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Background Report Reference

AP-42 Section Number: 9.9.1

Background Report Section: 4

Reference Number: 17

**Title: Determining Input Variables for
Calculation of Impact of New
Source Performance Standards:
Worksheets for Food and
Agricultural Industries**

**Research Corporation of New
England**

April 1977

EPA-450/3-76-018-c

April 1977

**DETERMINING
INPUT VARIABLES
FOR CALCULATION
OF IMPACT OF NEW
SOURCE PERFORMANCE
STANDARDS: WORKSHEETS
FOR FOOD AND
AGRICULTURAL 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 FOOD
AND AGRICULTURAL INDUSTRIES**

by

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Contract No. 68-02-1382

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Prepared for

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-c

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-450/3-76-018-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 Eu (uncontrolled emission rate). Volume 019-b contains ranked data for particulate, nitrogen oxide (NOx), and sulfur oxide (SOx) 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, SOx, NOx, 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 FOOD AND AGRICULTURAL INDUSTRY

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 11-27-74

Source Cotton Ginning

Pc:

Ref Oll p1-2

"Because of the number and complexity of all factors influencing the cotton market the National Cotton Council finds it impossible to project the future of cotton even one year."

* Production will remain in the range of 9-14 million bales/yr for the period 1970 to 1980.

A historical look at cotton production also points to the problem of estimating growth. (Ref Oll: 050)

1899	9.4×10^6 bales/yr	29,600 Gins
1969	10.0×10^6 bales/yr	3,943 Gins
1970	10.1×10^6 bales/yr	3,754 Gins

Over the 70 year period the overall growth appears nil and the number of gins has decreased remarkably. This is explained by an increase in the size of the typical gin afforded by mechanization and dictated by economics.

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Computation Sheet For Industrial Factors

Calculations Done By W. J. Morrone Date 11-27-74

Source Cotton Ginning

P_c : cont'd

Our estimate of growth in the cotton ginning industry will be based on the following development.

- ① 1970 production = 10.1×10^6 bales/yr
- ② 1980 production is estimated as the average of the 9 to 14×10^6 bale/yr range quoted above
- ③ Growth from 1970 to 1980 is assumed simple and based on the above data (1975 as baseline year)

$$P_{80} = \frac{9+14}{2} = 11.5 \times 10^6 \text{ bales/yr}$$

$$P_{70} = 10.1 \times 10^6 \text{ bale/yr}$$

$$\begin{aligned} \text{Growth} &= (11.5 - 10.1) \times 10^6 \text{ bale/yr} \\ &= 1.4 \times 10^6 \text{ bale/yr} \end{aligned}$$

$$\text{Yearly growth} = \frac{1.4 \times 10^6 \text{ bale/yr}}{10 \text{ yrs}} = .14 \times 10^6 \frac{\text{bale}}{\text{yr}}$$

$$P_{75} = 5 \times (.14 \times 10^6) + P_{70} = (.7 + 10.1) \times 10^6 \frac{\text{bale}}{\text{yr}}$$

$$P_{75} = 10.8 \times 10^6 \text{ bales/yr}$$

then

$$P_c = \frac{.14 \times 10^6}{10.8 \times 10^6} \approx .013 \text{ simple}$$

$$\therefore P_c = .013 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-27-74

Source Cotton Ginning

K:

Cotton gins are operational for very short periods generally encompass the normal cotton harvesting period. This usually is only 4-6 weeks in time. This implies that gins are inactive 46-48 weeks out of the year. It is expected that gins are designed to handle a certain ~~the~~ ginning rate and if production peaks above capacity then the length of the ginning period will be increased accordingly. All of this is to say that when gins are running they are producing at the peak design rate and for this reason the capacity utilization ratio is assumed equal to unity.

$$K = 1$$

A: Using $P_{75} = 10.8 \times 10^6$ bales/yr and $K = 1$

$$A = 10.8 \times 10^6 \text{ bales/yr}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 11-27-74

Source Cotton Ginning

P_B :

Ref 037 Class 39.0

Asset Guideline Period 12 yrs

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

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

$P_B = .042 \text{ simple}$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrow Date 11-27-74

Source Cotton Ginning

Particulates

E_u : Ref 075 Table 6.3-1

$$E_u = 12 \text{ lb/bale}$$

use total emissions
disregarding fallout
effect.

Breakdown given:

① Unloading	5
② Cleaner	1
③ Stick & Burr	3
④ Misc	<u>3</u>
	12 lb/bale

E_N : Ref 011 p4-2

99% eff on high pressure system (unloading, cleaner, stick and burr, gins, etc) achieved through use of small diameter (AEC) cyclones.

Ref 011 p4-4

overall eff of 87% on low-pressure system (lint cleaner and waste) with inline filter

These are considered best available control systems

We assume ① 99% eff on high pressure (5+1+3) 9 lb/bale
 ② 87% eff on low pressure (3) = 3 lb/bale

$$E = .01 \times 9 + .13 \times 3 = .09 + .39$$

$$E_N = .48 \text{ lb/bale}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-27-74

Source Cotton Ginning

Particulates

E_s:

The process weight necessary to produce 1 bale (500 lbs) of cotton is as mentioned in Ref 075 p 6.3-1 is about 2000 lb or 1 ton

Ref 011 pg 1-4 specifies a typical gin size of 10-15 bales/hr with an average of 12.5 bales/hr

$$12.5 \frac{\text{bales}}{\text{hr}} \times 2000 \frac{\text{lb input}}{\text{bale produced}} = 25000 \frac{\text{lb input}}{\text{hr}}$$

Ref 011 pg 1-6 Table 1 give 1968 Gin breakdown by state from which we may estimate state-wide capacity distribution

	<u>No of Gins</u>	<u>P_i</u>	<u>Allowable lb/hr</u>
Alabama	339	.081	17.3
Georgia	255	.061	22.4
S Carolina	224	.054	22.4
N. Carolina	143	.034	22.4
Virginia	7	.002	22.4
Florida	5	.001	17.3
Louisiana	181	.043	22.4
Arkansas	451	.108	17.3
Miss	511	.123	22.4
Tenn	23	.006	17.3
Missouri	115	.028	22.4
Kent	1	neg	22.4
Texas	1300	.312	37.5

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Computation Sheet For Emission Factors

Calculations Done By 21. Marone Date 11-27-74

Source Cotton Ginning

	<u>No. of Gins</u>	<u>A_i</u>	<u>Allowable</u>	<u>lb/hr</u>
Oklahoma	145	.035	22.4	
Arizona	116	.028	22.4	
California	291	.070	22.4	
New Mexico	58	.014	20.0	
Nevada	1	neg	22.4	
	<u>4166</u>	<u>Σ 1.00</u>		

$$E = .312 (37.5) + .014 (20.0) + .196 (17.3) + .478 (22.4)$$

$$11.7 + .28 + 3.39 + 10.71$$

$$E \approx 26.1 \text{ lb/hr}$$

$$E_s = \frac{26.1 \text{ lb/hr}}{12.5 \text{ bale/hr}} = 2.09 \text{ lb/bale}$$

$$E_s = 2.09 \text{ lb/bale}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marnone Date 5-15-75

Source Cotton Ginning

Arsenic (hazardous pollutant)

arsenic emissions from the ginning operation only may be estimated from value in Ref 275 pg 22

.03% of emitted particulate near gin was found to be arsenic.

pg 25 of the same reference suggests that particulate control measures should be adequate at controlling arsenical emissions.

We will develop the emission factors for arsenic E_u , E_s , E_N by using the appropriate particulate factor and assume the .03% relationship applies to uncontrolled, controlled, and allowable. This assumes "default" control of arsenic from cotton ginning through imposition of particulate reg.

$$E_u(\text{arsenic}) = .0003 \times 12 \frac{\text{lb}}{\text{bale}} = .0036 \text{ lb/bale}$$

$$E_N(\text{arsenic}) = .0003 \times .48 \frac{\text{lb}}{\text{bale}} = .00014 \text{ lb/bale}$$

$$E_s(\text{arsenic}) = .0003 \times 2.09 \frac{\text{lb}}{\text{bale}} = .00063 \text{ lb/bale}$$

it is assumed that existing plants can achieve controls suggested by E_N

$$E_{1121} = E_N = .00014 \text{ lb/bale}$$

Source Ammonium Sulfate

$$K_{\text{core over}} = 0.91$$

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Computation Sheet For Industrial Factors

Calculations Done By Holler

Date 8/30/74

Source Amosian Software

{ Prod.^{of} METHYL METHYL METH. = 250×10^6 Ref (95) 606.5030 C
Cap of " " = 320×10^6 Ref (95) 606.5030 B
Aug '66

$$K_{\text{METH}} = 0.78$$

$\left\{ \begin{array}{l} \text{Prod of HCN} = 146 \times 10^3 \text{ r} \\ \text{Cap. of HCN} = 215.5 \times 10^3 \text{ r} \end{array} \right.$
 Ref (95) 735.5020 D Apr. '65
 Ref (95) 735.5020 B

$K_{\text{row}} = .68$

THE ABOVE TWO WERE DONE FOR THE ENTIRE SACE INFO FOR THE AMM. SELF. ASPECT WAS NOT AVAILABLE

TOTAL ANN. SELF PROD. (1966) = 2900×10^3 TONS

BY PRIME =	1175.4×10^3	—	40.9 %
BY CAPE =	633.7×10^3	—	22. %
BY CORE-CEN =	746.5×10^3	—	26.0 %
BY METH.METH. =	290×10^3	—	10.1 %
BY HCN	27×10^3	—	0.9
	<u>2872.6</u>		

$$K_{AS} = (.409)(.82) + (.221)(.73) + (.26)(.91) + (.101)(.78) + (.009)(.68)$$

$$.34 + .17 + .24 + .08 + .01$$

$$K_{\text{AMMONIUM SULFATE}} = 0.84$$

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Computation Sheet For Industrial Factors

Calculations Done By H. H. H. H. Date 8/30/74

Source Ammonium Sulfate

REF (95) 708.5020 0

PROD 1960 = 1500×10^3 TONS

PROD 1966 = 2900×10^3 TONS

$$P_c = \sqrt[6]{\frac{2900}{1500}} - 1$$

$$P_c = \sqrt[6]{1.9333} \quad .1667$$

$$P_c = 11.6 \%$$

compound

$$A = \left(\frac{2900 \times 10^3 T}{0.84} \right) (1.116)^9 = 9270 \times 10^3 T$$

$$A = 9.270 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By William Marrowe Date 9-26-74

Source Ammonium Sulfate

P_B : Ref 037 pg 33 Section 28.0

Fertilizers are covered under this category of chemical and allied products manufacture.

Asset Guideline life 11 yrs

$P_B \text{ est} \approx 2 \times \text{IRS} = 22 \text{ yrs}$

100% Depreciation in 22 years

$$\frac{100\%}{22 \text{ yrs}} \approx 4.5\%/\text{yr simple}$$

$$P_B = .045 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By _____ Date 8/30/74

Source Ammonium Sulfate

Ref (49) p 326 TAB 15-1

EU = 1% OF PRODUCT

THIS # WAS ASSUMED
BY MAT & WE HAVE NOT LOCATED
ANY DATA

$$EU = .01 \frac{\text{# PROD}}{\text{# PROD}} \times 2000 \frac{\text{# PROD}}{\text{TON PROD}} = 20 \text{ * / TON}$$

$$EU = 20 \text{ * / TON}$$

SINCE AMMONIUM SULFATE IS PRODUCED AS BOTH A PRIME & BY-PRODUCT, NO SINGLE COLLECTION DEVICE WOULD BE FEASIBLE FOR ALL OPERATIONS DUE TO THE EXTREMES IN VARIABILITY OF THE PROCESSES. HOWEVER, THE FOLLOWING INFO IS HELPFUL IN SELECTING A "GENERAL" CONTROL DEVICE FOR THE PURPOSE OF THIS STUDY:

① AMMONIUM SULFATE REF (49) P 329

"THE DRYER IS USUALLY CONTROLLED BY CYCLONES OR WET SCRUBBERS"

② REF (49) P 332 "WET SCRUBBERS ARE PROBABLY THE MOST COMMON PIECE OF DUST AND FUME COLLECTION EQUIPMENT BEING USED IN FERTILIZER PLANTS"

∴ WE WILL CHOOSE A WET SCRUBBER AS THE "GENERAL" CONTROL DEVICE

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOOPER Date 8/30/74

Source Ammonium Sulfate

REF (40) (Dealing with the fertilizer industry)

SEC II TAB VII

Wet Scrubber efficiencies

$$94\% \leq \eta < 99.8\%$$

REF (40) includes the following report

"WET SCRUBBERS", Chem. Eng., Oct 14, 1968

WHICH STATES

$\eta_{\text{WET SCRUBBER}} = 95\%$ for phosphate dust
from fertilizer plants

We will use, therefore, $\eta = 95\%$

$$E_N = (0.05)(20) = 1 \text{ #/ton}$$

$$E_N = 1.0 \text{ #/ton}$$

For E_S , the following ^{ARE} plant loc'us $\frac{1}{2}$ capacity REF (95)
708.5020 F-L
VA (575)

TEX 140 + 130 + 60 + 90 + 100 + 383 + 100

Calif. 90 + 80 + 150 + 290

GA. 85

$$\frac{2273}{3346} = 68\%$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOPER Date 10/17/74

Source Ammonium Sulfate

Ammonium Sulfate

ES DETERMINATION

This data (p2) is not a complete list - only 68% of the industry.

$$\begin{aligned} \text{Typical plant size} &= 146.6 \times 10^3 \frac{\text{tons}}{\text{yr}} \Rightarrow 402 \text{ TPD (365 days)} \\ \text{TEXAS + CALIF.} &\Rightarrow 33,470 \text{ #/yr (8760 hrs)} \\ &\quad (16.74 \text{ TPN}) \end{aligned}$$

Since AS is produced as a prime product & as the by-product of many other processes, it is difficult (if not impossible) to generate a synthesized feed/product ratio. For the purpose of this study, we will assume a 1:1 ratio. This will result in a lower value of ES & therefore, a def'n of the minimum expected impact ($T_s - T_n$). Based on our experience with other calculations, the difference in ES, on a #/ton basis, will be small.

$$\text{For VA} \quad \frac{575}{3346} = 17\%$$

$$\text{TEX} \quad \frac{1003}{3346} = 30\%$$

$$\text{Calif} \quad \frac{610}{3346} = 18\%$$

$$\text{GA.} \quad \frac{85}{3346} = 2\%$$

Assume all other plants equally distributed around U.S. (37%)

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 10/18/74

Source Ammonium Sulfate

FROM REF (84) p 29 TABLE 1 & REF (148)

$$E_{SVA} = 27 \text{ \#}/\text{HR}$$

From Gen'l PWR curve

$$E_{STEX} = 50 \text{ \#}/\text{HR}$$

$$E_{GENL} = 26.0 \text{ \#}/\text{HR}$$

$$E_{GA.} = 27 \text{ \#}/\text{HR}$$

$$E_{CAL} = 24.5 \text{ \#}/\text{HR} \quad \text{Ref 156 p 37 (LA APCD)}$$

$$E_s = (27)(.17) + (50)(.3) + (27)(.02) + (24.5)(.18) \\ + (.37)(26.0)$$

$$= 4.59 + 15.0 + .54 + 4.41 + 9.62 = 34.16 \text{ \#}/\text{HR}$$

$$E_s = \frac{34.16 \text{ \#}/\text{HR}}{16.74 \frac{\text{TONS}}{\text{HR}}} = 2.04 \text{ \#}/\text{TON}$$

$$E_{s \text{ PART}} = 2.04 \text{ \#}/\text{TON}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Homer Date 9/4/74

Source FERTILIZERS - Diammonium Phosphate

Ref (95) p 760.5003 Q

$$1973 \text{ Prod} = 2.52 \times 10^6 \text{ TONS } P_2O_5$$

Ref (95) p 760.5001 B

"THE INDUSTRY OPERATED 'FLAT OUT' IN 1973,
 RESULTING IN AN AVERAGE TOTAL RATED
 CAPACITY UTILIZATION FIGURE OF ABOUT 90%."

p 760.5003 A

$$1972 \quad K = 87\% - 91\%$$

Ref (40) Sec VIII TAB 1

$$K_{1980} = \frac{4.60}{5.35} = 0.86$$

Therefore, choose

$$K = 0.89$$

Ref (95) 760.5001 C

Avg ANNUAL GROWTH RATE 1972-1980
 4.5 - 6.25% (STRAIGHT LINE)

$$\text{Assume Average} = (4.5 + 6.25)/2 = 5.4\%$$

$$P_c = 0.054$$

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 9/4/74

Source FERTILIZERS - DAP

$$\frac{(2.52 \times 10^6)}{(0.89)} \times [1 + (.054)(2)] = 3.14 \times 10^6 \text{ TONS } P_2O_5$$

$$A = 3.14 \times 10^6 \text{ TONS } P_2O_5$$

Obsolescence rate for fertilizers is estimated as follows:

Ref 037 pg 33 Sec 28

Asset guideline period 11 yrs

$P_b \text{ est} \approx 2 \times IRS = 22 \text{ yrs}$

$\frac{100\%}{22 \text{ yrs}} \approx 4.5\%/\text{yr}$ simple

$$P_b = .045 \text{ simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hager Date 9/4/74

Source Fertilizers - Diammonium Phosphate

REF (75) PG. 10-1 TAB 6.10-1

$$E_{up} = 82 \text{ \# / ton}$$

NO MENTION IS MADE OF THE PRODUCTION QUANTITY ASSOCIATED WITH THIS FACTOR. SINCE PRODUCTION IN THE INDUSTRY AS A WHOLE IS EXPRESSED AS EQUIVALENT P_2O_5 , WE FEEL IT REASONABLE TO ASSUME LIKEWISE.

$$E_{up} = 82 \text{ \# / ton } P_2O_5$$

REF (77) P 139 STATES

"..... WET SCRUBBING EQUIPMENT CONVENTIONALLY APPLIED FOR REMOVAL OF AMMONIA, FLUORIDES AND PARTICULATE DUSTS FROM EFFLUENT GAS STREAMS GENERATED IN DAP PLANTS "

REF (77) P 147 $\eta = 98\%$

$$E_{up} = 1.64 \text{ \# / ton } P_2O_5$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hoyer

Date

9/4/74

Source

Fertilizers - DAP

REF (77) P 147 STATES NH_3 EMISSION OF
 $8.0 \text{ } \# \text{NH}_3 / \text{TON } \text{P}_2\text{O}_5$

$$E_{\text{NH}_3} = 8.0 \text{ } \# / \text{TON } \text{P}_2\text{O}_5$$

SAME REF, SAME PAGE STATES

$\eta = 99\%$ for wet scrubber

$$E_{\text{NH}_3} = 0.08 \text{ } \# / \text{TON } \text{P}_2\text{O}_5$$

REDO FLUORIDES

REF (75) P 6.10-1 TAB 6.10-1

$$E_{\text{F}} = 0.04 \text{ } \# / \text{TON } \text{P}_2\text{O}_5$$

$$E_{\text{F}} = 0.04 \text{ } \# / \text{TON } \text{P}_2\text{O}_5$$

There are fluoride emissions from the
 dryer + cooler which are not included in this value.
 Another source of info must be found.

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/4/74

Source Fertilizers - DAP

Ref (33) p 36

$$.5 < E_U < .08$$

Assume Avg value

$$E_U = (.5 + .08) / 2 = 0.29$$

$$E_U = 0.29 \text{ \%/TON P}_2\text{O}_5$$

Ref (33) p 41

$$E_N = 0.06 \text{ \%/TON P}_2\text{O}_5$$

$$R = \frac{.29 - .06}{.29} = 79\%$$

DET'N OF E_{III}

(A) Ref (159) p 1-9 TAB 1-2
FLUORIDES

$$E_{III} = 0.06 \text{ \%/TON P}_2\text{O}_5 \text{ FLUORIDE}$$

(B) Ammonia P2 of these calc's indicates $\eta = 99\%$ WITH A
WET SCRUBBER. THIS IS BASED ON A RETROFIT SITUATION. THUS
 $E_{III} = E_N$ ($E_{III} = 0.08 \text{ \%/TON P}_2\text{O}_5$) AMMONIA

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By H. J. J. J. Date 10/16/76

Source FERTILIZERS - Diammonium Phosphate

DETERMINATION OF ES

PARTICULATES

No specific information could be located detailing the geographical distribution of DAP plants. However, we will assume that they are located in areas where phosphate rock is mined. REF (95) p 760.2010 H INDICATES THAT 73% of the U.S. supply of phosphate rock is in Florida.

