date 8-14-74

Source Phosphate Rock Processing (Calcining)

A: cont'd

Taking the 1975 calcined rock production and the value of  $K = .9$  we arrive at the 1975 capacity;

$$A = \frac{2.3 \times 10^6}{.9} = 2.55 \times 10^6 \frac{\text{Ton}}{\text{Yr}} \text{ rock}$$

$$\therefore A = 2.55 \times 10^6 \frac{\text{Ton}}{\text{Yr}} \text{ calcined rock}$$

$P_c$ : We approximated the growth rate from data on the attached graph. This was based on the base year 1975 and assumed to be simple growth. The production data was used for growth determination

$$P_c = \frac{.993 - .8}{5} \div .8 = .048$$

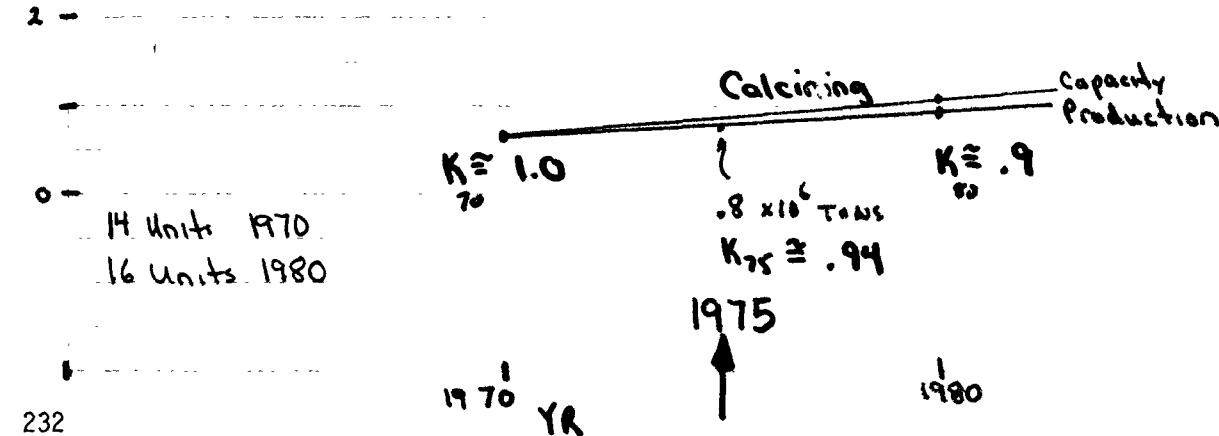
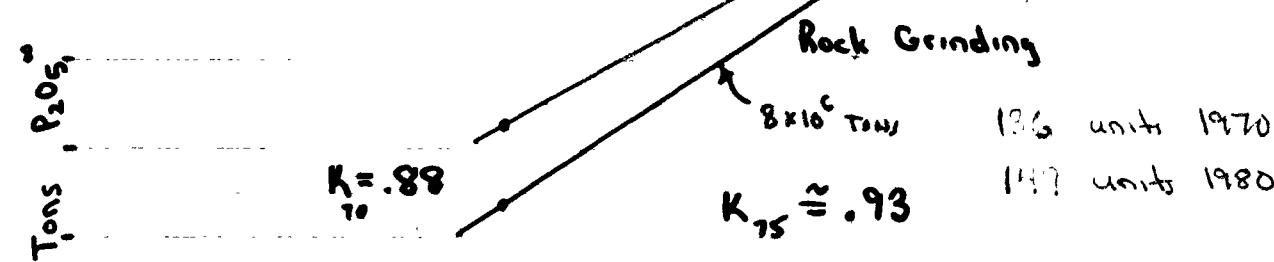
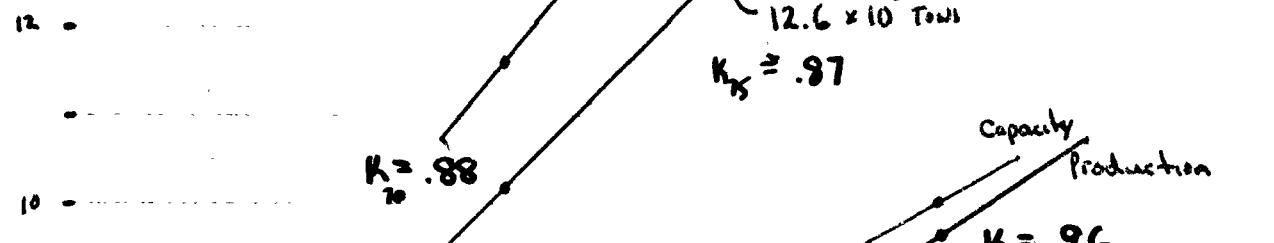
$$\therefore P_c = .048 \text{ simple}$$