So, we will synthesize ES based on weighting the Florida region by 73% & using the generalized process weight curve for the remaining 27%.

REF (33) p 38 indicates a "typical" plant of 500 TPD of P_2O_5

$$\frac{500 \frac{\text{TONS } P_2O_5}{\text{DAY}}}{\left(0.46 \frac{\text{TONS } P_2O_5}{\text{TON DAP}}\right) \left(24 \frac{\text{HRS}}{\text{DAY}}\right)} = 45.29 \frac{\text{TONS DAP}}{\text{HR}}$$

$$= 90,579 \text{ \# / HR DAP}$$

From Ref (84) p 29 TAB III

$$E_{SFH} = 31 \text{ \# / HR}$$

From gen'l DWR curve

$$E_{SOURCE} = 39.2 \text{ \# / HR}$$

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Computation Sheet For Emission Factors

Calculations Done By HOMER Date 10/12/74

Source FERTILIZERS - DAP

$$\frac{31 \text{ \%}}{45.29 \frac{\text{TONS}}{\text{HR}}} = .6845$$

$$\frac{39.2}{45.29} = .8655$$

$$E_s = \left[(.73)(.6845) + (.27)(.8655) \right] \div .46$$

$$E_s = 1.595 \text{ \% TON } P_2O_5$$

THIS IS ESSENTIALLY THE SAME AS E_{NH}

HOWEVER, REF (95) p 760.5003A shows that there were 42 plants producing 2.52×10^6 TONS of DAP (P_2O_5) in 1973

$$\frac{2.52 \times 10^6}{(42)(8760)} = 6.849 \text{ TONS } P_2O_5/\text{HR}$$

REF (95) p 760.5002A indicates feed req'ts per ton of DAP

$$NH_3 \text{ AVG} = 0.245 \text{ TONS}/\text{TON DAP}$$

$$\text{Phosphoric Acid} = .4875 \text{ TON}/\text{TON DAP (40-45\% } P_2O_5 \text{)} \\ (\text{P}_2\text{O}_5 \text{ BASIS})$$

$$\text{Sulfuric Acid} = .012 \text{ TON}/\text{TON DAP}$$

$$\frac{0.4875}{.425} = 1.147 \text{ TONS } H_3PO_4/\text{TON DAP}$$

$$\text{AVG} \rightarrow 1.147 + .245 + .012 = 1.404 \text{ TONS FEED}/\text{TON DAP}$$

From Ref (95) p 760.5001B, $\frac{2.318 \times 10^6 \text{ TONS } P_2O_5}{5.040 \times 10^6 \text{ TONS DAP}} = 0.46$

$$\frac{1.404 \frac{\text{TONS FEED}}{\text{TON DAP}}}{.46 \frac{\text{TONS } P_2O_5}{\text{TON DAP}}} = 3.052 \text{ TONS FEED}/\text{TON } P_2O_5$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper

Date 10/16/74

Source Fertilizers - DAP

$$PWR = 6.849 \frac{\text{TON P}_2\text{O}_5}{\text{HR}} \times 2000 \frac{\#}{\text{TON}} \times 3.052 \frac{\text{TONS FEED}}{\text{TON P}_2\text{O}_5} = 41,806 \frac{\# \text{ FEED}}{\text{HR}}$$

From Ref (84) p29 TAB III & Ref (148)

$$E_{\text{FLA}} = 22 \frac{\#}{\text{HR}}$$

From gen'l PWR curve,

$$E_s = 30 \frac{\#}{\text{HR}}$$

$$E_s = (.73) \left(\frac{22}{6.849} \right) + (.27) \left(\frac{30}{6.849} \right) = 2.345 + 1.183 = 3.528$$

$$E_{s \text{ PART}} = 3.528 \frac{\#}{\text{TON P}_2\text{O}_5}$$

Ammonia

THERE ARE NO STATE CONTROLS. Assume $E_s = E_u$

$$E_{s \text{ NH}_3} = 8.0 \frac{\#}{\text{TON P}_2\text{O}_5}$$

FLUORIDES

Ref (148) Florida has a reg of $0.06 \frac{\#}{\text{TON P}_2\text{O}_5}$
Assume other States to be UNCONTROLLED

$$E_s = (.73)(.06) + (.27)(.29) = .438 + .0783 = 0.1221$$

$$E_{s \text{ FLUORIDES}} = 0.122 \frac{\#}{\text{TON P}_2\text{O}_5}$$

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 9/3/74

Source FERTILIZERS - Granulated Triple Superphosphate

REF (95) p 760.4004B

ESTIMATES

$$1975 \text{ PRODUCTION} = \left(\frac{.860 + .930}{2} \right) \times 10^6 \text{ TONS } P_2O_5$$

$$= 0.895 \times 10^6 \text{ TONS } P_2O_5$$

GROWTH BETWEEN 1975 AND 1980 IS

$$.895 \times 10^6 \rightarrow 1.100 \times 10^6$$

$$P_c = \sqrt[5]{\frac{1.100}{0.895}} - 1.0 = 4.2\%$$

$$P_c = 0.042$$

COMPOUND

REF (95) p 760.4001B

STATES capacity utilization in 1976 to be

$$.72 < K < .8$$

Assume the average = 0.76

$$K = 0.76$$

$$A = \frac{.895 \times 10^6}{.76} = 1.178 \times 10^6$$

$$A = 1.178 \times 10^6 \text{ TONS } P_2O_5$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-26-74

Source Granulated Triple Super phosphate

P_B :

Ref 037 pg 33 sec 28.0

Asset ~~period~~ guideline 11 yrs

$$P_B \text{ est} \approx 2 \times \text{IRS} = 22 \text{ yrs}$$

$$\frac{100\%}{22 \text{ yrs}} = 4.5\% / \text{yr simple}$$

$$P_B = .045 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By H. H. H. H. Date 9/6/74

Source FERTILIZERS - Granulated Triple Superphosphate

I. PRODUCTION

Fluorides

REF (33) p 52 STATES "... poorly controlled STSP plants can release up to 0.6 pounds of fluoride per ton of P_2O_5 input."

WE WILL ASSUME THIS TO BE EU SINCE REF (77) p 107 STATES THAT, "..... THE BLUNDER AND REACTION TANKS ARE USUALLY VENTILATED THROUGH A COMMON SCRUBBER...."

AS A RESULT OF THE INDUSTRY HAVING PARTIAL CONTROL,

$$E_U = 0.6 \text{ #/TON } P_2O_5$$

REF (33) p 53 INDICATES THAT EMISSIONS FROM A WELL CONTROLLED STSP PLANT CAN BE AS LOW AS 0.12 #/TON P_2O_5

$$\therefore E_N = 0.12 \text{ #/TON } P_2O_5$$

REF (159)
PI-9 TAB 1-2

$$E_{IND} = 0.2 \text{ #/TON } P_2O_5$$

PARTICULATE

REF (040) p II-15 STATES

"ALL modern plants in the U.S. [granulated or pulverized SPA] MAKE USE OF SOME TYPE OF WET SCRUBBER FOR FLUORIDES AND RESIDUAL DUST. THE LATTER WILL HAVE BEEN

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Computation Sheet For Emission Factors

Calculations Done By HOMER Date 9/6/74

Source FERTILIZER - GTSP

REDUCED, UPSTREAM OF THE SCRUBBER, TO LOW LEVEL by
dry collectors that RETURN SOLIDS TO THE PROCESS.

$$\therefore E_{U_1} = 0$$

$$E_{U_2} = 0$$

In addition, REF (75) pp 6.10-1,2 MAKES NO
MENTION OF PARTICULATES from production of
GTSP.

II. STORAGE

FLUORIDES

p 57

REF (33) EMISSIONS from poorly controlled
GTSP PLANT :

REF (33)

P 52

TYPICAL PLANT
500 TPD P_2O_5

$$.0007 < E_U < .0015 \quad \frac{\#F}{\text{TON} \cdot \text{HR}} \quad P_2O_5$$

CONSIDERING the AVERAGE for A 24 HR DAY

$$E_U = 0.026 \quad \frac{\#}{\text{TON } P_2O_5}$$

REF (33), p 57 STATES F- EMISSIONS from A
WELL-CONTROLLED STORAGE FACILITY = .0005 $\frac{\#}{\text{HR} \cdot \text{TON}}$
FOR A 24-HR DAY

$$E_{NF} = 0.012 \quad \frac{\#}{\text{TON } P_2O_5}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/6/74

Source FERTILIZERS - GTSP

REF (33) p 52

$$E_{ind} = E_N = .012$$

$$E_{ind} = 0.012 \frac{\#}{TON P_2O_5}$$

PARTICULATE

No emission info could be located regarding PARTICULATE EMISSIONS from GTSP storage. However, REF (49) p 326 TAB 15-1 MAKES REFERENCE to LOSSES DURING HANDLING OF PHOSPHATE FERTILIZERS in GENERAL. FOR LACK OF ANY SPECIFIC INFO, we will USE THIS VALUE. EMISSIONS FROM STORAGE DURING QUIESCENT PERIODS IS CONSIDERED TO BE NEGLIGIBLE

$$E_{up} = 1 \frac{\#}{TON product}$$

$$@ 46\% P_2O_5 \text{ (Ref (33) p 50)}$$

$$E_{up} = 2.17 \frac{\#}{TON P_2O_5}$$

REF (75) p 6.10-1 TAB 6.10-1 STATES

$\eta = 99\%$ WITH fabric filters

$$E_{N_p} = 0.022 \frac{\#}{TON P_2O_5}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 10/16/74

Source FERTILIZERS - GTSP

DETERMINATION OF E_s

PARTICULATES (DUST)

REF (33) "... Projected granular triple superphosphate production is expected to be conducted by complexes designed for multiple applications. Therefore, facilities equipped for DAP manufacture will also produce GTSP to satisfy demand. ..."

Assume, therefore, same distribution of plants as for DAP

73% - Florida

27% - Scattered Around U.S.

REF (153) PZS STATES 16 PLANTS WITH A CAPACITY OF 5.3×10^6 TONS IN 1965 (P_2O_5)

$$\frac{(5.3 \times 10^6)(2000)}{(16)(8760)} = 75,628 \quad \frac{\# P_2O_5}{HR} (37.81 TON)$$

From Ref (95) p 760.4002A, yield is 63-73% TSP

So, assuming the average $1 \# FEED \rightarrow .68 \# TSP @ 46\% P_2O_5$

$$\frac{1 \# FEED}{0.68 \# TSP}$$

$$\frac{0.46 \# P_2O_5}{\# TSP}$$

$$= 3.197 \frac{\# FEED}{\# P_2O_5}$$

$$\left(75,628 \frac{\# P_2O_5}{HR} \right) \left(3.197 \frac{\# FEED}{\# P_2O_5} \right) = 241,783 \frac{\# FEED}{HR}$$

From Ref (84) p 29 TABLE

$$E_{SFA} = 39 \#/HR$$

From the gen'l PWR curve

$$E_s = 50 \#/HR$$

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Source FERTILIZER - GTSP

$$E_s = (.73) \left(\frac{39}{37.81} \right) + (.27) \left(\frac{50}{37.81} \right) = .753 + .357 = 1.11$$

$$E_{s \text{ PART STORAGE}} = 1.11 \text{ \# / TON P}_2\text{O}_5$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 10/16/74

Source Fertilizers - GTSP

Fluorides (Production)

REF (148) Florida has a regulation of $0.15 \text{ */ton P}_2\text{O}_5$
 Assume other states to be UNCONTROLLED

$$E_s = (.73)(.15) + (.27)(.6) = .1095 + .162 =$$

$$E_{s_{\text{FLUORIDE, PRODUCTION}}} = 0.272 \text{ */ton P}_2\text{O}_5$$

(Storage)

REF (148) Florida has a regulation of $0.05 \text{ */ton P}_2\text{O}_5$

This value of E_s for Florida

- ① IS GREATER than E_U
- ② HAS NO time factor ASSOCIATED WITH IT

Therefore, we will assume $E_s = E_U$

$$E_{s_{\text{FLUORIDE STORAGE}}} = 0.026 \text{ */ton P}_2\text{O}_5$$

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Computation Sheet For Industrial Factors

Calculations Done By HOMER Date 9/3/74

Source NITRATE FERTILIZERS

REF (75) P 6.8-1

WE WILL CONSIDER AMMONIUM NITRATE TO BE MOST REPRESENTATIVE OF THE CATEGORY "NITRATE FERTILIZERS".

REF (95) P 706.5020B OCT 1968

HOWEVER, NOT ALL AMMONIUM NITRATE IS USED FOR FERTILIZER. SOME IS USED FOR EXPLOSIVES & AS A PRECURSOR FOR NITROUS OXIDE.

IN 1967, TOTAL CONSUMPTION WAS 5,445,000 TONS OF WHICH 4,590,000 TONS WERE USED FOR FERTILIZER OR

$$\frac{4.59}{5.445} = 84\%$$

$$P_{\text{FERTILIZER}} = 77\%$$

(Assume CPD)

REF (95) P 706.5020B

1967 PROD = 5.605×10^6 TONS - OR - 1967 PROD of AN for fert = $(.84)(5.605) \times 10^6$

$$\text{PROD 1975 of AN FOR FERTILIZER} = \left(\dots \right) (1.07)^8 = 4.708 \times 10^6 \text{ TONS}$$

$$\begin{matrix} 1975 \\ \text{PROD} \\ \text{AN} \\ \text{(for fert)} \end{matrix} = 8.089 \times 10^6 \text{ TONS}$$

K is between 75% - 80% REF (95) P 706.5020A OCT '68

Assume 77%

$$K = 0.77$$

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Calculations Done By HOMER Date 9/3/74

Source NITRATE FERTILIZERS

$$A = \frac{8.089 \times 10^6}{0.77} = 10.505 \times 10^6$$

$$A = 10.505 \times 10^6 \text{ TONS}$$

WM 9-26-74

Depreciation of Fertilizer plants (Obsolescence Rate P_o) may be estimated by IRS Guideline Table

Ref 037 pg 33 Section 28.0

Asset guideline period 11 yrs

P_o est $\approx 2 \times$ IRS 22 yrs

100% Depreciate in 22 yrs

$$\frac{100\%}{22 \text{ yr}} \approx 4.5\% / \text{yr simple}$$

$$\therefore P_o = .045 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By H9927R Date 9/3/74

Source NITRATE FERTILIZERS

REF (95) 706.5020 F OCT '68 STATES

"1. PRILLING. PRACTICALLY ALL SOLID PRODUCTS FOR USE IN FERTILIZERS ARE MADE IN THIS MANNER."

2. GRANULATION

TWO COMPANIES PRODUCE AN USING ROTARY GRANULATORS

(a) COMINCO AM., NEBRASKA

(b) CHEMUR CHEM., CALIFORNIA

REF (42) STATES THE CAPACITY OF THESE TWO PLANTS & THE CAPACITY OF THE INDUSTRY IN 1966

(a) 200,000 TONS

(b) 55,000 TONS

TOTAL CAP. = 7.864×10^6 T
1966

$$\therefore \frac{255,000}{7.864 \times 10^6} = 3.2\% \text{ USING GRANULATOR}$$

P 6.8-2 TAB 6.8-1

96.8% USING PRILLING TOWER

REF (75) GIVES THE EMISSION FACTORS WHICH WE WILL SCALE BY % UTILIZATION

$$E_{\text{PART}} = (.968)(0.9 + 12) + (.032)(0.4 + 7.0)$$

$$12.487 + .237 = 12.72 \text{ *ton}$$

$$E_{\text{PART}} = 12.72 \text{ *ton}$$

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Computation Sheet For Emission Factors

Calculations Done By _____ Date 9/8/74

Source NITRATE FERTILIZERS

$$E_{NH_3} = .968(2) + (.032)(2 + .5 + 1.3) \\ = 1.936 + .122 = 2.058$$

$$E_{NH_3} = 2.058 \text{ \# / ton}$$

$$E_{NO_3} = (3.9)(.032) = .125 \text{ \# / ton} = E_{NO_3}$$

This emission is found with granulation process only

REF 122 , p 72

$\eta = 98\%$ for SCRAMBLER/FILTER SYSTEM ON
 PRILLING TOWER OPERATION

$$E_{part} = 0.02(12.72) = 0.254$$

$$E_{part} = 0.254 \text{ \# / ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/3/74

Source NITRATE FERTILIZERS

Ref (40) p III-1 $\eta_{NH_3} = 98\%$ WITH WET SCRUBBER

$$E_{NH_3} = .02(2.058) = 0.041$$

$$E_{NH_3} = 0.041 \text{ \#T/W}$$

As we have done with other pollutants whose emissions appear to be low before control, an $E_N = 0$ is assumed to determine the maximum impact ($T_p - T_n$) of NSPS. If the impact is negligible, the assumption will have served its purpose; if, however, the impact is great, a control level would have to be determined.

$$E_{NH_3} = 0$$

Ref (42) p 14-15 gives 1966 plant locations
TO AND IN E_s synthesis

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Computation Sheet For Emission Factors

Calculations Done By HOOPER Date 10/17/74

Source NITRATE FERTILIZERS

Es

REF (42) p 14-16 indicates production in 28 states

% We will use the general process weight curve for ALL STATES BEING REPRESENTATIVE OF THE INDUSTRY.

REF (42) p 14-5 shows a 1966 capacity of 7.864×10^6 TONS PRODUCED BY 59 COMPANIES

$$\frac{(7.864 \times 10^6)}{(59)(8760)} = 15.22 \text{ TPD PER PLANT of AN}$$

$$15.22(2000) = 30,431 \text{ \#/HR of AN}$$

From the gen'l PWR curve

$$E_s = f(30,431 \times 1.025) = f(31,192 \text{ \#/hr}) = 24.9 \text{ \#/hr}$$

$$E_{sp} = \frac{24.9}{15.22} = 1.64 \text{ \#/TON AN}$$

$$E_{s, \text{PART}} = 1.64 \text{ \#/TON AN}$$

REF (45) p 706.5020 D

FEED RATES

.210 - .225 TONS NH_3

+
.800 - .815 TONS HNO_3

PER TON of AN

∴ 1.01 - 1.04 / TON AN

AVG = 1.025 / 1

THERE ARE NO STATE REGS FOR AMMONIA. Assume $E_s = E_U$

$$E_{s, \text{NH}_3} = 2.058 \text{ \#/TON AN}$$

NO₃

INDIANA, ILLINOIS, & MASSACHUSETTS have gen'l NO_x regulations
REF (148)

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Computation Sheet For Emission Factors

Calculations Done By HOMER

Date 10/17/74

Source NITRATE FERTILIZERS

ILLINOIS' is $5 \frac{\#NO_x}{TON \text{ of } HNO_3 \text{ USED}}$

INDIANA'S is a function of ambient AIR quality
There are no AN plants in the 3RD state, Mass.

From ref (42) p 14-16

6% of the AN capacity is in Illinois
27% " " " " " 12 in Indiana

Assume 8% of capacity to have a $5 \frac{\#}{TON \text{ AN}}$ req

92% of capacity, $\frac{1}{2}$ UNCONTROLLED

REF (95) p 706.5020 D STATES 0.800 - 0.815 TONS HNO_3 (ton)
PORTION of AN
Assume, 0.807

$$5 \frac{\#NO_x}{TON \text{ } HNO_3} \times \frac{0.807 \text{ TON } HNO_3}{TON \text{ AN}} = 4.035 \frac{\#NO_x}{TON \text{ AN}}$$

$$E_s = \left[(0.08)(4.035) + (.92)(3.9) \right] \times (.032) = (.3228 + 3.588)(.032)$$

↑
% plants using granulation

$$E_{s_{NO_3}} = 0.125 \frac{\#}{TON \text{ AN}}$$

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Computation Sheet For Emission Factors

Calculations Done By HORR Date 11/1/74

Source NITRATE Fertilizers

DET'N OF E_{ind}

REF (40) P-1111-1 STATED A CONTROL EFFICIENCY OF 98% WITH A WET SCRUBBER. SINCE THIS IS BASED ON 1970 TECHNOLOGY & SCRUBBERS ARE AMENABLE TO RETRIFIT SITUATIONS, WE WILL ASSUME

$$E_{\text{ind}} = EN$$

$$E_{\text{ind}} = 0.041 \text{ \#/TON}$$

AMMONIA

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Computation Sheet For Industrial Factors

Calculations Done By HORER Date 4/23/75

Source Fertilizer - Normal Superphosphate

Ref (95) p 760.3001 A, B STATES

THIS IS AN UPDATE OF 9/4/75
CALCULATION SHEET

- ① "... NSP, USED EXCLUSIVELY AS A FERTILIZER, HAS STEADILY DECLINED OVER THE PAST TWENTY YEARS ..."
- ② "... NSP SHOULD THEN CONTINUE TO BE PHASED OUT ..."

Ref (95) p 760.3001 B

1973 PRODUCTION = 750×10^3 tons P_2O_5

1980 PRODUCTION = 435×10^3 tons P_2O_5 (AVG of 400 + 475×10^3)

$$P_C = \sqrt[7]{\frac{435}{750}} - 1 = -7.49\%$$

$$P_C = -0.075 \text{ compound}$$

Ref (95) p 760.3001A STATES THAT THE NUMBER OF PLANTS HAS DECREASED FROM 154 IN 1967 TO 66 IN 1971. WE WILL ASSUME THAT THE MAJORITY OF THESE ARE OBSOLETE (OR NEARLY) PLANTS WHICH ARE NOT BEING REPLACED.

$$\therefore P_B = 0$$

ASSUME K TO BE EQUAL TO THAT FOR GTSP & ROP-TSP PLANTS. SEE "INDUSTRIAL FACTORS" FOR THESE TWO CATEGORIES

$$K = 0.76$$

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Calculations Done By HOPPER Date 4/23/75

Source Fertilizers - NSP

$$A = \frac{(750 \times 10^3)(1 - .075)^2}{.76} = 0.844 \times 10^6 \text{ tons}$$

$$A = 0.844 \times 10^6 \text{ tons } P_2O_5$$

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Computation Sheet For Emission Factors

Calculations Done By HOOPER Date 4/23/75

Source FERTILIZER - NSP

Since P_c is negative & $P_B = 0$, NSPS do not apply to the criteria pollutants; however, the states must regulate designated pollutants under Sec 116 of the CAA

FLUORIDES

Ref (239) p 3-177 gives an emission factor for "average industry operation" of 6.9 #/ton

$$E_{UF-} = 6.9 \text{ \#/TON } P_{2O5}$$

Using two stage cyclonic scrubbers with an $\eta_{max} = 99.25\%$ the controlled emission factor is (same Ref + page)

EN is not applicable because of negative P_c & zero P_B .

$$E_{116F-} = 0.5 \text{ \#/TON } P_{2O5}$$

This ref gives a fugitive emission factor of 6.9 #/ton.

Assume that the geographic distribution of plants is the same as for REF-TSP OR GTSP (see "INDUSTRIAL FACTORS" for these categories)

i.e. 60% - Fla
40% elsewhere

Florida has no specific req for NSP; however, they state (Ref 108) that such a source "will comply with best technology." Assuming that best technology is 0.5 #/ton & that emissions are uncontrolled in the other states,

$$E_S = .6(.5) + .4(6.9) = .3 + 2.76 = 3.1 \text{ \#/TON } P_{2O5} = E_{SF-}$$

obsolete
CAKs

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By H. D. A. S. Date 9/4/74

Source FERTILIZERS - Normal Superphosphate

REF (95) STATES

P 760.3001 A.13

- " NSP, USED EXCLUSIVELY AS A FERTILIZER, HAS
① STEADILY DECLINED OVER THE PAST TWENTY YEARS "
② "... NSP should then continue to be phased out ... "

It is our judgement in this case that since the
production of NSP is being phased out, the following
are occurring

- ① No new plants are being built
② As plants and equipment ~~are~~ become
obsolete, they are NOT repaired or
replaced since there is no economic
incentive to do so.

$$\therefore P_C = \text{NEGATIVE} \\ P_B = 0$$

This industry is NOT A CANDIDATE FOR NSPS

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOPPER

Date 4/23/75

Source FERTILIZER - ROP Triple Superphosphate

This is an update of the 9/4/74 calculation sheet

Ref (95) p 760.4001 A STATES

- B. Since 1955, TSP has typically represented 25% to 30% of the total annual domestic P_2O_5 fertilizer supply, and its overall growth trend has tended to parallel that of the total. This pattern will not necessarily continue. Demand for ROP (run-of-pile) grade, used almost exclusively as a phosphate source in "wet" mixed fertilizers produced in regional continuous ammoniation plants, is expected to decline from an estimated 474 thousand short tons P_2O_5 in 1972 to between 250 and 350 thousand short tons P_2O_5 by 1980 (average annual growth rate $(-4) - (-7.75)\%$). This rate of change is predicated on slow attrition in the demand for chemically mixed fertilizers by medium to small farms, particularly in the Southeast. Actually, the precise trend in output and supply of ROP grade will be determined more by management decisions to operate or close continuous ammoniation plants than by true demand (need).

ASSUME 474,000 TONS IN 1972
300,000 TONS IN 1980

$$P_c = \sqrt[8]{\frac{300}{474}} - 1 = -5.6\%$$

$$P_c = -5.6\% \text{ compound}$$

$$\text{1975 Production} = (474,000)(1 - .056)^3 = 0.399 \times 10^6 \text{ tons } P_2O_5$$

Assume K to be the same as for granulated TSP
SEE "INDUSTRIAL FACTORS
" FERTILIZERS - GRANULATED TSP"

$$K = 0.76$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOWER Date 4/23/75

Source FERTILIZERS - ROP Triple Superphosphate

$$A = \frac{0.399 \times 10^6}{0.76} = 0.525$$

$$A = 0.525 \times 10^6 \text{ tons } P_2O_5$$

Ref (37) p33 ac 28.0 gives the IRS ASSET guideline period of 11 years. Assuming twice this value yields a obsolescence rate of

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

Since P_c is greater than this, we can assume that no obsolete facilities are being replaced. In fact, even existing plants would be shut down or the productivity decreased.

$$P_B = 0$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 4/23/75

Source ROP-TSP

Since P_c is negative & $P_b = 0$, NSPS do not apply to the criteria pollutants; however, the states must regulate designated pollutants under Sec. 111 of the CAA.

FLUORIDES

Ref (33) p 43 states

$$E_{UF} = 1 \text{ */ton } P_2O_5$$

Ref (159) p 1-9 TAB 1-2 gives

$$E_{HID} = 0.2 \text{ */ton } P_2O_5$$

using a two stage
SYSTEM

(c) VENTURIS AND SPRAY -
CROSSFLOW PACKED BED
SCRUBBER

Ref (159) p 8-7

E_N is not applicable because of
negative P_c & zero P_b .

From Ref (148), Florida has a regulation of .17 */ton P_2O_5 .

From Ref (159) p 8-7, 60% of the industry is located in Florida.
 Assume other States to be uncontrolled.

$$E_S = (.60)(.17) + (.40)(1.0) = .102 + .4 = .502$$

$$E_{SF} = 0.50 \text{ */ton } P_2O_5$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 4/23/75

Source ROP-TSP

NH₃ was listed in the original contract listing as a potential pollutant. We can find no evidence of this type of emission from ROP-TSP process. In fact EPA states
"Only particulates and fluorides are potential pollutants from this process" Ref (33) p 45

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obsolete
CALC'S

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HORNER Date 9/4/74

Source Fertilizer - ROP Triple Super phosphate

REF (95) p 760.4001A STATES

- B. Since 1955, TSP has typically represented 25% to 30% of the total annual domestic P_2O_5 fertilizer supply, and its overall growth trend has tended to parallel that of the total. This pattern will not necessarily continue. Demand for ROP (run-of-pile) grade, used almost exclusively as a phosphate source in "wet" mixed fertilizers produced in regional continuous ammoniation plants, is expected to decline from an estimated 474 thousand short tons P_2O_5 in 1972 to between 250 and 350 thousand short tons P_2O_5 by 1980 (average annual growth rate $(-4) - (-7.75)\%$). This rate of change is predicated on slow attrition in the demand for chemically mixed fertilizers by medium to small farms, particularly in the Southeast. Actually, the precise trend in output and supply of ROP grade will be determined more by management decisions to operate or close continuous ammoniation plants than by true demand (need).

Since production of ROP-TSP is being phased out, it is highly unlikely that obsolescent plants & equipment would be replaced. Due to the lack of economic incentive, we will assume that

$$P_B = 0$$

$\therefore$ The ROP-TSP industry does not appear to be a likely candidate for NSPS

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Computation Sheet For Industrial Factors

Calculations Done By HOPER Date 4/28/75

Source Fertilizers - Superphosphoric Acid (Submerged Combustion)

Ref (95) p 760.2503 G Dec '73

1973 Production of SPA = $.530 \times 10^6$ tons
P₂O₅

Ref (159) p 8-4 STATES THAT 79% OF THE INDUSTRY USES VACUUM EVAPORATION PROCESS

$$\begin{aligned} \text{1973 Prod. by Sub.Comb} &= (1 - .79) (.530 \times 10^6 \text{ tons}) \\ &= 0.111 \times 10^6 \text{ tons} \end{aligned}$$

From Ref (33) p 28

".... ITS COST [CONTRACT] MAY RENDER THE SUBMERGED COMBUSTION PROCESS ECONOMICALLY UNATTRACTIVE FOR FUTURE CONSTRUCTION."

Ref (33) p 32

".... THE MAJORITY OF MEMBERS OF THE PHOSPHATE FERTILIZER INDUSTRY CONSIDER SUBMERGED COMBUSTION AN OUTDATED PROCESS AND FUTURE GROWTH UNLIKELY."

We will assume, therefore that

$$P_c = 0.0$$

Ref (159) p 3-8,9. TAB 3-4 indicates that there are only two sub. comb. process plants in existence. One was built in 1967, the other in 1966.

This same Ref, page 3-29 indicates average plant life span 15-20 years. Using this value, we can assume that there will be no replacement of facilities before 1985.

Therefore,

$$P_b = 0.0$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/28/75

Source Fertilizer - SPA (Submerged Combustion)

Assuming the K for submerged combustion is equal to that for vacuum evaporation (Ref (95) p 760.2503A "Capacity utilization rate between 70-72%")

Assume the
avg

$$K = 0.71$$

$$A = 0.111 \times 10^6 / 0.71 = 0.156 \times 10^6$$

$$A = 0.156 \times 10^6 \text{ tons } P_2O_5$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HORRER

Date 4/28/75

Source FERRUGINES - SAA (Sua. Cmb.)

Since $P_c \neq P_b$ are zero, we are concerned only with emissions of designated pollutants

Fluorides

Ref (159) p 5-7

Avg uncontrolled fluoride emissions between 13 & 22 pounds of fluoride per ton of P_2O_5 . Assuming the avg.

$$E_{UF} = 17.5 \text{ lb/ton } P_2O_5$$

Ref (159) p 8-4

$$E_{ind} = 0.01 \text{ lb/ton } P_2O_5$$

E_U is not applicable due to $P_c \neq P_b$ being equal to zero

Ref (159) p 3-8 The two plants are located in LA. & FLA.

LA - 127,000 tons P_2O_5

FLA - 69,000 " "

$$\frac{69}{196} = 35\%$$

196,000

LA. has no req - Assume E_U . FLA. has no specific req'n; however, they state (Ref (148)) that such a source "will comply with best technology". Assume that best technology is 0.01 lb/ton.

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 4/30/75

Source FERTILIZERS - SPA (SUA CAMP.)

EU is a totally uncontrolled plant. Existing plants do have some control however.

From Ref (159) p 8-4 .01 is a 90% reduction of fluorides now being emitted

$$\frac{.01}{.1} = 0.1$$

$$S_0 \quad E_{sf} = (.35)(.01) + (.65)(.1) = .0035 + .065 = .0685$$

$$E_{sf} = 0.069 \text{ LB/TON } P_2O_5$$

Acid Mist

Ref (40) p VII-7 TAB VII-1 gives acid mist emission factor (controlled) of 10 mg P_2O_5 /m³ gas. This is 1/5 the value for controlled fluoride emissions

$$E_{acid} = \frac{0.01}{5} = 0.002 \text{ LB ACID MIST (AS } P_2O_5) \text{ / TON } P_2O_5$$

Ref (40) p II-22 indicates control of acid mist using venturi with phosphoric acid as the scrubbing medium

Ref (40) p 8-8 indicates a typical η between 99.2% & 99.6%
Using the avg of 99.4%

$$\frac{EU - .002}{EU} = .994$$

$$EU = 0.33 \text{ LB } P_2O_5 \text{ / TON } P_2O_5$$

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Computation Sheet For Emission Factors

Calculations Done By HOMER Date 4/30/75

Source FERTILISERS - SAA (SUB. CMAA.)

Since there are no Regs for Acid Mist,

$$E_{AM} = EU = 0.33$$

$$E_{AM} = 0.33 \frac{\text{LB P}_2\text{O}_5}{\text{TON P}_2\text{O}_5}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 10/17/74

Source Fertilizers - Superphosphoric Acid (VAC. EVAP)

REF (95) p 760.2503 6 DEC '73

1973 Production = 530,000 tons P_2O_5

REF (95) p 760.2503 A Capacity utilization rate
BETWEEN 70 - 72%

Assume the avg

$$K = 0.71$$

REF (95) p 760.2501 B

Growth rate between 7.25% + 9.75% (projected)
IF WE ASSUME the average to be compd.

$$P_c = 0.085 \quad \text{CPD}$$

$$A = \frac{(.530 \times 10^6)(1 + .085)^2}{0.71} = 0.879 \times 10^6 \text{ tons}$$

$$A = 0.879 \times 10^6 \text{ tons } P_2O_5$$

From Ref (37) p 33 section 28.0, the depreciation guideline for
FERTILIZER PLANTS is 11 YEARS. ASSUME 2x IRS guideline for P_B

$$P_B = \frac{100\%}{22 \text{ yrs}} = 4.5\%$$

$$P_B = 0.045 \quad \text{simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 10/31/74

Source Fertilizers - SPA (VAC. EVAP)

WE ARE CONCERNED WITH THE VACUUM EVAPORATION
 PROCESS ONLY & ∴ "A" MUST BE CHANGED

REF (159) p 8.4 STATES

79% OF THE SPA INDUSTRY USES VAC. EVAP &
 NO ADDITIONAL CONTROL (BY THE STATES) WILL BE
 REQUIRED.

$$A = (0.879 \times 10^6)(.79) = 0.694 \times 10^6$$

$$A_{\text{VAC EVAP}} = 0.694 \times 10^6 \text{ TONS } \text{P}_2\text{O}_5$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOMER Date 10/17/74

Source FERTILIZERS - SUPERPHOSPHORIC ACID (VAC. EVAP)

SUPERPHOSPHORIC ACID, A CONCENTRATED FORM OF PHOSPHORIC ACID, IS MANUFACTURED BY TWO PROCESSES:

- (1) VACUUM EVAPORATION
- (2) SUBMERGED COMBUSTION

For the submerged combustion process, REF (33) p 28

"... ITS COST [CONTROL] MAY RENDER THE SUBMERGED COMBUSTION PROCESS ECONOMICALLY UNATTRACTIVE FOR FUTURE CONSTRUCTION."

REF (33) p 32

"... THE MAJORITY OF MEMBERS OF THE PHOSPHATE FERTILIZER INDUSTRY CONSIDER SUBMERGED COMBUSTION AN OUTDATED PROCESS AND FUTURE GROWTH UNLIKELY"

We will assume that all growth will employ the VACUUM EVAPORATION METHOD. EMISSION FACTORS WILL BE SET'S FORTH IN THIS PROCESS.

Ref (77) p 86

$$EU_{\text{FLUORE}} = \frac{0.062(24)}{300} = 0.005 \text{ \#/ton } P_2O_5$$

$$EU_{FI} = 0.005 \text{ \#/ton } P_2O_5$$

Ref (77) p 86

$$EN = f(82.5\% \text{ EFF}) = \frac{0.011(24)}{300} = 0.00088$$

$$ENR = 0.00088 \text{ \#/ton } P_2O_5$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 10/17/74

Source Fertilizers - SPA (VAC. EVAP)

ADD most emissions are associated only with the submerged combustion process.

Def'n of E_S

There are no specific state regulations controlling emissions from SPA plants.

Assume, therefore $E_S = E_U$

$$E_{S_{FI}} = 0.005 \text{ \%/ton } P_2O_5$$

Def'n Of $E_{III(D)}$

REF (159) p 8-4 states that no additional control by the states is req'd.

Assume: $E_{III(D)} = E_N$

$$E_{III(D)} = 0.00088 \text{ \%/ton } P_2O_5$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 1/28/75

Source Pesticides

The production of pesticidal chemicals are listed in ref 269, p. 108 for the years 1964-1967 as the following:

Year	Production (Thousands of pounds)
1964	805,206
1965	872,759
1966	1,000,688
1967	1,019,218
1970	12,390,000 (Ref 0957 - Summary of total prod. tables)

Assuming a compound growth rate P_c is calculated as follows:

$$P_c = \sqrt[1970-1964]{\frac{\text{Prod in 1970}}{\text{Prod in 1964}}} - 1.0 = \sqrt[6]{\frac{12,390,000}{805,206}} - 1.0 = \sqrt[6]{1.539} - 1.0$$

$$= 1.074 - 1.0 = .074$$

$$P_c = .074$$

compound

From ref 144, p. 48, Table 1 we obtain the fractional utilization rate of chemical manufacturers for the period Dec 1965-Dec 1973, which is 83%. No specific K could be found.

$$K = .83$$

$$A = \frac{(12,390,000,000 \text{ lbs})(1.074)^5}{(.83)(2000 \frac{\text{lbs}}{\text{TON}})} = 1.067 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$A = 1.067 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 1/28/75

Source Pesticides

From Ref 37, p. 33, the allowable IRS guideline for manufacture of chemicals and allied products... " is 11 years. Assuming twice the allowable

$$P_B = \frac{1}{2(11)} = 0.045$$

$P_B = 0.045$ simple

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/28/75

Source Pesticides

The pesticide industry does not produce one specific hazardous chemical but rather many ^{that are} potentially hazardous. In addition this industry is constantly changing by the introduction of new pesticides, modification of present pesticides, and the reduction in production of obsolete pesticides. We make the assumption that all product emissions from the pesticide industry are hazardous chemicals.