# Phosphate Rock Processing

- 18 -  
 - based on data in Ref 040  
 Table VIII - 1

- 16 -  
 - 60 units 1970  
 65 units 1980

14 -



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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-26-74

Source Phosphate Rock Processing

$P_B$ :

We estimate the obsolescence rate from IRS guideline with the assumption that the rate will be the same for each of the operations in this industry

Ref 037 pg 30 Sec 10.0 (Mining)

$$\text{Asset guideline life} = 10 \text{ years}$$

$$P_B \text{ est } \approx 2 \times \text{IRS} = 20 \text{ years}$$

$$100\% \text{ Depreciation in 20 years} \Rightarrow \frac{100\%}{20 \text{ yrs}} = 5\%/\text{yr simple}$$

$$P_B \text{ (Drying and Handling)} = .05 \text{ simple}$$

$$P_B \text{ (Grinding)} = .05 \text{ simple}$$

$$P_B \text{ (Calcining)} = .05 \text{ simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing  
Particulates

$E_u$ :

The following uncontrolled emission factors were obtained from Reference 047 Table 4.11-1 pg 147

<u>Process</u>	<u><math>E_u</math></u>
use combined value	
1. Drying	12 lb/Ton rock
2. Material Handling	2 lb/Ton rock
3. Grinding	2 lb/Ton rock
4. Calcining	40 lb/Ton calcined rock

Drying and Material handling agree well with data from AP-42 Table 818.1 Dry = 15 lb/Ton rock (Ref 075) M.H. = 2 lb/Ton rock

however, AP-42 reports a value of 20 lb/Ton for grinding. The data was referenced to our Ref 047 so we believe the AP-42 to be a possible typo-error. We will use 21b/Ton until more better verification is obtained.

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 8-14-74  
 Source Phosphate Rock Processing

Particulates cont'd

$E_N$ :

Ref 075 (AP-42) T 8.18-1 lists collection efficiency ranges for control devices on drying, grinding, and material handling.

Drying: 95-99% eff

Grinding: 99.5 - 99.9% eff

Transfer Stages : 99.5 - 99.9% eff

For available control in 1975 we will use (assume) the higher value in this range to calculate  $E_N$  values

$$\begin{aligned} E_{\text{Mat Handling}} &= .001 \times 2 = .002 \text{ lb/T} \\ E_{\text{Drying}} &= .01 \times 12 = .12 \text{ lb/T} \end{aligned}$$

$$\boxed{\begin{aligned} E_N &= .001 \times E_u \\ E_u &= .01 \times E_u \end{aligned}}$$

$$E_N = .122 \text{ lb/Ton rock} \\ (\text{Drying \& Material Handling})$$

$$E_{\text{Grinding}} = .001 \times 2 \text{ lb/ton} = .002 \text{ lb/T}$$

$$E_N = .001 \times E_u$$

$$E_N = .002 \text{ lb/ton rock (Grinding)}$$

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Computation Sheet For Emission Factors

Calculations Done By William Monroe Date 8-14-74

Source Phosphate Rock Processing

$E_N$ : cont'd

Calcining

Information was obtained on the average control efficiency for particulates from Calcining of Phosphate Rock Ref 047 p231 95% control with wet scrubbers

We found no other data in the literature which would support a higher efficiency level however we assume that a level comparable to control on the rock dryer kiln should be attainable on the calcining kiln.

Until more definitive data appears we will use 99% efficiency

$$E_N = .01 \times E_u = .01 \times 40 \text{ lb/Ton} \\ = .4 \text{ lb/TN}$$

$E_N = .4 \text{ lb/Ton}$  of calcined rock

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Computation Sheet For Emission Factors

Calculations Done By William Marzone Date 10-18-74  
 Source Phosphate Rock Processing

$E_s$  : Particulate

Ref 040 Table VII -1 gives the number of process units for Drying, Grinding, and Calcining in the years 1970 and 1980.

	<u>1970</u>	<u>1980</u>
Drying & Mat Handling	60	65
Grinding	136	149
Calcining	14	16

We assume that the number of process units in 1975 is midway between these two values such that;

$$N_{75} \text{ Drying} = 63 \text{ units}$$

$$N_{75} \text{ Grinding} = 143 \text{ units}$$

$$N_{75} \text{ Calcining} = 15 \text{ units}$$

Taking the 1975 Production Capacity for each operation and the number of units in 1975 we may estimate a typical process weight rate.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-18-74