From ref 269, p.39 we find that "pesticides are generally manufactured in closed systems of a continuous - process nature. The process systems are normally maintained at a slightly negative pressure to avoid leakage." No information regarding emissions of pesticides were found but from the previous reference we make the assumption that 0.5% of pesticide production is emitted to the atmosphere.

$$E_u = \frac{(.005 \times 1.067 \times 10^6 \frac{\text{TONS}}{\text{YR}}) \left(2000 \frac{\text{lbs}}{\text{TON}} \right)}{1.067 \times 10^6 \frac{\text{TONS}}{\text{YR}}} = 10 \frac{\text{lbs}}{\text{TON}}$$

$$E_u = 10 \frac{\text{lbs}}{\text{TON}}$$

We make the assumption that the majority of these uncontrolled emissions are in the form of particulates. We further assume that a baghouse filter will be able to control emissions by 99%. E_N will then equal $10 \times .01 = .1 \text{ lbs/TON}$

$$E_N = 0.1 \frac{\text{lbs}}{\text{TON}} \text{ hazardous chemicals}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower

Date 1/30/75

Source Pesticides

We also assume that efficiency from a baghouse filter will be the same for both an existing plant and a new plant. $E_{IIND} = E_N$

$$E_{IIND} = 0.1 \frac{\text{lbs hazardous chemicals}}{\text{TON}}$$

There are no general state hazardous chemicals regulations. If one assumes state particulate regulations for the control of pesticide emissions the following emission factor can be derived:

Ref 269, p. 118 states there are 340 pesticide plants.

$$\text{Process Weight Rate} = \frac{(1.067 \times 10^6 \frac{\text{TONS}}{\text{YR}})(2000 \frac{\text{lbs}}{\text{TON}})}{(260 \frac{\text{DAYS}}{\text{YR}})(8 \frac{\text{HRS}}{\text{DAY}})(340 \text{ plants})} = 3.02 \times 10^3 \frac{\text{lbs}}{\text{TON/PLANT}}$$

From the general process weight curve, ref 089 & ref 148, we obtain a 5.5 lbs/hr/PLANT allowable emissions.

$$\frac{\text{TONS/HR}}{\text{PLANT}} = \frac{(1.067 \times 10^6 \frac{\text{TONS}}{\text{YR}})}{(260 \frac{\text{DAYS}}{\text{YR}})(8 \frac{\text{HRS}}{\text{DAY}})(340 \text{ PLANTS})} = 1.51$$

$$E_s = \frac{5.5 \frac{\text{lbs}}{\text{hr}}}{1.51 \frac{\text{TONS}}{\text{hr}}} = 3.64 \frac{\text{lbs}}{\text{TONS}}$$

$$E_s = 3.64 \frac{\text{lbs}}{\text{TON}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-1-74

Source Animal Feed Defluorination

K: Ref 040 pg VIII-2 Table VIII-1

Figures given for Defluorinated Rock Industry	{	1970 Production	180,000 T/yr	as P_2O_5
		1970 Capacity	200,000 T/yr	as P_2O_5
		1980 Production	180,000 T/yr	as P_2O_5
		1980 Capacity	200,000 T/yr	as P_2O_5

$$K_{70} = \frac{180,000}{200,000} = .9$$

$$K_{80} = \frac{180,000}{200,000} = .9$$

$$\Rightarrow K = .9$$

A: Capacity for 1970 = 200,000 T/yr as P_2O_5
 Capacity for 1980 = 200,000 T/yr as P_2O_5

$$\therefore A = 200,000 \text{ T/yr as } P_2O_5$$

P_c : The above reference indicates that the current number of plants is 4 and through to 1980 no additional plants or capacity is expected to be added. We will assume that this is valid up to 1985.

$$P_c = 0$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 10-14-74

Source Animal Feed Dechlorination

P_B :

We refer to Ref 037 to seek some estimate of the obsolescence rate (P_B)

The dechlorination of phosphate rock is in truth a mineral preparation operation however it a sector of the animal feed industry. We have compromised by using these categories in combination to estimate P_B

Section 10.0 pg 30
Mining

$$\begin{aligned} \text{Asset Period} &= 10 \text{ yrs} \\ P_B \rightarrow 2 \times \text{IRS} &= 20 \text{ yrs} \\ \frac{100\%}{20 \text{ yrs}} &= 5\%/\text{yr simple} \end{aligned}$$

Section 20.1 pg 31

$$\begin{aligned} \text{Asset Period} &= 17 \text{ yrs} \\ P_B \rightarrow 2 \times \text{IRS} &= 34 \text{ yrs} \\ \frac{100\%}{34 \text{ yrs}} &\approx 3\%/\text{yr simple} \end{aligned}$$

We use the average of 4% / yr

$$\therefore P_B = .04 \text{ simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrow Date 9-17-74

Source Animal Feed Defluorination

Fluorides

E_u : Ref 095 pg 760.2010H

$\approx 73\%$ of phosphate rock supply since 1930
 has been coming from Florida

Ref 095 pg 761.5020D Fla Rock 33.9-34.4% P_2O_5
 Avg $\approx 34.2\% P_2O_5$

P_2O_5 content of rock in other areas is obtained from
 data in Ref 095 pg 760.2010H 1966 Prod Figures

Tenn 3.0 Ton rock .8 Ton/ P_2O_5 $\rightarrow 26.7\% P_2O_5$

Arkansas 5.2 " 1.5 Ton/ P_2O_5 $\rightarrow 28.8\% P_2O_5$

Avg $\approx 27.8\% P_2O_5$

We estimate the "weighted average" P_2O_5 content of
 phosphate rock as:

$$\%P_2O_5 = .73(34.2) + .27(27.8)$$

$$= 24.97 + 7.5$$

$$\%P_2O_5 \approx 32.5\% \text{ for average rock } P_2O_5 \text{ content}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

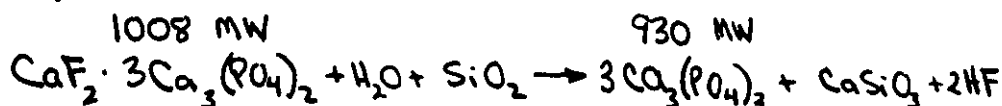
Calculations Done By W. Marone Date 9-17-74

Source Animal Feed Defluorination

Fluorides cont'd

E_u :

Rock defluorination occurs simply ^{by} the following reaction;



Since the molecular weight change is not significant we make the assumption that the P_2O_5 content of rock feed and the defluorinated product is the same. Therefore - 32.5% P_2O_5 content

From Ref 050 "Animal Feed Defluorination" pg 1

Rock of 3.5 to 4% F content can be thermally treated to reduce the fluorine content to less than .2% in which case it is suitable for use in animal feed supplements.

Now,

1 Ton Rock contains 32.5% P_2O_5
3.75% F

1 Ton Product contains 32.5% P_2O_5
.2% F

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-17-74

Source Animal Feed Defluorination

Fluorides cont'd

E_u : Feed Rock (TON)	Defluorinated Rock (TON)
650 lb P_2O_5	650 lb P_2O_5
75 lb F	4 lb F

The Quantity potentially emitted to atmosphere is approximated by the difference of these two figures based on a ton of P_2O_5

$$\text{Feed} = \frac{75}{650} \times 2000 = 231 \text{ lb F/TON } P_2O_5$$

$$\text{Product} = \frac{4}{650} \times 2000 = 12.3 \text{ lb F/TON } P_2O_5$$

$$\text{Potentially Emitted} = 231 - 12.3 \approx 219 \text{ lb/TON } P_2O_5$$

$$\therefore E_u = 219 \text{ lb/TON } P_2O_5 \text{ content}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marvone Date 9-17-74

Source Animal Feed Defluorination

Fluorides cont'd

E_N : Ref 050 "Animal Feed Defluorination" pg 2-3

Described a control system which will remove particulates and attain 95-98% removal of fluoride emission. We will use eff = 99.8% to establish E_N , highest eff system (packed scrubber pg 3)

$$E_N = .02 \times E_u = .002 \times 219 \text{ lb} / \text{TON } P_{2}O_5 \\ = .438 \text{ lb} / \text{TON } P_{2}O_5$$

It is assumed that existing plant can attain the same degree of efficiency such that $E_{\text{std}} = E_N$

$$E_{\text{std}} = .44 \text{ lb} / \text{TON } P_{2}O_5 \text{ content}$$

$$\therefore E_N = .44 \text{ lb} / \text{TON } P_{2}O_5 \text{ content}$$

E_S :

Ref 084 § 148

Ref 050 pg 3

Florida } state with
Texas } production
Montana }

Florida has .4 lb/TON $P_{2}O_5$ limitation

There are no fluoride regulations applicable for animal feed defluorination plants so that $E_S = E_u = 219 \text{ lb} / \text{TON } P_{2}O_5$ for Texas and Montana

Using 73% Prod from Florida we may obtain a weighted E_S

$$E_S = (.73 \times .4) + (.27 \times 219) = 59.4 \text{ lb} / \text{TON } P_{2}O_5$$

$$\therefore E_S \approx 59.4 \text{ lb} / \text{TON } P_{2}O_5 \text{ content}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 1-29-75

Source Animal Feed DeStuorination

Particulates

E_u : We were not able to obtain emission factors, emission data or any estimates for particulate emissions from this source. We make the judgment that animal feed destuorination plants being thermal treating and rock handling processes may be compared at this point with lime plants until more definitive data become available.

$$E_u(\text{lime}) = 203 \text{ lb} / \text{TON} \begin{smallmatrix} \text{Lime} \\ \text{product} \end{smallmatrix}$$

$$E_u(\text{AFD}) = 203 \frac{\text{lb}}{\text{TON Product}} \times \frac{\text{TON prod}}{.325 \text{ TON } P_{205}} = 625 \frac{\text{lb}}{\text{TON } P_{205}}$$

This includes kiln emissions, material handling operations, and rock classifying operations.

$$\therefore E_u = 625 \text{ lb} / \text{TON } P_{205}$$

E_N : An efficiency for particulates at 99.99% with baghouses
 $E_u = .0001 \times E_u$

$$E_N = .0625 \text{ lb} / \text{TON } P_{205}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-29-75

Source Animal Feed Desturbinator

Particulates, cont'd

E_s :

Using; $A = .2 \times 10^6$ TON/yr P_{205}

Plants = 4

32.5% P_{205}

8760 hr/yr

We may estimate the avg process weight rate for a plant

$$\text{Avg Plant} = \frac{.2 \times 10^6 \text{ TON } P_{205} / \text{yr} \times \frac{\text{hr}}{\text{yr}} \times \frac{2000 \text{ lb}}{\text{TON}}}{\frac{.325 \cancel{P_{205}} \times 4}{\text{TON}} \times 8760 \text{ hr} \times \cancel{\text{TON}}}$$

$$\text{Avg Plant} = 35,125 \text{ lb/hr}^{\text{Process wt}}$$

With the states of Florida, Texas, and Montana and assuming 73% from Fla and 13.5% from each of Texas and Montana, we may develop a "weighted" E_s from allowable emissions by state process weight rate curves. Ref 084-148

Florida - 21 lb/hr

Texas - 52 lb/hr

Montana 28 lb/hr

$$\begin{aligned} \text{weighted lb/hr} &= .73(21) + .135(52) + .135(28) \\ &= 15.33 + 7.02 + 3.78 \end{aligned}$$

$$\text{weighted } \frac{\text{lb}}{\text{hr}} \approx 26.1 \text{ lb/hr}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 1-29-75

Source Animal Feed Defluorination

Particulates cont'd

E_s :

$$\text{Avg Plant } \frac{\text{TON } P_{2O_5}}{\text{hr}} = \frac{.2 \times 10^6 \text{ TON } P_{2O_5}/\text{yr} \times \frac{4 \text{ yr}}{8760 \text{ hr}} \approx 5.71 \frac{\text{TON}}{\text{hr}}$$

$$E_s = \frac{26.1 \text{ lb/hr}}{5.71 \frac{\text{TON } P_{2O_5}}{\text{hr}}} = 4.57 \text{ lb/TON } P_{2O_5}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-19-74

Source Beer Processing

P_c : Ref 012 pg 8-2

"Malt Liquor production should increase by 7 percent per year through 1980,"

We assume this growth rate (compound) to be applicable for the period 1975-1985

$$\therefore P_c = .07 \text{ compound}$$

K : Ref 144 pg 48 Table 1
 July 1974

The table gives a summary of capacity utilization rates for various manufacturing sectors. We will use the Average Value (Dec 1965 to Dec 1973) of $K = .81$ which is identified as representing the Food (including beverage) industry.

$$\therefore K = .81$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-19-74

Source Beer Processing

A:

Ref 012 pg 1-3

1970 Production 134.7×10^6 barrels

from pg 8-2 there are 31 gal/barrel, therefore we calculate

$$P_{70} = 134.7 \times 10^6 \frac{\text{barrel}}{\text{yr}} \times 31 \frac{\text{gal}}{\text{barrel}} = 4.175 \times 10^9 \text{ Gal/yr}$$

Using the value of $P_c = .07$ we may estimate the 1975 production level

$$P_{75} = P_{70} (1 + P_c)^5$$

$$P_{75} = 4.175 \times 10^9 (1.07)^5$$

(see attached graph) $\rightarrow P_{75} = 5.85 \times 10^9 \text{ Gal/yr}$

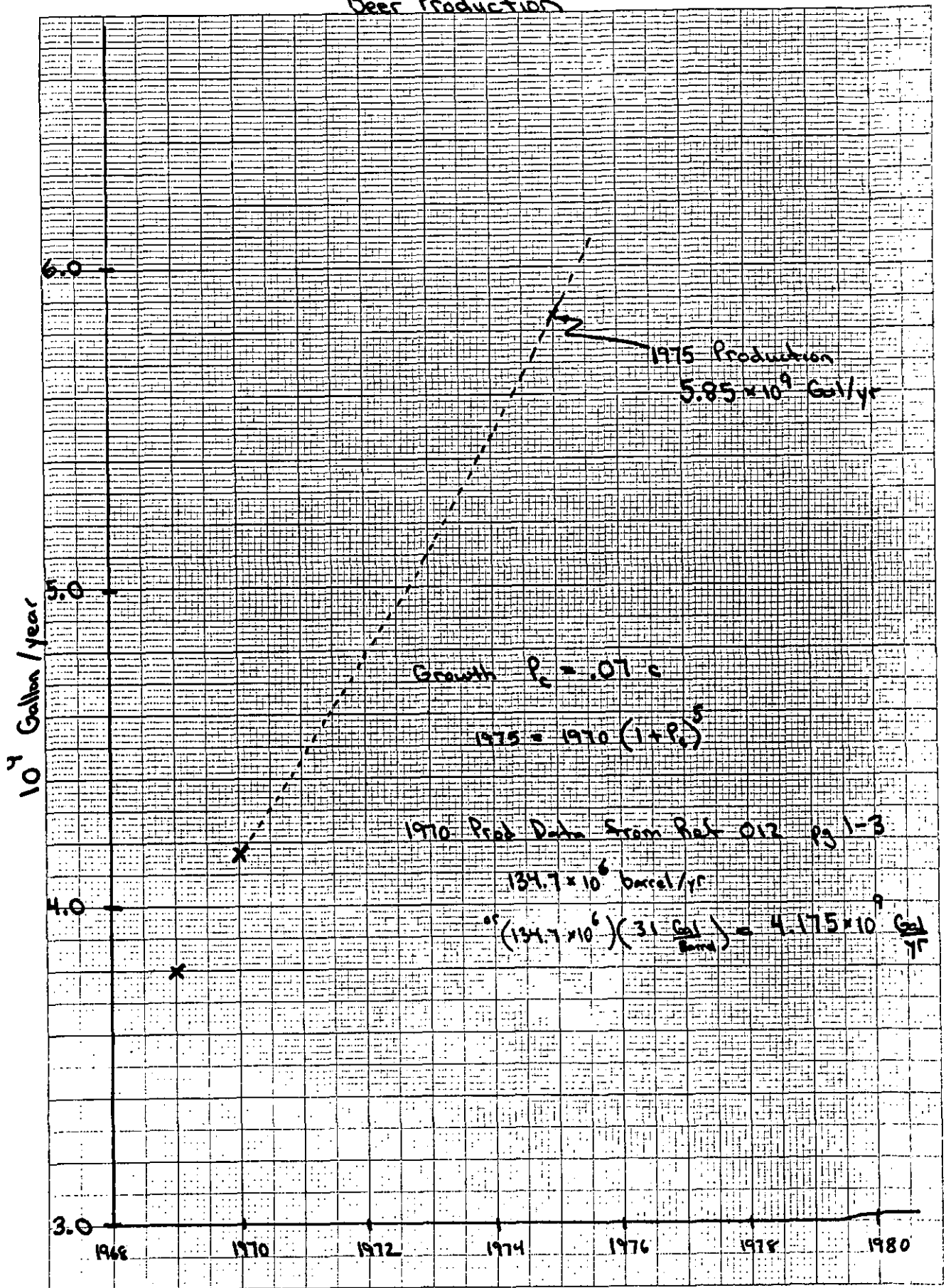
with $K = .81$;

$$A = \frac{P_{75}}{K} = \frac{5.85 \times 10^9}{.81} = 7.2 \times 10^9 \text{ Gal/yr}$$

$$\therefore A = 7.2 \times 10^9 \text{ Gal/yr}$$

$$\text{or } A = 7.2 \times 10^6 \text{ Thous } \frac{\text{Gal}}{\text{yr}}$$

Beer Production



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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-19-74

Source Beer Processing

P_B :

Ref 037 pg 31 Section 20.4

Asset guideline period = 12 yo

P_B est $\approx 2 \times IRS = 24$ yrs

$$\frac{100\%}{24 \text{ yrs}} \approx 4\% / \text{yr simple}$$

$$\therefore P_B = .04 \text{ simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marvone Date 9-19-74

Source Beer Processing

Ref 012 pg 1-3

In 1970 there were 5.69×10^9 lb grain used in breweries

As mentioned in "Industrial Factors" the 1970 production was 4.175×10^9 Gal.

We may estimate the grain input requirements per gal of beer produced.

$$F = \frac{5.69 \times 10^9 \text{ lb grain}}{4.175 \times 10^9 \text{ Gal}}$$

$$F = 1.363 \text{ lb grain/Gal}$$

Ref 075 Table 6.5-I pg 6.5-2

Particulates

Grain handling	3 lb/TON Grain	} Emissions
Drying Spent Grains	5 lb/TON	

Note! Ref 012 p 3-4 also reports the value of 5 lb/TON for drying spent grains but is unclear what the TON is referring to. We assume it refers to the feed input total.

Note! Ref 012 p 3-4 reports the same EFs as Ref 075... It's not that amazing! If one takes the time to check the ref's on p 3-4 of Ref 012, he will see that they come from Ref 075!

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 9-19-74

Source Beer Processing

Particulates

Based on the assumption that the emission factor are in terms of Tons of total grain handled (input) we have

$$E = 3 + 5 = 8 \frac{\text{lb Pt}}{\text{TON Grain}}$$

This factor is converted to $\text{lb Pt} / 10^3 \text{ Gal}$ by utilizing the previously calculated F.

$$E = \frac{8 \text{ lb Pt}}{\text{TON Grain}} \times \frac{\text{TON Grain}}{2000 \text{ lb Grain}} \times \frac{1.363 \text{ lb Grain}}{\text{Gal produced}}$$

$$E = .00545 \frac{\text{lb Pt}}{\text{Gal produced}} \text{ or } 5.45 \frac{\text{lb Pt}}{10^3 \text{ Gal}}$$

$$E_u = 5.45 \frac{\text{lb}}{10^3 \text{ Gal beer produced}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 9-19-74

Source Beer Processing

Particulates cont'd

grain driers are normally equipped with cyclone separators which are reported to be about 90% eff
Ref 012 pg 3-4 and 4-2

baghouse or cyclone separators are normally employed on all grain handling operations. Table 1 pg 4-3 to 4-4 of Ref 012 shows eff for grain handling at about 90%.

We have assumed that the above control are representative of this industry and as such E_u represents emissions from a suitably controlled industry.

E_N :

Cyclone separator and baghouses have been identified as applicable control systems for the beer processing activities. We assume that further control may be achieved by their employment. Estimated eff 95%.

$$E_N = .05 \times E_u = .05 \times 5.45 \text{ lb}/10^3 \text{ Gal}$$

$$E_N = .27 \text{ lb}/10^3 \text{ Gal beer produced}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 10-31-74

Source Beer Processing

E_g : Particulate

Ref 157, we find that the number of plants in the malt beverage industry in 1967 was 185

Using the 1975 Prod Cap and the Growth rate ($P_c = .07c$) we may estimate the 1967 Prod Cap. This result along with the number of plants is an approximation to the typical plant capacity for beer processing

$$A_{75} = 7.2 \times 10^9 \frac{\text{Gal}}{\text{yr}}$$

$$Cap_{67} = \frac{7.2 \times 10^9}{(1+.07)^8} = 4.19 \times 10^9 \text{ Gal/yr}$$

$$\text{Typical plant} = \frac{4.19 \times 10^9 \text{ Gal/yr}}{185} = 22.65 \times 10^6 \text{ Gal/yr}$$

$$\text{Using a plant schedule of } 365 \frac{\text{d}}{\text{yr}} \times 16 \frac{\text{hr}}{\text{d}} = 5840 \frac{\text{hr}}{\text{yr}}$$

$$\text{Typical Plant} = 3.88 \times 10^3 \text{ Gal/hr Beer}$$

Using the F-factor determined above;

$$1.363 \text{ lb grain / Gal}_{\text{Beer}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Mannon Date 10-31-74

Source Beer Processing

E_s : Particulate cont'd

$$\text{Typical Plant} = 1.363 \frac{\text{lb grain}}{\text{Gal}} \times 3.88 \times 10^3 \frac{\text{Gal}}{\text{hr}}$$

$$\begin{array}{l} \text{Typical Plant} \\ \text{Grain Processing} \\ \text{Weight} \end{array} \cong 5.29 \times 10^3 \text{ lb/hr grain}$$

The allowable emissions for this process weight rate is obtained from the "50 state arithmetic average".

$$\text{Allowable Emission} = 8.1 \frac{\text{lb Pt}}{\text{hr}}$$

$$E_s = \frac{8.1 \frac{\text{lb Part}}{\text{hr}}}{3.88 \frac{10^3 \text{ Gal Beer}}{\text{hr}}} = 2.09 \frac{\text{lb Pt}}{10^3 \text{ Gal Beer}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-19-74

Source Beer Processing

Hydrocarbons:

Ref 075 Table 6.5-1

No quantitative data given; however HC emissions are reported to be emitted from the drying of spent grains.

Ref 012 pg 3-8

identifies ethyl alcohol as the "possible" major portion of the exhaust streams emitted from the drying of spent grains. No emission data were presented.

1-29-75

In light of the lack of any data with respect to hydrocarbon emissions from drying spent grain we must make some judgments.

We will assume that the grains have lost 20% of their weight in the beer process and that hydrocarbon content of the spent grain is 1% by weight.

$$\begin{array}{lcl}
 1 \text{ lb spent grains} & \rightarrow & .01 \text{ lb hydrocarbons} \\
 \text{and } \frac{1 \text{ lb}}{.8} = 1.25 \text{ lb grain} & & \text{therefore } \frac{.01 \text{ lb HC}}{1.25 \text{ lb grain}}
 \end{array}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 8-29-75

Source Beer Processing

Hydrocarbons cont'd

E_u : using the factor $F = 1.363 \text{ lb grain/Gal beer}$

$$E = \frac{.01 \text{ lb HC}}{1.25 \text{ lb grain}} \times 1.363 \frac{\text{lb grain}}{\text{Gal beer}}$$

$$E = .0109 \text{ lb HC/Gal beer}$$

or

$$E_u = 10.9 \text{ lb}/10^3 \text{ Gal beer}$$

E_N : Since the emissions have been identified as ethyl alcohol it is suspected that this emission due to its high heat content could be adequately eliminated by incineration. ~~ESS~~ of 99% is assumed.

$$E_N = .01 \times 10.9 \text{ lb}/10^3 \text{ Gal}$$

$$E_N = .109 \text{ lb}/10^3 \text{ gal beer}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 1-27-75

Source Beer Processing

Hydrocarbons cont'd

Ref 084 § 148

There are no regulations specifically applicable to hydrocarbon emissions from beer plants so that we assume $E_s = E_u$.

$$E_s = 10.9 \text{ lb} / 10^3 \text{ Gal beer}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-18-74

Source Castor Bean Processing

Ref 023 pg 5

This source states that the last domestic crop was harvested in 1971 with a dim likelihood of ever being revived. Importing of foreign seeds is also essentially non-existent. This implies and is so stated, that there is a total absence of domestic seed crushing and oil extraction.

This source (pg 5) also adds that the castor industry is presently only concerned with refining imported oil into its derivative products and with subsequent distribution of the oil.

Since castor seed crushing and extraction of the oil are no longer performed in the U.S., emission of particulate and hydrocarbon normally attributed to this industry no longer exist. Any emissions associated with further refining of castor oil into the many myriad products or derivatives would not be considered as coming under the heading of "Castor Bean Processing". We therefore conclude this source to not come under NSPS.

NOT NSPS

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-16-74

Source Coffee Roasting

K: Ref 006 pg 39

Capacity utilization range for the industry
 is 80 to 90 percent.

We will use the average as an approximation
 of K

$$\therefore K = .85$$

P_c: Ref 006 pg 39

"No significant change in production or capacity
 is expected in the current decade. The 1980
 green coffee estimate is 19.9 million bags."

pg 38 indicated that the 1970 production was about
 20 million bags.

We conclude that $P_c \approx 0$

$$\therefore P_c = 0$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-16-74

Source Coffee Roasting

P_B : Ref 037 pg 31 Section 20.4

Asset guide line life 12 yrs

P_B est $\approx 2 \times IRS = 24$ yrs

100% Depreciation in 24 yrs

$$\frac{100\%}{24 \text{ yrs}} \approx 4.1\% \text{ simple}$$

We approximate P_B by using 4% simple obsolescence rate

$$\therefore P_B = .04 \text{ simple}$$

A: We will use the 1980 est of 19.9 million bags as the production est for 1975

$$P_{75} = 19.9 \times 10^6 \text{ bag/yr}$$

Ref 006 pg 1 1 bag = 132.276 lbs

$$P_{75} = 19.9 \times 10^6 \frac{\text{bag}}{\text{yr}} \times 132.276 \frac{\text{lb}}{\text{bag}} \times \frac{\text{Ton}}{2000 \text{ lb}}$$

$$P_{75} = 1.32 \times 10^6 \text{ Ton/yr}$$

Applying $K = .85$ we calculate the 1975 Prod. Capacity

$$A = \frac{1.32 \times 10^6}{.85} = 1.55 \times 10^6 \text{ Ton/yr}$$

$$\therefore A = 1.55 \times 10^6 \text{ Ton/yr} \text{ green coffee beans}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-16-74

Source Coffee Roasting

The majority of emissions come from the roasting and subsequent cooling of the coffee beans

Particulates

E_u : Ref 075 pg 6.2-1

Avg Roaster emission chosen $\frac{7.6 + 4.2}{2} = 5.9 \text{ lb/TON}$

Stoner & cooler 1.4 lb/TON

$E = 5.9 + 1.4 = 7.3 \text{ lb/TON}$ green coffee beans

$$\therefore E_u = 7.3 \text{ lb/TON}$$

E_N : Ref 006 indicates that afterburner systems, afterburners with cyclones, or cyclone-multi cyclone systems are applicable to the coffee roaster. The highest reported eff was 99.7%

Cyclone on cooler-stoner will reduce emission by 70%
 (Ref 075 pg 6.2-1)

$$E = (.003 \times 5.9) + (.3 \times 1.4) \text{ lb/TON}$$

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Computation Sheet For Emission Factors

Calculations Done By 2) Morrone Date 9-16-74

Source Coffee Roasting

Particulate cont'd

$$E_N: \quad E_N = E = .0177 + .42 \approx .44 \text{ lb/TON}$$

This represents an overall eff of $\frac{7.3 - .44}{7.3} = .939$
 or $\approx 94\%$ eff

$$\therefore E_N = .44 \text{ lb/TON "green" beans}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-16-74

Source Coffee Roasting

Hydrocarbons

E_u : Ref 075 Table 6.2-1

Emissions of aldehydes and organic acids
will represent the hydrocarbon emissions
from the roaster;

$$E = (.2 + .9) \text{ lb/TON} = 1.1 \text{ lb/TON}$$

$$\therefore E_u = 1.1 \text{ lb/TON}$$

E_N : Using a cyclone - afterburner system on the roaster
will effectively eliminate particulate emission however,
it should be effective in reducing organic
compounds (to CO_2 & H_2O) provided the incineration temp
is high enough. We assume a 99.5% eff
for hydrocarbon reduction

$$E = .005 \times E_u = .005 \times 1.1 =$$

$$\therefore E_N = .0055 \text{ lb/TON coffee beans}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marnone Date 9-16-74

Source Coffee Roasting

NO_x

E_u : Ref 075 Table 6.2-1

Roaster emission only $E_u = .1 \text{ lb/TON}$

$$E_u = .1 \text{ lb/TON}$$

Controls for coffee roasters applicable to NO_x emissions generally are not a state of the art.

We may judge the maximum effect of NO_x from this industry by assuming $E_N = 0$

In this case $T_s - T_N$ would be maximized

$$E_N = 0 \quad \underline{\underline{\text{change}}}$$

2-6-75 WAM

Ref 242 p 7-13

It may apply NO_x reduction from Combustion source in MSST program than we would expect at best a 50% reduction

$$E_N = .5 \times E_u = .05 \text{ lb/TON}$$

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Computation Sheet For Emission Factors

Calculations Done By U.F. Russo Date Oct. 4, 74

Source Coffee Roasting

Particulates:

Ref. 006 lists the "breakdown" of plants by State. Eighteen States are represented. Only 2 states are not in the "top" 25 states based on population. These 2 states (Oklahoma and Oregon) have only 6 total plants from 268 national plants. $\therefore$ Use 50 state average:

$$\text{Average plant size} = \frac{A}{268} = \frac{1.55 \times 10^6}{268} \text{ TONS/YR-plant}$$

$$\approx 5785 \text{ TONS/YR/PLANT}$$

Assuming 16 HR/DAY, 7 DAYS/WK operation

$$\text{Process Weight Rate} = \frac{5785 \text{ TONS/YR-PLANT}}{16 \text{ HR/DAY} \cdot 7 \text{ DAY/WK} \cdot 52 \text{ WK/YR}} \cdot \text{PLANT}$$

$$\approx 1990 \text{ lbs/HR}$$

$$\text{Allowable Emissions} = 41 \text{ lbs/HR-PLANT}$$

$$E_s = \frac{41 \left(\frac{\text{lbs}}{\text{HR}} \right) \left(16 \frac{\text{HR}}{\text{DAY}} \right) \left(7 \frac{\text{DAY}}{\text{WK}} \right) \left(52 \frac{\text{WK}}{\text{YR}} \right) 268 \text{ plants}}{1.55 \times 10^6 \text{ TONS/YR}}$$

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Computation Sheet For Emission Factors

Calculations Done By U.F. Russo Date Oct. 4, 1974

Source Coffee Roasting

PARTICULATES: (Cont.)

$$\therefore E_s = 0.794 \text{ lbs particulate/Ton}$$

HYDROCARBONS:

The HC emissions resulting from Roasting are aldehydes and organic acids. Since these emissions do not involve a solvent, the regulations are inapplicable.

$$\begin{aligned} m &= 0 \\ h &= 268 \end{aligned}$$

$$\therefore E_s = E_u \sum_{i=1}^{268} A_i = E_u$$

Hence for HC

$$E_s = 1.1 \text{ lbs/Ton}$$

NO_x Emissions:

There are no regulations applicable to coffee Roasting

$$\therefore E_s = E_u = 0.1 \text{ lb/Ton}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/22/75

Source DEEP FAT FRYING

Ref (24) p 2-9 gives 1975 production of foods that have been deep fat fried. This same ref (p 3-2) states that the pollution problem relates to the moisture content of the food. That is, if the % moisture is $< 20\%$, there should be no emission problem. Potato chips, sticks, french fries & donuts have a moisture content $> 20\%$, so for the purpose of this study, we will consider the frying of these items only.

From p 2-9 of Ref (24)

1975 Production (items $> 20\%$ moisture) = 4.279×10^9 lbs

1980 Production (" " ") = 5.229×10^9 lbs

Assuming compound growth

$$P_c = \sqrt[5]{\frac{5.229}{4.279}} - 1.0 = 0.0433$$

$$P_c = 0.0433$$

compound

Ref (144) p 48 gives a K for the food industry of 81% (avg between 1965 & 1973). We will assume this value to hold.

$$K = 0.81$$

$$A = \frac{4.279 \times 10^9}{(0.81)(20000)} = 2.641 \times 10^6 \text{ tons}$$

$$A = 2.64 \times 10^6 \text{ tons of food processed}$$

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Computation Sheet For Industrial Factors

Calculations Done By HORRE Date 1/22/75

Source Deep for faying

For P_b , we will use twice the IRS allowable depreciation rate.

From Ref (37) p31, the allowable is 18 yrs for "Vegetable oils and vegetable oil products."

$$P_b = \frac{1}{(2)(18)} = 0.0278$$

$$\boxed{P_b = 0.0278} \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By HOOPER Date 1/22/75

Source DEEP FAT FRYING

PART

Ref (46) p 801 gives a particulate emission factor "normally less than 0.1 gr/scf, which is well below common limits for particulate emissions".

Ref (24) p 5-6 states that a scrubber system would require 1000 - 4000 CFM typically. If we assume the avg, 2500 CFM

$$\frac{(0.1 \frac{\text{gr}}{\text{scf}})(2500 \frac{\text{ft}^3}{\text{min}})(60 \frac{\text{min}}{\text{hr}})}{7000 \frac{\text{gr}}{\text{lb}}} = 2.14 \frac{\text{lb}}{\text{hr}} \text{ from a typical fryer}$$

Ref (24) p 2-5 gives 145 potato chip plants in 1966.

The production for that year can be determined thusly:

1969 Potato chip production = 886×10^9 lbs Ref (24) p 2-2

$$886 \times 10^9 = \text{PR}_{1966} [1 + 0.0433]^3$$

$$1966 \text{ Prod} = 780 \times 10^9 \text{ lbs} = \frac{.39 \times 10^6 \text{ tons}}{\text{yr}}$$

$$\frac{0.39 \times 10^6 \text{ tons/yr}}{145 \text{ plants}} = 2689.7 \frac{\text{TON}}{\text{yr} \cdot \text{plant}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/22/75

Source DEEP FAT FRYING

Ref (24) p 3-2 states that the avg potato chip plant has 1-6 cookers. Assuming 3 cookers, 16 hrs/day, 6 days/wk, 52 wks/yr

$$\frac{2689.7}{3} = 896.6 \frac{\text{ton}}{\text{yr. plant}} \quad \frac{(896.6)(2000)}{4992} = 359 \text{ lb/hr}$$

$$\frac{(359)}{30.9} = 11.9 \text{ lb/TON FOOD PROCESSED}$$

$$E_{\text{cooker}} = 11.9 \text{ lb/TON FOOD PROCESSED}$$

Ref (46) p 800,801 indicates that incineration has been an acceptable technique to control emissions since practically all are combustible.

We will assume an $\eta = 99\%$

$$E_{\text{port}} = (1 - .99)(11.9) = 0.119$$

$$E_{\text{port}} = 0.119 \text{ lb/TON FOOD PROCESSED}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper

Date 1/22/75

Source DEEP FAT Frying

Es

Particulate could be controlled by gen'l reg's for particulate emissions.

Using the gen'l PWR generated from Refs (84) & (148)
for a PWR of 359 ^{lb}/hr, the allowable is 1.28 ^{lb}/hr

$$E_{\text{part}} = \frac{(1.28)(2400)}{359} = 7.13 \text{ }^{\text{lb}}/\text{ton}$$

$$E_{\text{part}} = 7.13 \text{ }^{\text{lb}}/\text{ton food processed}$$

Hydrocarbons

No emission data on hydrocarbons is available; however, emissions have been reported and are known to be a problem. (Ref (24) p 3-2, 3-4)
We will Assume an emission factor equal to that for vegetable oil mfg (See "Emission Factors - Vegetable Oil Production")

$$E_U = 38 \text{ }^{\text{lb}}/\text{TON veg. oil}$$

Ref. (24) p 2-9 gives the oil/fat content of the food fried

$$\frac{874 \times 10^6 \text{ LBS OIL}}{4279 \times 10^6 \text{ LBS PRODUCT}} = 0.204 \frac{\text{LBS OIL}}{\text{LBS PROD.}}$$

$$E_{U_{HC}} = (38)(.204) = 7.75 \text{ }^{\text{lb}}/\text{TON FOOD PROCESSED}$$

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Computation Sheet For Emission Factors

Calculations Done By H. B. R. C.

Date 1/22/75

Source Deep Fat Frying

$$E_{UHC} = 7.75 \text{ lb/ton food processed}$$

Using incineration & assuming an $\eta = 99\%$

$$E_{NHC} = (1 - .99)(7.75) = 0.078 \text{ lb/ton}$$

$$E_{NHC} = 0.078 \text{ lb/ton food processed}$$

Hydrocarbons are generally controlled by odor nuisance regs, if at all.

Item Ref (24) p 3-2, out of 76 potato chip plants, there were 15 odor complaints. Assuming that these 15 represent, ultimately, control to the level of E_U and the remaining 61 represent no control (E_U)

$$E_{SNC} = \left(\frac{15}{76}\right)(.078) + \left(\frac{61}{76}\right)(7.75) = .015 + 6.22$$

$$E_{SNC} = 6.24 \text{ lb/ton food processed}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 11/8/75

Source Direct Firing of Meats

Since no "production" values could be located, it will be necessary to develop the factors on a different basis - the number of units since this value is available (partially)

Ref (50) p 3 is reproduced on the attached graph. We will assume that the growth of HARDEE'S in terms of the number of units parallels the increase in revenues as is the case for McDonalds. This assumption is necessary because

- ① Only unit data for one year (1972) is known for HARDEE'S (565)
- ② McDonalds is a similar industry but does not fire meat directly

Based on the attached curve, the # of units @ HARDEE in 1975 is about 700

This corresponds to a growth rate of

$$\frac{700 - 565}{(3)(700)} = 6.4\%$$

Ref (50) p1 indicates that in 1966 there were 26,000 gas-fired broilers in the U.S. Since HARDEE'S is a "growth" industry & it represents only a small % of the total, it would be unreasonable to assume this value for P_c . Population growth might be another factor to consider. However, there are reasons why this value might be too low. The # of fast food chains using direct meat firing is increasing faster than the population and there is an increasing trend for Americans to eat out.

We will assume the growth in this industry as follows:

$$P_c = (2/3)(P_{pop}) + 1/3 (P_{HARDEE'S})$$

$$P_{pop} = 1.8\% \text{ (See "Industrial Factors - Dry Cleaning")}$$

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Computation Sheet For Industrial Factors

Calculations Done By Harold Date 1/8/74

Source DIRECT FILING OF MEATS

$$P_c = (.6667)(0.018) + (.333)(.064) = .012 + .021 = 0.033$$

$$P_c = 0.033 \text{ simple}$$

In 1966, there were 26,000 units

In 1975, the # of units would be

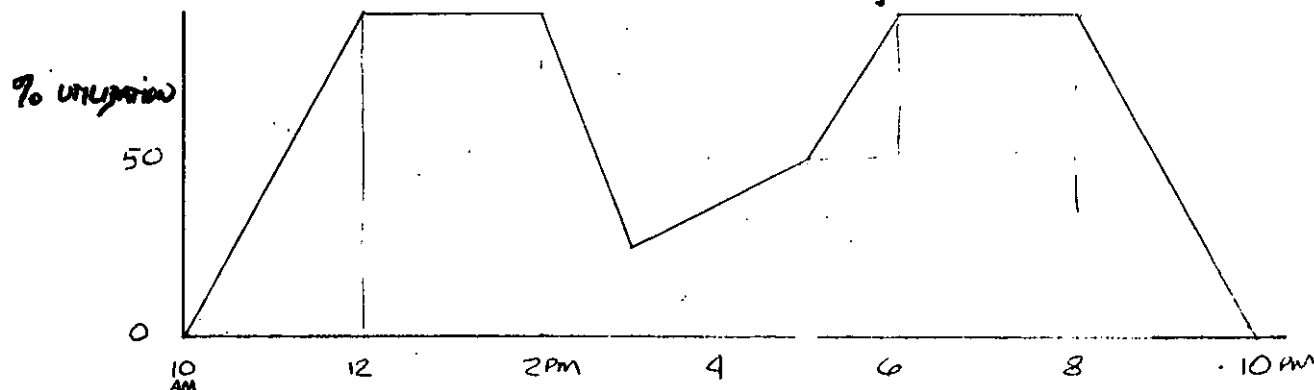
$$(26000)[1 + (9)(.033)] = 33,722$$

Since emission factors will be in terms of $\text{lb}/\text{yr-unit}$ based on emissions during peak operation, 33,722 units can be considered capacity & K will scale the results to a typical "production rate" consistent with realistic operation

$$A = 33,722 \text{ units}$$

$K = f(\text{typical daily operational schedule})$

We will assume a typical operating day as follows:



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Calculations Done By HORRIG Date 1/8/75