Source Phosphate Rock Processing

$E_s$ : Particulate cont'd

	<u>A<sub>75</sub></u>	<u>N<sub>75</sub></u>	<u>Typical Plant Size</u>
Drying: Mat Hand	$43.9 \times 10^6$ TON/yr	63	$697 \times 10^3$ TON/yr
Grinding	$25.7 \times 10^6$ TON/yr	143	$180 \times 10^3$ TON/yr
Calcining	$2.55 \times 10^6$ TON/yr	15	$170 \times 10^3$ TON/yr

Assuming  $16 \frac{\text{hr}}{\text{day}} \times 350 \frac{\text{d}}{\text{yr}} = 5600 \frac{\text{hr}}{\text{yr}}$  we may convert the Typical Plant size on a Ton/yr basis to Ton/yr and eventually lb/hr (Process weight)

Since all material going through each of these processes is not intentionally lost or added to the process weight based on feed is the same as the process weight we calculate on the route of production capacity.

$$\frac{\text{lb}}{\text{hr}} = \frac{\text{TON}}{\text{yr}} \times \frac{\text{yr}}{5600 \text{ hr}} \times \frac{2000 \text{ lb}}{\text{TON}} \quad (\text{per plant})$$

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Computation Sheet For Emission Factors

Calculations Done By William Marrone Date 10-18-74

Source Phosphate Rock Processing

$E_S$ : Particulate cont'd

	<u>Process Weight (Typical Plant)</u>
Drying	$249 \times 10^3$ lb/hr
Grinding	$64 \times 10^3$ lb/hr
Calcining	$61 \times 10^3$ lb/hr

Ref 095 760.2010 H & I identifies the following states as having phosphate rock production:

- (1) Florida
- (2) Georgia
- (3) North Carolina
- (4) Tennessee
- (5) Kentucky
- (6) South Carolina
- (7) Arkansas
- (8) Idaho
- (9) Montana
- (10) Utah
- (11) Wyoming

It also states that about 73% of the process rock comes from Florida.

We will develop our estimates of  $E_S$  for these processes in the phosphate rock processing industry by weight the Florida Allowable (73%) emissions with the Generalized Average [50 state] process weight rate curve.

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 10-18-74  
 Source Phosphate Rock Processing

$E_s$  : Particulate cont'd

	<u>Process Wt</u>	<u>Florida Allowable</u>	<u>50 State Allowable</u>
Drying	$249 \times 10^3$ lb/hr	39.5 lb/hr	50 lb/hr
Grinding	$64 \times 10^3$ lb/hr	28.0 lb/hr	36 lb/hr
Calcining	$61 \times 10^3$ lb/hr	27.2 lb/hr	35.5 lb/hr

Weighting, we obtain

$$\begin{array}{lll} \text{Drying} & .73(39.5) + .27(50) = 42.3 \text{ lb/hr} \\ \text{Grinding} & .73(28.0) + .27(36) = 30.2 \text{ lb/hr} \\ \text{Calcining} & .73(27.2) + .27(35.5) = 29.4 \text{ lb/hr} \end{array}$$

Using 5600 hr/yr we may convert these allowable emission to lb/yr and by dividing by the typical plant output capacity, we obtain  $E_s$  in lb/TON product.

$$\frac{\text{lb/hr Part} \times 2000 \text{ lb}}{\text{lb/hr rock}} = \frac{\text{lb ft}}{\text{TON Product}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-18-74

Source Phosphate Rock Processing

$E_s$ : Particulates cont'd

Drying:  $E_s = \frac{42.3 \times 2000}{249,000} \approx .34 \text{ lb/Ton rock product}$

Grinding:  $E_s = \frac{30.2 \times 2000}{64,000} \approx .94 \text{ lb/Ton product}$

Calcining:  $E_s = \frac{29.4 \times 2000}{61,000} \approx .96 \text{ lb/Ton product}$

**TECHNICAL REPORT DATA**  
 (Please read Instructions on the reverse before completing)

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		6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S) Thomas G. Hopper William A. Marrone		8. PERFORMING ORGANIZATION REPORT NO.	
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16. ABSTRACT The purpose of this document is to present the results of a study to determine the impact of new source performance standards on nationwide emissions. The work presented covers 14 potential pollutants from approximately 200 source categories for the year 1985. The results are being used by EPA as input to the development of an overall standard setting strategy. The report contains information regarding controlled and uncontrolled emission factors, State emission limitations, industrial capacity, utilization, growth and retirement rates. The results of this study have been published as three volumes which encompass ten separate documents. This document contains Appendix 4D of Volume II - Calculation Sheets for the Mineral Products Industry.			
17. KEY WORDS AND DOCUMENT ANALYSIS			
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Air Pollution Air Pollution Control Industrial Processes Combustion Regulations Economic Factors	Priorities Chemical Industry Paper Industry Petroleum Industry	Metal Industry Agricultural Mineral Flyash Exhaust Gases	
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