Source DIRECT Firing Of Motors

The avg utilization on this curve is 62%

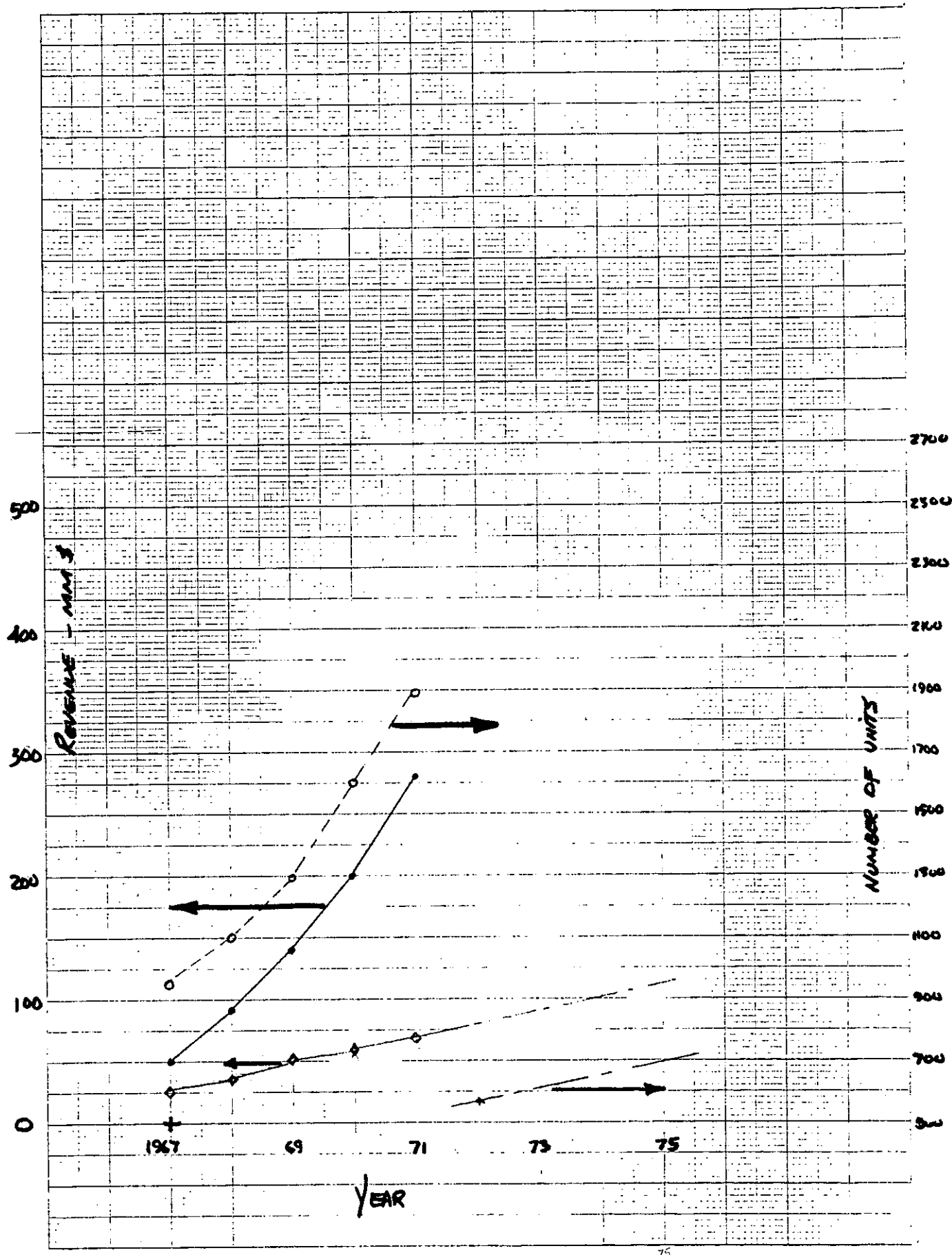
$$K_{avg} = \frac{\Sigma \text{ AREA UNDER CURVE}}{12 \text{ hrs}}$$

$$K = 0.62$$

The IRS depreciation guideline for "Wholesale and Retail Trade including assets used in the operation of restaurants" is 10 yrs. Assuming twice the allowable Ref (37) p 42

$$P_0 = \frac{1}{(2)(10)} = 5.0\%$$

$$P_0 = 0.05 \text{ simple}$$



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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 1/8/75

Source Direct Firing Of Meats

Particulars

Ref (218) p 4 Results of emission tests @ Hardee's (peak operation)

$$3 \text{ TEST AVE} = \frac{0.641 + .486 + .757}{3} \text{ LB/HR} = 0.628 \text{ LB/HR}$$

Ref (254) p 3 Additional Hardee test

If we assume that ^{0.726} E_u equals the average

$$E_u = (.641 + .486 + .757 + .726) / 4 = 0.653 \text{ LB/HR PER UNIT}$$

If we assume

12 hrs/day, 6 $\frac{\text{days}}{\text{WK}}$, 52 $\frac{\text{WKS}}{\text{YR}}$

then, the yearly emission rate based on peak operation is

$$0.653 \frac{\text{LB}}{\text{HR} \cdot \text{UNIT}} \times 12 \times 6 \times 52 = 2444.8 \frac{\text{LB}}{\text{YR} \cdot \text{UNIT}}$$

$$E_{u,p} = 2444.8 \frac{\text{LB}}{\text{YR} \cdot \text{UNIT}}$$

Ref (255) describes an ESP that was installed @ a Hardee's to reduce particulate emission. We will assume that this or a similar unit could be used. The vendor quotes an xcfm = 4400 with an associated $\eta = 92\%$

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Calculations Done By HOPPER Date 11/8/75

Source DIRECT FIRM OF MENTS

$$\therefore E_{NP} = 2444.8(1-.92) = 195.6$$

$$E_{NP} = 195.6 \frac{\text{LB}}{\text{UNIT-YR}}$$

Ref (50) p5 N.C. is the only State (presently) attempting to enforce a visible emissions reg'n. No states appear to be enforcing a PWR reg (if applicable). Assume, $\therefore$ that $E_S = E_U$

$$E_S = 2444.8 \frac{\text{LB}}{\text{UNIT-YR}}$$

Hydrocarbons

Ref (218) p 6 gives CH_2O emissions from a Hardee's test during the nighttime peak. The avg during this peak period is $1.49 \frac{\text{LB}}{\text{HR}}$

Ref (218) p 7 gives CH_4 emissions (Avg) as $0.149 \frac{\text{LB}}{\text{HR}}$

$$\text{TOTAL} = 1.639 \frac{\text{LB}}{\text{HR-UNIT}}$$

$$E_{HC} = 1.639 \times 12 \times 6 \times 52 = 6136 \frac{\text{LB}}{\text{YR-UNIT}}$$

$$E_{HC} = 6136 \frac{\text{LB}}{\text{YR-UNIT}}$$

Ref (254) p 4 gives an avg emission (Hardee's test with an oxidizer scrubber) of $\text{CH}_2\text{O} = 0.64$. If we assume that the CH_4 value is $1/10$ that of the CH_2O (as was the case for the uncontrolled results)

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Computation Sheet For Emission Factors

Calculations Done By HOPPER

Date 1/8/75

Source Direct Firing of Motors

Then the total = $0.64 + .064 = 0.0704$

$$.0704 \times 12 \times 6 \times 52 = 2636 \frac{\text{LB}}{\text{YR} \cdot \text{UNIT}}$$

$$E_{NHC} = 2636 \frac{\text{LB}}{\text{YR} \cdot \text{UNIT}}$$

$$R = \frac{6136 - 2636}{6136} = 57\%$$

Incineration has been employed but its costs are excessive & could not be considered an economically feasible control method.

Again, N.C. is the only State (presently) attempting to enforce odor nuisance regs to control H/C's. Considering the number of units throughout the U.S., we will assume $E_S = E_U$

$$E_{SHC} = 6136 \frac{\text{LB}}{\text{YR} \cdot \text{UNIT}}$$

Our entire analysis is based on the fact that all units are equal in size to the two units tested @ the above's

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 8/1/78

Source FEED MILLING

THE PURPOSE OF FEED MILLING IS TO REDUCE CEREAL GRAINS & MEALS TO A DESIRED SIZE & CONSISTENCY & TO MIX THEM WITH OTHER INGREDIENTS.

FEED MILLING CAN BE BROKEN DOWN INTO TWO CATEGORIES

① ALFALFA DEHYDRATING

② OTHER WHICH INCLUDE WHEAT, GLUTEN, RICE, BREWER'S & DISTILLERS DRY GRAINS & DRIED BEET PULP

1968 PRODUCTION FIGURES

① 1.6×10^6 TONS OF DRY MEAL

② 8.4×10^6 " " "

REF ④⑨

TAB 8-2

P 93

REF ④⑨

TAB 8-2

P 93

REF ②⑧ P 4-81

$$P_c = 3.5\%$$

ASSUME COMPOUND

REF ① STATES $P_c = 1.5\%$ FOR GRAIN HANDLING WHICH SHOULD EXPERIENCE SIMILAR GROWTH TRENDS

WE CONCLUDE THAT $P_c = 3.5\%$ IS MORE REALISTIC SINCE IT IS COMPARABLE TO THE U.S. POPULATION GROWTH TREND UPON WHICH THE DEMAND WOULD BE BASED.

$$1975 = 1968(1 + P_c)^7$$

$$A_b = (8.4 \times 10^6)(1.035)^7 = 10.69 \times 10^6 \text{ TONS DRY MEAL}$$

FOR ALL OTHER

FEED MILLING PROCESSES

$$A_s = (1.6 \times 10^6)(1.035)^7 = 2.04 \times 10^6$$

TONS DRY MEAL FOR
ALFALFA DEHYDRATING

$$K = 0.5$$

REF ②⑧ P 4-81

THIS VALUE COULD BE FURTHER DEFINED IF MORE INFO IS FOUND IN THE LITERATURE.

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 8/1/74

Source FEED MILLING

$$A_{\text{MEAL}} = \frac{2.04 \times 10^6}{0.5} = 4.08 \times 10^6 \text{ TONS DRY MEAL} = A$$

$$A_{\text{OTHER}} = \frac{10.69 \times 10^6}{0.5} = 21.38 \times 10^6 \text{ TONS DRY MEAL} = A$$

REF (50) INDICATES

1969 PRODUCTION
 OF 50×10^6 TONS

IF NECESSARY, THIS VALUE
 & THE TONS OF DRY MEAL FOR THE
 SAME YEAR CAN BE USED TO RELATE
 TO E_s

NOTE: REF (1) SHOWS
 U.S. MAP LOCATING
 GRAIN ELEVATORS. THIS
 COULD BE HELPFUL IN
 SYNTHESIZING E_s .

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 9-26-74

Source Feed Milling

P_B : The obsolescence rate for both the "Alkali" and "other" portions of the Feed Milling Industry are assumed identical and will be estimated as follows:

Ret 037 pg 31 Sec 20.1

Asset guideline period = 17 yrs

P_B is est by $2 \times IRS = 34$ yrs

100% depreciation in 34 yrs or $\frac{100\%}{34 \text{ yr}} \Rightarrow 2.9\% / \text{yr}$
 simple

$\therefore P_B = .029$ simple

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 8/1/74

Source FEED MILLING

$$E_{\text{ALFALFA}} = 50 \text{ \#/TON DRY MEAL}$$

REF (47) p 50
TAB 4.1-1

$$E_{\text{OTHER}} = 1\% \text{ OF PRODUCTION}$$

$$\frac{\left(8.364 \times 10^6 \frac{\text{TONS MEAL}}{\text{YR}} \right) \left(\frac{\text{\# PART.}}{\text{TON MEAL}} \right)}{\left(2000 \frac{\text{\# PART.}}{\text{TON MEAL}} \right)} = \frac{\text{TONS PART.}}{\text{YR}} = (8.364 \times 10^6) (0.01)$$

$$\frac{\text{\# PART.}}{\text{TON}} = 20 \text{ \#/TN} = E_{\text{OTHER}}$$

THESE EMISSIONS ARE AFTER THE 1ST COOLING CYCLONE WHICH IS COMMON TO ALL DEHYDRATORS

FROM REF (77) P 225 TAB 76

$$E_N = f(\eta = 97.8\%) \text{ FABRIC FILTER SYSTEM}$$

$$E_{\text{ALFALFA}} = 50 (1 - 0.978) = 1.1 \text{ \#/TON DRY MEAL} = E_{\text{ALFALFA}}$$

$$E_{\text{OTHER}} = 20 (1 - 0.978) =$$

$$0.44 \text{ \#/TON DRY MEAL} = E_{\text{OTHERS}}$$

N/G
SEE P2
N/G

REF (28) P 4-80 STATES

$\eta = 95\%$ WE MAINTAIN THAT 97.8% IS FEASIBLE SO E_N WILL BE BASED ON IT.

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 2

Source Feed Milling

Additional INFO?

REF (50) STATES $\eta = 99.5\%$

$$\therefore E_{\text{NAHARA}} = 50(1 - .995) = 0.25 \frac{\#}{\text{TON DRY MEAL}} = E_{\text{NAHARA}}$$

$$E_{\text{OTHER}} = 20(1 - .995) = 0.1 \frac{\#}{\text{TON DRY MEAL}} = E_{\text{OTHER}}$$

*Therefore, these #'s will
 be used*

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Computation Sheet For Emission Factors

Calculations Done By Hopper

Date 10/14/74

Source FEED MILLING

Determination of Es:

REF (001) p 55, FIG 8.1 gives geographical distribution of the 11,147 grain elevators existing in 1969. IF WE ASSUME THAT THE DISTRIBUTION OF FEED MILLING PLANTS IS THE SAME, THEN WE WILL HAVE THE FOLLOWING DISTRIBUTION

KANSAS	-	1204/11,147	=	10.8 %
ILLINOIS	-	1116/11,147	=	10.0 %
IOWA	-	1082/11,147	=	9.7 %
NEBRASKA	-	883/11,147	=	7.9 %
TEXAS	-	806/11,147	=	7.2 %
N. DAK	-	774/11,147	=	6.9 %
MINN	-	768/11,147	=	6.9 %
MISS	-	499/11,147	=	4.5 %
				<u>63.9 %</u>

The remaining 36.1% are unevenly distributed throughout THE REST OF THE COUNTRY

Several states have regs for FEED & Grain Processing
The following states reg apply to FEED SPECIFICALLY:

Illinois - 0.3 grains/scf
IOWA - 0.1 " allowable

We will assume that particulate emissions will be a function of the general particulate regs for the remaining 6 states. FOR THE REMAINING 36.1%, WE WILL USE THE "GENERALIZED" PROCESS WEIGHT TABLE.

REF (2) p 4-21 gives rule of thumb of

1.38 ACFM throughput for hundred weight production per day.

IF WE ASSUME ACFM x SCFM, then

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Calculations Done By Hopper

Date 10/14/74

Source Feed Milling

$$\frac{\left(\frac{\text{gr}}{\text{scf}}\right) \left(\frac{\text{ACF}}{\text{MIN}}\right) \left(60 \frac{\text{MIN}}{\text{HR}}\right) \left(24 \frac{\text{HR}}{\text{DAY}}\right)}{\left(\text{CWT}\right) \left(\frac{0.5 \text{ TONS}}{\text{CWT} \cdot \text{DAY}}\right) (7000 \frac{\text{gr}}{\#})} = \frac{1}{\frac{\text{TONS}}{\#}} = \frac{\#}{\text{TON}}$$

for Illinois,

$$\frac{(0.3)(1.38)(60)(24)}{(1.05)(7000)} = 1.70 \frac{\#}{\text{TON}} = E_{\text{ILL}} \quad *$$

for Iowa

$$= \frac{1.70}{3} = 0.567 \frac{\#}{\text{TON}} = E_{\text{IOWA}} \quad *$$

for KANSAS (REF 84 p 29 TABLE)

"TYPICAL" plant size = 10,350 #/HR (REF 001 p 24 TAB 3.6)

$$E_{\text{KANSAS}} = (12.0 \frac{\#}{\text{HR}})$$

$$\frac{(12.0)(2000)}{(10,350)} = 2.32 \frac{\#}{\text{TON}} \quad *$$

for NEBRASKA,

$$E_{\text{S}} = f(9.73 \frac{\#}{\text{HR}})$$

$$\frac{(9.73)(2000)}{10,350} = 1.88 \frac{\#}{\text{TON}} \quad *$$

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Calculations Done By Hopper

Date 10/14/74

Source FEED MILLING

for TEXAS

$$E_s = f(15.2 \text{ \#}/\text{hr})$$

$$\frac{(15.2)(2000)}{10,350} = 2.94 \text{ \#}/\text{ton} \quad *$$

N. DAKOTA

$$E_s = f(12.0 \text{ \#}/\text{hr}) = 2.32 \text{ \#}/\text{ton} \quad *$$

for MINN.

$$E_s = 2.32 \text{ \#}/\text{ton} \quad *$$

for MISSISSIPPI:

$$E_s = 2.32 \text{ \#}/\text{ton} \quad *$$

for ALL STATES (generic)

$$E_s = f(11.5 \text{ \#}/\text{hr}) \quad *$$

$$\frac{(11.5)(2000)}{10,350} = 2.22 \text{ \#}/\text{ton} \quad *$$

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Computation Sheet For Emission Factors

Calculations Done By Hypack

Date 10/15/74

Source

Feed Milling

$$ES_{\text{FM}} = (.108)(2.32) + (.100)(1.70) + (.097)(.567) + (.079)(1.88) \\ + (.072)(2.94) + (.069)(2.32) + (.069)(2.32) + (.045)(2.32) \\ + (.361)(2.22)$$

$$= .2506 + .1700 + .0550 + .1485 + .2117 + .1601 + .1601 + .1044 \\ + .8014 = 2.062 \frac{\#}{\text{TON}}$$

$$ES_{\text{FEED MILL}} = 2.062 \frac{\#}{\text{TON}}$$

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Computation Sheet For Industrial Factors

Calculations Done By William Marone Date 9-19-74

Source Fish Meal Processing

P_c :

Ref 050 "Fish Meal Processing" pg 2 (1971)

"No additional plants are forecast for the next five years."

We have no information on growth during the bulk of the period 1975-1985 however since little expansion is occurring in the near future we make the assumption that any growth in 1975-1985 would be insignificant. $\Rightarrow P_c = 0$

$$P_c = 0$$

This assumption is not gross especially if we ref to Fig 1 at the above Ref. Fish meal domestic production has not greatly changed since 1960.

P_B :

Ref 050 pg 2 & 2

1971 Production of Fish Meal = 292,429 TON

No of Fish Meal Plants = 123

$$\text{Avg size of plant industry-wide} \approx \frac{292,429 \text{ TON/yr}}{123 \text{ plant}} \approx 2,377 \frac{\text{TON}}{\text{yr plant}}$$

Knowing that $P_c = 0$ we may state that the 1975 production of fish meal is equivalent to the 1971 level or 292,429 TON/yr

$$P_{75} = 292,429 \frac{\text{TON}}{\text{yr}} \text{ fishmeal}$$

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Computation Sheet For Industrial Factors

Calculations Done By 21. Morrone Date 9-19-74

Source Fish Meal Processing

P_b cont'd

As stated in the above reference; one fish meal plant will be replaced annually over the next five years. We assume this to be true for 1975-1985. With a simple decay rate based on the 1975 baseline year this calculates out to;

Avg size plant 2,377 TON/yr

1975 Prod Fish Meal 292,429 TON/yr

$n=1$

$$P_b \approx \frac{2,377}{292,429} = .008 \text{ simple}$$

K:

Fish meal production is a sub-industry of the whole fish processing market, however for the most part it is associated with the fish canning (food processing) industry. We will make the analogy that capacity utilization in fish meal plants will parallel fish canneries or food plants in general.

Ref 144 pg 48
July 1974

Avg K for 1965-1973 Table 1
for Food Mfg $\approx .81$

$$\therefore K = .81$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-19-74

Source Fish Meal Processing

A: Using the 1975 Production ~~rate~~ of 292,429 TON/yr of Fish Meal and the capacity utilization of .81 (K) we are able to calculate the 1975 Production Capacity,

$$A = \frac{P_{75}}{K} = \frac{292,429 \text{ TON/yr}}{.81}$$

$$\therefore A = 361,025 \text{ TON/yr Fish Meal}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-19-74

Source Fish Meal Processing

Particulates

E_u : Ref 075 Table 6.6-1

Drier Emissions .1 lb / TON of Fish scrap

If we refer to Ref 046 pg 806 we obtained information on the character of scrap feed to the fish meal plant.

Charge material $\approx$ 20-30% solids

We will assume for this source that the feed is 25% solids and this solid represents the total fish meal produced. Another way of representing this is by:

$$.25 \frac{\text{TON Fish meal}}{\text{TON Fish Scrap}}$$

Converting $.1 \frac{\text{lb}}{\text{TON Fish Scrap}}$ to $\text{lb} / \text{TON Fish meal}$

$$E = \frac{.1 \text{ lb}}{\text{TON Fish scrap}} \times \frac{\text{TON Fish Scrap}}{.25 \text{ TON Fish Meal}}$$

$$E_u = .4 \text{ lb} / \text{TON Fish Meal}$$

This value is suspected of representing the emission after the cyclone normally integral with fishmeal driers.

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-19-74

Source Fish Meal Processing

Particulates cont'd

E_N :

cyclones are generally applied and achieve 90% eff
 Ref OSO pg 3-4 "Fishmeal Processing"

$$E_N = .1 \times E_u = .1 \times .4 \text{ lb/TON Fish meal}$$

$$E_N = .04 \text{ lb/TON Fish Meal}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-19-74

Source Fish Meal Processing

H₂S

Sulfide emissions are identified and quantified
 from cookers in the fish meal plant Ref 075
 Table 6.6-1

$$E = .01 \text{ lb H}_2\text{S} / \text{TON Fish Meal (Fresh Fish)}$$

and

$$E = .2 \text{ lb H}_2\text{S} / \text{TON Fish Meal (Stale Fish)}$$

In many cases, fish meal plants will be in close proximity or a integral part of fish canneries so that stale fish would not represent a major portion of the scrap input. We assume the following split as representative

25% Stale Scrap
 75% Fresh Scrap

A weighted emission factor is determined by;

$$E = .75 (.01) + .25 (.2)$$

$$E \approx .058 \text{ lb} / \text{TON Fish Meal}$$

$$\therefore E_u = .058 \text{ lb} / \text{TON Fish Meal}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-19-74

Source Fish Meal Processing

H₂S / cont'd

Control of fish meal driers to remove odorous compounds is accomplished by thermal incineration, condenser + afterburners, and chlorinating-scrubber systems.

H₂S and (CH₃)₃N [Trimethylamine] are odorants which have been identified (Ref 015 pg 6.6-1) from cookers.

We assume that an odor control system will be comparatively effective with respect to H₂S removal.

Ref 050 pg 3

Efficiencies of ~ 99% are achievable

$$E_N = .01 \times E_u = .01 \times .058 \text{ lb/ton}$$

$$E_N \approx .0006 \text{ lb/TON Fish Meal}$$

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone

Date 10-16-74

Source Fish Meal Processing

E_s : Particulates

A breakdown of fish meal capacity statewide was not obtained however we surmise that it will at least occur in those states bordering on the major fishing waters, including the Atlantic, Pacific Oceans, the Gulf of Mexico, and the Great Lakes. We will not consider the latter as a major contributing area. Those states therefore which would conceivably support a fish processing industry are listed as follows:

Alaska	South Carolina
Washington	North Carolina
Oregon	Virginia
California	Maryland
Texas	Delaware
Louisiana	New Jersey
Mississippi	New York
Florida	Massachusetts
Georgia	Maine
Alabama	Rhode Island
Hawaii	

This represents essentially half of the state and if we assume that the emission "table" generated by assimilating the process weight guidelines of these 21 states would not differ appreciably from the 50 state average (General Process weight rate curve) we may calculate the allowable emissions as follows:

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Project Number -- 32391 -- New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-16-74

Source Fish Meal Processing

E_s : Particulates

Typical Plant size = 2,377 T/yr
 (see P₈)

If we assume an operating schedule of 8 hrs/day 350 d/yr
 $8 \times 350 = 2800$ hr/yr

$$\frac{2377 \text{ T/yr}}{2800 \text{ hr/yr}} = .849 \text{ T/hr} \text{ or } \approx 1700 \text{ lb/hr}$$

process weight

Allowable emission from "General Process weight Curve"

$$E_a = 3.7 \text{ lb/hr}$$

using this allowable emission rate and the typical dryer weight rate we may estimate E_s for Fish Meal Drying.

$$E_s = \frac{3.7 \text{ lb/hr PT}}{.849 \text{ Ton/hr Meat}} = 4.36 \text{ lb/Ton Meat}$$

$$E_s = 4.36 \text{ lb/Ton Fish Meal}$$

Since this value of E_s is much higher than the uncontrolled source ($E_u = .4 \text{ lb/ton}$) we

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Computation Sheet For Emission Factors

Calculations Done By W. Marrow

Date 10-16-74

Source Fish Meal Processing

E_s : Particulates cont'd

must assume the value to be used
for E_s should be E_u

$$E_s = E_u = .04 \text{ lb/TON}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marvone Date: 10-16-74

Source Fish Meal Processing

E_s : H_2S

Ref 148 and 84

There are apparently no hydrogen sulfide limitations which may be applied to fish meal processing plants in the SIP's.

In this instance $E_s = E_u$

$$E_s = .058 \text{ lb/ton Fish meal}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 11-1-74

Source Fish Meal Processing

E_{H_2S} :

Application of control systems (condenser - afterburner, incinerator, or chlorinator scrubbers) is assumed to be equally feasible on existing fish meal plants as for new plants such that $E_{H_2S} = E_N$

$$\therefore E_{H_2S} = .0006 \text{ lb/Ton fish meal}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOMER

Date 1/23/78

Source GRAIN HANDLING & PROCESSING

THIS SOURCE CATEGORY IS UNUSUAL IN THAT THE PRODUCT (OF WHICH THERE ARE MANY TYPES) IS HANDLED MANY TIMES, EACH PRODUCING AN EMISSION OF PARTICULATE MATTER. FOR THE PURPOSE OF THIS STUDY, WE WILL DEFINE INDUSTRIAL EMISSION FACTORS FOR THE FOLLOWING CATEGORIES:

- ① Loading, unloading, transferring, conveying
- ② Screening, cleaning
- ③ DRYING
- ④ PROCESSING

VALUES OF A & P_c WILL REFLECT ACTUAL PRODUCTION, GROWTH & CAPACITY UTILIZATION. THE EMISSION FACTORS WILL REFLECT THE MULTIPLE HANDLING ASPECTS.

Ref ① p 53 gives 1968 production of 177×10^6 tons of grain

Ref ① p 54 gives the growth rate of 1.5% (Assume compound)

Ref ④ p 81 indicates that 83% of the grain produced goes through country elevators

Ref ④ p 48 indicates the avg K for the food industry (1965-1973) is 81%. If we assume that country elevators could handle 100% of the grain produced & take the avg of these two data sources,

$$K = 0.82$$

ASSUME VALID FOR ALL CATEGORIES

We will assume that all the grain produced is loaded & handled, etc, screened, etc & processed, then

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/23/75

Source GRAIN HANDLING & PROCESSING

$$A = \left(\frac{177 \times 10^6}{0.82} \right) (1 + 0.015)^7 = 239.6 \times 10^6$$

$$A_{\text{total}} = 239.6 \times 10^6 \text{ TONS}$$

Ref (47) p 82 indicates that only 20% of the grain produced is decayed

$$A_{\text{decay}} = (239.6 \times 10^6) (0.20) = 47.9 \times 10^6$$

$$A_{\text{decay}} = 47.9 \times 10^6 \text{ TONS}$$

$$P_c = 0.015$$

compound

Assume valid for all categories

From Ref (37) p 30, the IRS allowable depreciation guideline for
"Agriculture Machinery and equipment, including grain bins..." 10 yrs

Ref (37) p 31 "GRAIN AND ⁺GRAIN MILL PRODUCTS...." 17 yrs

Assuming hence the avg of the above values

$$P_d = \frac{1}{2 \left(\frac{17+10}{2} \right)} = 0.037$$

$$P_d = 0.037$$

simple

Assume valid for all categories

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Computation Sheet For Industrial Factors

Calculations Done By Horne Date 1/23/75

Source Grain Handling & Processing

E_U

Ref (47) p 82 gives an uncontrolled emission factor for loading, unloading, transferring & conveying of 20^{lb}/TON GRAIN. This value considers multiple handling.

$$E_{U_{\text{handling etc}}} = 20 \text{ LB/TON GRAIN}$$

Ref (47) p 82 gives E_U for screening & cleaning (assumed once through)

$$E_{U_{\text{screening etc}}} = 6 \text{ LB/TON GRAIN}$$

Ref (47) p 83,

$$E_{U_{\text{drying}}} = 6 \text{ LB/TON GRAIN}$$

Ref (75) p 6.4-2 TAG 6.4-1

Assuming the avg for the processing of corn & soybean,

$$E_{U_{\text{processing}}} = 6 \text{ LB/TON GRAIN}$$

E_N

For loading, unloading, transferring & conveying, proper hooding & ventilation through fabric filters (preceded by a cyclone in some cases) would represent BPT. Ref (1) p 26-29.

$$\eta = 99\%+$$

Assuming 99%

$$E_{N_{\text{handling etc}}} = (1-99)(20) = 0.2 \text{ lb/ton}$$

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Computation Sheet For Industrial Factors

Calculations Done By H. H. H.

Date 1/23/75

Source GRAIN Handling & Processing

$$E_{\text{handling etc}} = 0.2 \text{ LB/TON GRAIN}$$

Assuming that screening & cleaning op's can be similarly controlled,

$$E_N = (1 - .99)(6.0) = 0.06$$

$$E_{\text{cleaning etc}} = 0.06 \text{ LB/TON GRAIN}$$

Ref ① p 25 states dust emission from grain milling arise from handling the raw grain. Emissions from the milling operations, per se, are well contained within the building...."

∴ We will assume similar control as for handling, etc

$$E_{\text{processing}} = (1 - .99)(6.0) = 0.06$$

$$E_{\text{processing}} = 0.06 \text{ LB/TON GRAIN}$$

Ref ① p 30 Fabric filters are not used on grain dryers because of the high moisture content of the discharged air. A sliding bar cleaning system on a settling screen would appear to have the greatest potential (Ref ① p 32). With a 100 mesh screen, 1.5-2.0 LB/HR of dust emission were det'd for a 2000 cu/HR dryer.

From Ref ① p ① an avg conversion factor would be 58 LB/BU.

$$(58 \text{ LB/BU})(2000 \text{ BU/HR}) \div 2000 = 58 \text{ TPH}$$

For an avg emission of 1.75 LB/HR

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Computation Sheet For Emission Factors

Calculations Done By H. B. B. R.

Date 1/23/75

Source Grain Handling & Processing

$$E_N = \frac{1.75}{58} = 0.030$$

$$E_{N \text{ drying}} = 0.03 \text{ lb/TON GRAIN}$$

E_S Ref ① p1 There are 11,147 grain elevators in the U.S.
p55 gives the geographical distribution

KANSAS	— 10.8%
✓ ILLINOIS	— 10.0%
✓ IOWA	— 9.7%
NEBRASKA	— 7.9%
TEXAS	— 7.2%
N. DAKOTA	— 6.9%
MINN.	— 6.9%
MISS.	— 4.5%
	<u>63.9%</u>

The remaining 36.1% are distributed throughout the U.S.
of the above only Ill. & Iowa have specific regs, the remainder being
covered by PWR limitations. From Ref ⑧④ + ④⑧

ILLINOIS — 0.3 gr/scf for wet corn MILLING (processing)

Typical data from Ref ① p24

10,350 lb/hr

3790 scfm

$$\left(0.3 \frac{\text{gr}}{\text{scf}}\right) \left(3790 \frac{\text{scf}}{\text{min}}\right) \left(60 \frac{\text{min}}{\text{hr}}\right) \left(2000 \frac{\text{lb}}{\text{ton}}\right)$$

$$\left(7000 \frac{\text{gr}}{\text{lb}}\right) \left(10,350 \frac{\text{lb}}{\text{hr}}\right)$$

$$= 1.88 \text{ lb/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer

Date 1/23/75

Source Grain Handling & Processing

Iowa - 0.1 gr/2F for grain processing

This corresponds to $1.88 \left(\frac{.1}{.3} \right) = 0.627 \text{ lb/ton grain}$

For the other states mentioned, we will use the PWR eqs; for the remaining 36.1% we will use the gen'l PWR curve generated from Ref (84) + (148)

We will assume 10,000 lb/hr as the PWR for grain processing

$$\text{KANSAS} - 12 \text{ lb/hr} \quad \frac{(12)(2000)}{10000} = 2.4 \text{ lb/ton}$$

$$\text{NEBRASKA} - 9.73 \text{ lb/hr} \quad \frac{(9.73)(2000)}{10000} = 1.95 \text{ lb/ton}$$

$$\text{TEXAS} - 15.2 \text{ lb/hr} \quad \frac{(15.2)(2000)}{10000} = 3.04 \text{ lb/ton}$$

$$\text{N. DAK.} - 12 \text{ lb/hr} \quad 2.4 \text{ lb/ton}$$

$$\text{MINN.} \quad " \quad 2.4 \text{ lb/ton}$$

$$\quad " \quad 2.4 \text{ lb/ton}$$

MISS.

$$\text{All others} \quad 11.6 \text{ lb/hr} \quad \frac{(11.6)(2000)}{10000} = 2.32 \text{ lb/ton}$$

$$E_S = (.108)(2.4) + (.100)(1.88) + (.097)(.63) + (.079)(1.95) + (.072)(3.04) + (.069)(2.4) \\ + (.069)(2.4) + (.045)(2.4) + (.341)(2.32)$$

$$= .2592 + .1880 + .0611 + .1541 + .2189 + .1656 + .1656 + .1080 + .8375 = 2.158$$

$$E_{S \text{ processing}} = 2.15 \text{ lb/ton grain}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 1/23/75

Source Grain Handling & Processing

Drying

Ref ① p 8 indicates a "typical" PWR of 2000 BU/HR. From p 2 of these cals, a factor of 58 ^{lb}/BU would yield

$$(2000)(58) = 116,000 \text{ }^{\text{lb}}/\text{HR} \text{ (Assume 120,000)}$$

KANSAS	-	46.3/58	=	.7983
ILL	-	22.5/58	=	.3879
IOWA	-	46.3/58	=	.7983
NEBR	-	33.28/58	=	.5738
TEX	-	82.0/58	=	1.4138
N. DAK	-	46.3/58	=	.7983
MINN.	-	46.3/58	=	.7983
MISS.	-	63.7/58	=	1.0983
ALL OTHERS	-	42.0/58	=	.7241

$$\begin{aligned}
 E_{\text{drying}} &= (.108)(.7983) + (.100)(.3879) + (.097)(.7983) + (.079)(.5738) + (.072)(1.4138) \\
 &\quad + (.069)(.7983) + (.069)(.7983) + (.045)(1.0983) + (.361)(.7241) \\
 &= .0862 + .0388 + .0774 + .0453 + .1018 + .0551 + .0551 + .0494 \\
 &\quad + .2614
 \end{aligned}$$

$$E_{\text{drying}} = 0.771 \text{ }^{\text{lb}}/\text{TON GRAIN}$$

Handling, etc.

Ref ② p V-16 gives a typical elevator size AS 12,600 ^{lb}/HR

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Computation Sheet For Emission Factors

Calculations Done By NORR Date 1/23/75

Source GRAIN HANDLING + PROCESSING

KANS. - $(14)(2000)/12,600 \times .108 = .2400$
ILL. - $(6.8)(2000)/12,600 \times .100 = .1079$
IOWA - SAME AS KANSAS $\times .097 = .2156$
NEBR. - $(7.3)(2000)/12,600 \times .079 = .0915$
TEX - $(9.7)(2000)/12,600 \times .072 = .1109$
N.DAK. - SAME AS KANSAS $\times .069 = .1533$
MINN - " " $\times .069 = .1533$
MISS - " " $\times .045 = .100$
OTHERS - $(13.3)(2000)/12,600 \times .361 = .762$

$$\Sigma = 1.935$$

$$E_{\text{HANDLING ETC}} = 1.94 \text{ LB/TON GRAIN}$$

Cleaning Screening

Ref (236) p V-18 gives grain cleaning process weights of
10,000 - 53,000. We will assume an average
of 30,000 lb/hr (15 TPH)

KANSAS - $25.0/15 \times .108 = .1800$
ILL - $10.8/15 \times .100 = .072$
IOWA - $25/15 \times .097 = .1617$
NEBR. - $19/15 \times .079 = .100$
TEX. - $44/15 \times .072 = .211$
N.D. - $25/15 \times .069 = .115$
MINN - $25/15 \times .069 = .115$
MISS - $25/15 \times .045 = .075$
OTHERS - $24/15 \times .361 = .5776$

$$\Sigma = 1.607$$

$$E_{\text{CLEANING ETC}} = 1.61 \text{ LB/TON GRAIN}$$

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Computation Sheet For Emission Factors

Calculations Done By HOMER Date 1/24/75

Source Grain Handling & Processing

Summary:

	<u>E₀</u>	<u>E_N</u>	<u>E_S</u>
Handling, etc.	20.0	0.2	1.94
Screening, etc.	6.0	0.06	1.61
Drying	6.0	0.06	0.77
Processing	6.0	0.03	2.16

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-17-74

Source Smoked Meat

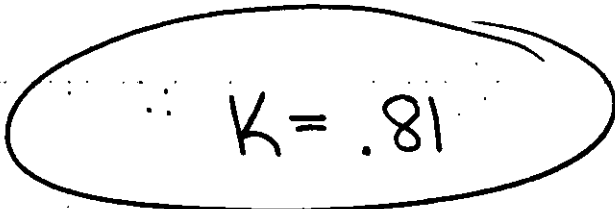
K:

Ref 144 pg 48
July 1974

Capacity utilization for this industry was not readily obtainable in the literature. The best estimate was obtained from the above reference which listed the 1965 to 1973 average capacity utilization rate for the manufacturing of food products.

$$K_{avg} = .81 \quad \text{range } 1965-1973 \quad .75-.83$$

We use this average value and assume it applicable to meat smokehouses during the period 1975-1985.


$$K = .81$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Morrone Date 9-17-74

Source Smoked Meat

Pc: Production data was obtained from Ref 004 pg 1-3

<u>Year</u>	<u>Fish Smoked</u>	<u>Meat Smoked</u>
1963	49,350	2,300,000
1967	21,400	2,500,000
1968	20,392	N.A.

These data were plotted and appear on the attached graph. In 1963 $\frac{49,350}{2,300,000 + 49,350} \approx 98\%$ of smoked production was meat and similarly in 1967, 99% of production was meat.

We estimate that the slow growth during the period 1963 - 1967 is representative of this industry.

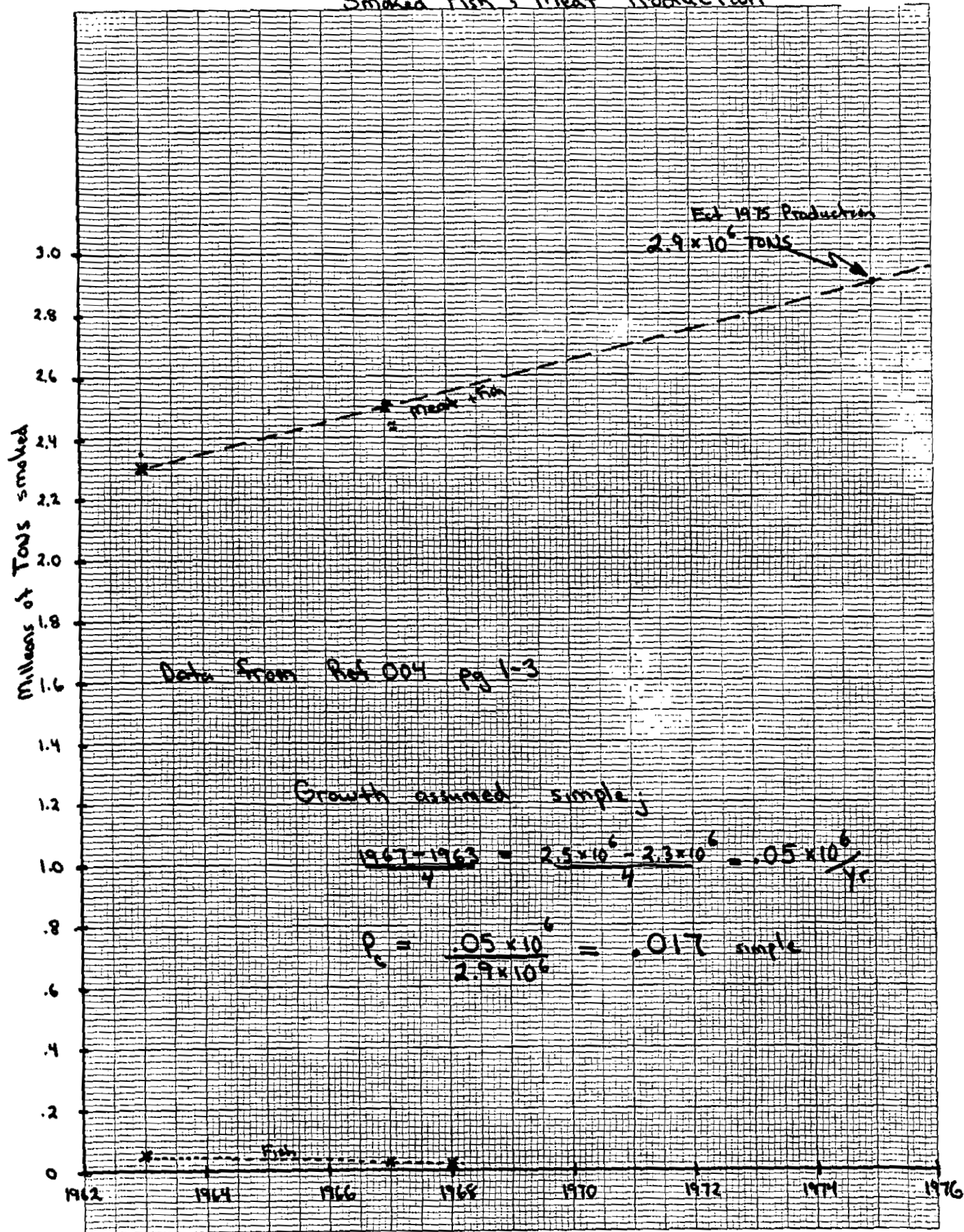
Growth is calculated by the relationship

$$\frac{1967-1963}{4} = \frac{2.5 \times 10^6 - 2.3 \times 10^6}{4} = \frac{5 \times 10^4 \text{ TON/YR}}{\text{YR}}$$

Extrapolating the above data (considering fish prod as negligible) we may estimate the 1975 production of smoked meat. Note! simple growth assumed.

$$P_{75} = 2.9 \times 10^6 \text{ TON/year}$$

Smoked Fish & Meat Production



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Computation Sheet For Industrial Factors

Calculations Done By W. Manore Date 9-17-74

Source Smoked Meats

P_c : cont'd

The simple growth based on the base-year of 1975 is represented by,

$$P_c = \frac{5 \times 10^4}{2.9 \times 10^6} = .017 \text{ simple}$$

$$\therefore P_c = .017 \text{ simple}$$

A:

The production capacity is calculated from the 1975 production estimate and the value of $K = .81$

$$A = \frac{P_{75}}{K} = \frac{2.9 \times 10^6}{.81} = 3.58 \times 10^6$$

$$\therefore A = 3.6 \times 10^6 \text{ TON/yr smoked meat}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-17-74

Source Smoked Meat

P_B :

Ref 037 pg 31 Section 20.4

~~Meat~~ Meat smoking is assumed to be covered under this general category in the IRS Table of asset guidelines.

Asset guideline = 12 yrs

P_B est by 2x IRS = 24 yrs

100% Dep in 24 yrs $\Rightarrow \frac{100\%}{24 \text{ yr}} = 4.1\%/\text{yr simple}$

We will approximate this as 4% / yr

$$\therefore P_B = .04 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 9-17-74

Source Smoked Meat

Ref 075 Table 6.7-1

E_u & E_N

<u>Pollutant</u>	<u>E_u lb/Ton meat</u>	<u>E_N lb/Ton meat</u>
Particulate	.3	.1
CO	.6	0
HC $\left\{ \begin{array}{l} \text{CH}_4 \\ \text{Aldehyde} \\ \text{Org. Acids} \end{array} \right.$	.35	.15

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-16-74

Source Smoked Meat

E_s : CO and Hydrocarbons

There are no regulations for CO or HC
which may be applied to Meat smokehouses
so that we assume $E_s = E_u$

$$E_s \text{ CO} = .6 \text{ lb/TON meat}$$

$$E_s \text{ HC} = .35 \text{ lb/TON meat}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone

Date 10-29-74

Source Smoked Meat

E_s :

Particulate

Figures detailing the number or distribution of meat smoking plants in the US. are not available. Ref 004 Figure 2 pg 1-4 show the state-wide % breakdown of meat smoking production. From Ref 158 we know the total number of plants in the Industry SIC code 2013 (Sausages & other prepared meats) for 1972 was 1,297.

550 of these establishments employ 20 or more people. For the purpose of estimation we first assume that all of these latter plants smoke meat

From the production curve attached

$$P_{72} \approx 2.75 \times 10^6 \text{ T/yr} \Rightarrow \text{Cap}_{72} = \frac{P_{72}}{K}$$

$$\text{Cap}_{72} = \frac{2.75 \times 10^6}{.81} \text{ T/yr} \approx 3.4 \times 10^6 \text{ T/yr} \text{ smoked meat}$$

Typical Meat Smoking Annual Capacity

$$\frac{3.4 \times 10^6 \text{ T/yr}}{550} = 6.18 \times 10^3 \text{ T/yr per plant}$$

We assume an operating schedule of $8 \frac{\text{hr}}{\text{d}} \times 365 \frac{\text{d}}{\text{yr}} = 2920 \frac{\text{hr}}{\text{yr}}$

Typical Plant Meat Smoking Hourly Capacity Rate

$$6.18 \times 10^3 \frac{\text{T}}{\text{yr}} \times \frac{\text{yr}}{2920 \text{ hr}} \times \frac{2000 \text{ lb}}{\text{T}} = 4,233 \text{ lb/hr smoked meat}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-29-74

Source Smoked Meat

E_s : Particulate cont'd

Ref. 075 Table 6.7-1 pg 6.7-1

"Emissions from smokehouse are generated from the burning hardwood rather than from the cooked product itself"

Emission factors are presented on the basis of $\frac{110 \text{ lb meat smoked}}{1 \text{ lb wood burned}}$

It is a matter of interpretation as to which components to include in the process weight rate (wood + meat or wood only)

Calculating an allowable emission based on wood only and the 50 state Average Process Weight Table we obtain

$$\frac{4,233 \text{ lb meat}}{\text{hr}} \times \frac{1 \text{ lb wood}}{110 \text{ lb meat}} = 38.5 \text{ lb wood/hr}$$

$$\text{Allowable Emission} \approx .01 \text{ lb Pt/hr}$$

and;

$$\frac{.01 \text{ lb Pt/hr} \times 2000 \text{ lb}}{4,233 \text{ lb meat/hr}} \approx .005 \text{ lb Pt/TON meat}$$

This value is a factor of 20 lower than the estimated value of E_N .

We make the assumption that the true interpretation would in fact include the weight of the meat and the wood.

$$\therefore \text{Process Rate} = \frac{4,233 \text{ lb}}{\text{hr}}_{\text{meat}} + \frac{38.5 \text{ lb}}{\text{hr}}_{\text{wood}}$$

$$\text{Process Rate} \approx 4272 \text{ lb/hr}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-29-74

Source Smoked Meat

E_s : Particulate cont'd

From the 50 state ^{Average} process Table we obtain
 an allowable emission of 7 lb/hr

and;

$$E_s = \frac{7 \text{ lb pt/hr}}{4,233 \text{ lb meat/hr} \times \frac{\text{Ton}}{2000 \text{ lb}}} \cong 3.31 \text{ lb pt/Ton meat smoked}$$

Since $E_s > E_u$ ($E_u = .3 \text{ lb/Ton sm meat}$)
 we conclude that these plant would necessarily
 comply with ~~the~~ state regulations based on a general
 process weight rate table using the meat & wood
 input rate. $\Rightarrow E_s = E_u$ for the model

$$E_s = .3 \text{ lb/Ton smoked meat}$$

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Computation Sheet For Industrial Factors

Calculations Done By Boyer Date 1/24/75

Source STACH

Ref (236) p V-29 gives 1964 starch production @ 5.8×10^9 lbs.

Since no information could be located regarding growth, we will assume that, because of its high consumer use, growth parallels the population. See "INDUSTRIAL FACTORS - Day Cleaning"

$$P_c = 0.018$$

compound

No specific value of K could be det'd, so we will use that for the CHEMICAL INDUSTRY IN GEN'L. From Ref (144) p 48, the avg K for the chemical industry between 1965 & 1973 is 83%

$$K = 0.83$$

$$A = \frac{(5.8 \times 10^9)(1.018)^n}{(.83)(2000)} = 4.25 \times 10^6 \text{ tons}$$

$$A = 4.25 \times 10^6 \text{ tons starch}$$

From Ref (37) p 33, the allowable IRS guideline for "Manufacture of Chemicals and Allied Products" is 11 yrs

$$P_B = \frac{1}{2(11)} = 0.045$$

$$P_B = 0.045$$

simple

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/24/75

Source Starch

Ref (75) PG. 11-1 TAB C. 11-1

$$E_{up} = 8.0 \text{ lb/ton starch}$$

Also,

$$E_{np} = 0.02 \text{ lb/ton starch} \text{ using a centrifugal gas scrubber}$$

$$\frac{8 - 0.02}{8} \times 100 = 99.75\%$$

Ref (236) PU-29 states the capacity of a "large manufacturing plant" @ 18,200 lb/hr

We will assume a "typical" size of 15,000 lb/hr & use the gen'l PWE curve generated from Ref (48) & (184)

The Abundance is 15.0 lb/hr

$$E_{sp} = \frac{15(2000)}{15000} = 2.0$$

$$E_{sp} = 2.0 \text{ lb/ton starch}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-1-74

Source Bagasse Burning from Sugar Cane Processing

K: Ref 003 pg 8-1

"mills in Fla and La have 10-15% unused capacity. Puerto Rico is believed to have somewhat more unused capacity and Hawaiian mills an unknown amount, but in each instance other factors limit the availability of cane for grinding."

We will assume as a conservative estimate that approximately 25% of the capacity is unused. This will take into account the older plants operating in La and Hawaii and the typical factors that normally limit production. (crop failure, crop variability, etc)

$$K = .75$$

a better estimate may be found

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Computation Sheet For Industrial Factors

Calculations Done By W. Mannon Date 8-1-74

Source Bagasse Burning

A: From Fig 2 pg 8-3 Ref 003 we obtain directly the estimated 1975 production of raw cane sugar

$$\text{raw cane sugar } P_{75} \cong 3.65 \times 10^6 \text{ Ton/yr}$$

Information supplied in Ref 093 pg 571-572 permits the determination of the quantity of cane necessary to produce the 1975 raw cane prod.

11-15% of cane is sucrose
 96% of sucrose juice is reclaimed

We will assume 15% sucrose in cane and 96% recovery

$$\begin{aligned} 1975 \text{ cane} &= \frac{1975 \text{ raw cane sugar}}{.15 \times .96} \\ &= \frac{3.65 \times 10^6}{.15 \times .96} \end{aligned}$$

$$1975 \text{ cane} = 25 \times 10^6 \text{ Ton/yr}$$

The fraction of bagasse from cane is reported to be 30% (Ref 003 p 2-3) and according to an estimate of 70% bagasse burned in reference 093 p 577 we may calculate the 1975 bagasse production rate.

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 8-1-74

Source Bagasse Burning

A: cont'd

using 1975 cane prod = 25×10^6 T/yr
 % bagasse in cane = 30%
 % bagasse burned = 70%

$$\begin{aligned} \text{bagasse}_{1975} \text{ burned} &= .70 \times .30 \times 25 \times 10^6 \text{ T/yr} \\ &= 5.25 \times 10^6 \text{ T/yr} \end{aligned}$$

Using the value of $K = .75$ we calculate the 1975 production capacity.

$$A = \frac{5.25 \times 10^6}{.75}$$

$$A = 7 \times 10^6 \text{ T/yr bagasse burned}$$

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Source Bagasse Burning

P_c :

Growth rate in the raw sugar cane industry will approximately mirror the growth in bagasse burning. This of course assumes that the use of bagasse for fuel in process boilers remains attractive. This may not be true in light of environmental regs and control costs, Rising fuel costs and uncertain availability may encourage bagasse burning, on the other hand.

From Fig 2 p 8-3 Ref 003
 the simple growth for the period
 1975 to 1985 is assumed to be identical
 with the slope of the total domestic
 raw sugar cane production estimated for
 1970 - 1980

$$\text{slope} = \frac{3.98^{1980} - 3.33^{1970}}{10} \text{ yr} = .055 \times 10^6 \frac{\text{yr}}{\text{yr}}$$

$$P_c = \frac{.055 \times 10^6}{3.65 \times 10^6} = .015 \text{ simple}$$

↑
1975 prod

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Calculations Done By W. Malone Date 9-23-74

Source Bagasse Burning (Sugar Processing)

P_B : Ref 038 pg 121-124 identifies water-tube boilers in bagasse burning. Small boiler and larger boilers are depicted as 40,000 lb/hr steam and >70,000 lb/hr steam respectively.

This puts them in the class of #1 watertube according to the Table in "Fossil Fuel Boilers" Industrial Factors

The P_B determined for this boiler type was 5% simple

Also considering bagasse boilers to be comparable to medium size industrial boiler (10-250 x10⁶ BTU/hr) we would obtain a P_B of 5.0% simple according to The Summary table of "Fossil Fuel Boiler"-Industrial Factors

$$P_B = .05 \text{ simple}$$

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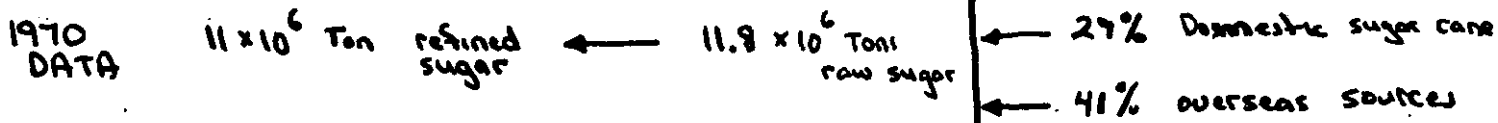
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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 8-1-74

Source Bagasse Burning

Sugar Cane Processing: Ref 003



Bagasse is usually burned at raw sugar cane mills to eliminate solid wastes and provide process steam

Particulate emissions are due to:

- ① low heat value
- ② fibrous nature of bagasse
- ③ substantial moisture

≈ 30% of raw cane entering the mill may end up as bagasse there have been some, although limited, ventures of using bagasse for paper or livestock bedding, etc

≈ 70% of bagasse is normally used as fuel to boilers with auxiliary fuel like gas or oil

Ref - 093

p 577

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Computation Sheet For Emission Factors

Calculations Done By 20. Marrone Date 8-1-74

Source Bagasse Burning

Particulate

E_u : Ref 075 p 6.12-1 Table 6.12-1

$$E_u = 22 \text{ lb / Ton of bagasse}$$

E_N : According to control info in Ref 003 pg 4-1 to 4-2 the most modern mills presently use small dia mechanical collectors (multiclones) which when operating properly yield efficiencies of 60-75%.

Development of other more effective systems has not proven out. This has been explained due to the erosive and excessive fly ash content of the exhaust stream.

Pilot tests have been performed Ref 003 pg 4-3 on several mills with two control devices in series the first device being a multiclone and the second either a venturi or cyclone wet scrubber. Results have shown 90-99% eff.

Even though the above reference indicates problems of a mechanical nature with piloted control system and waste disposal difficulties we will assume these will be worked out and giving the best ~~judgment~~ of attainable control efficiency we will consider 90% to be ¹⁹⁷⁵⁻¹⁹⁸⁵ within technology.

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Computation Sheet For Emission Factors

Calculations Done By W. Malone Date 8-1-74

Source Bagasse Burning

Particulate

E_N : cont'd

therefore;

$$E_N = .10 \times E_u$$

where $E_u = 22 \text{ lb/T}$

$$E_N = 2.2 \text{ lb/Ton of bagasse burned}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 8-1-74

Source Bagasse Burning

Predominant location of Sugar Cane Mills : Ref 003

ATO
Data

- ① Florida 4-5 months/yr
- ② Hawaii year round
- ③ Louisiana two months/yr
- ④ Puerto Rico 4-5 month/yr
- ⑤ Texas ?

Florida 9 sugar cane mills around W. Palm Beach

Louisiana 43 sugar cane mills south central La

Texas 1973-74 exp start of operation quota 100,000 T/yr sugar

Hawaii 25 sugar cane mills 4 main islands

Puerto Rico 15 sugar cane mills (industry declining in recent years)

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-17-74

Source Bagasse Burning

E_s : Particulate

Ref 038 Table 43 ^{pg 130} and Table 42 were used to obtain a typical size plant.

T/hr	Distribution
2.4-10	25%
10.1-20	62.5%
20.1-28.7	12.5%

The above distribution for Florida is assumed applicable industry-wide. We take the average burning rate in this three ranges and weight by the % distribution to obtain a typical plant size

$$.625(15) + .25(6.2) + .125(24.4)$$

$$9.375 + 1.55 + 3.05$$

Typical Plant $\approx$ 14 T/hr bagasse burning rate

Ref 038 pg 135 Heating value of Bagasse 3,600 BTU/lb

pg 135 Supplemental fuel in 1972 Florida season was "Bunker C" @ 1.05 gal/ton bagasse which we assume typical of industry

BTU for "C" or No 6 ref 101 Table 9.9 pg 9-6
Gal

BTU/Gal 150,700 - 152,000 Avg = 151,350

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-17-74

Source Bagasse Burning

E_s : Particulate

We will calculate the heat input for the typical bagasse boiler burning 14 T/hr bagasse and supplementary fuel (oil)

$$H.I. = 14 \frac{\text{T}}{\text{HR}} \times \frac{2000 \text{ lb}}{\text{T}} \times 3600 \frac{\text{BTU}}{\text{lb}} + 1.05 \frac{\text{Gal}}{\text{HR}} \times 151,350 \frac{\text{BTU}}{\text{Gal}}$$

$$H.I. = (1.008 \times 10^8) + (2.22 \times 10^6) \frac{\text{BTU}}{\text{hr}}$$

$$\text{or } H.I. \approx 1.03 \times 10^8$$

$$H.I. \approx 103 \times 10^6 \frac{\text{BTU}}{\text{hr}}$$

$$\text{Oil Fuel supplement contribute } \frac{2.22 \times 10^6}{103 \times 10^6} \times 100 = 2.2\% \text{ of heat input}$$

Since the majority of the heat input is attributable to the bagasse we will compare emissions with the regulations in suitable states for solid fuels

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Computation Sheet For Emission Factors

Calculations Done By W. Marvone Date 10-17-74

Source Bagasse Burning

E_s : Particulate Ref 148

State

Regulations

Puerto Rico

.30 lb / 10⁶ BTU heat input

Texas

.3 lb / 10⁶ BTU heat input

use average →
 5 lb / 10⁶ BTU

Florida

.3 lb / 10⁶ BTU Existing
 .2 lb / 10⁶ BTU New

Louisiana

.6 lb / 10⁶ BTU

Hawaii

.4 lb / 100 lb bagasse burned

Converting the lb / 10⁶ BTU figure into lb / Ton of bagasse burned
 and (lb / 100 lb)

$$\frac{\text{lb PT}}{10^6 \text{ BTU}} \times \frac{10^6 \text{ BTU/HR}}{\text{TON/HR}} = \text{lb PT/TON Bagasse}$$

$$\frac{\text{lb PT}}{100 \text{ lb}} \times \frac{2000 \text{ lb}}{\text{TON}} = \text{lb PT/TON Bagasse}$$

Puerto Rico $.3 \times \frac{103}{14} = 2.2 \text{ lb / TON}$

Texas $.3 \times \frac{103}{14} = 2.2 \text{ lb / TON}$

Florida $.25 \times \frac{103}{14} = 1.8 \text{ lb / TON}$

Louisiana $.6 \times \frac{103}{14} = 4.4 \text{ lb / TON}$

Hawaii $.4 \times \frac{2000}{100} = 8.0 \text{ lb / TON}$

Aug = $\frac{\Sigma}{5} = \frac{18.6}{5}$

Aug = $3.7 \frac{\text{lb}}{\text{TON}}$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-17-74

Source Bagasse Burning

E_s : Particulate cont'd

$$E_s = 3.7 \text{ lb / TON of Bagasse}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrowe Date 9-17-74

Source Field Burning (Sugar Cane Processing)

K:

Emission Factors are presented in terms of acres burned. By this basis $K=1$ however, it is not interpreted directly as utilization of capacity

$$\therefore K=1$$

P_c :

The growth rate for sugar cane field burning is assumed identical to the rate determined for bagasse burning. Both these operations are directly related to Sugar cane production. The 1970-1980 est simple growth was determined to be 15% which we apply to 1975-1985 period

$$\therefore P_c = .015 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Morrone Date 9-17-74 & 9-23-74

Source Field Burning (Sugar Cane)

A:

The following yield info was obtained from the Dept of Agriculture

2.93 Tons sugar per acre of sugar cane

Telecom 9-23-74 Sugar Div Dept of Agr

<u>Year</u>	<u>Ton Sugar Cane / acre</u>
1971	38.1
1972	41.0
1973	35.4

Aug $\approx$ 38.2 Ton/acre

From Industrial Factors on "Bagasse Burning" under the development of A (1975 production capacity) we obtained the 1975 cane prod est of 25×10^6 TONS cane

We may now estimate the 1975 sugar cane acreage necessary to support this cane based on the above value of 38.2 $\frac{\text{TON}}{\text{acre}}$ (more amenable to our calculation procedure)

$$\frac{25 \times 10^6 \text{ Tons cane}}{38.2 \text{ TON/acre}} = .65 \times 10^6 \text{ acres}$$

This acreage is assumed burned in 1975 after producing 25×10^6 TONS of cane which ultimately produced 3.65×10^6 TONS of raw cane sugar (see Bagasse Burning)

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Computation Sheet For Industrial Factors

Calculations Done By D. Morrone Date 9-23-74

Source Field Burning (Sugar Cane Processing)

A: cont'd

The 1975 sugar cane acreage estimated of
being burned is about; 650,000 acres
with $k=1$

$$\therefore A = .65 \times 10^6 \text{ acres burned}$$

P_B :

Replacement of obsolescence capacity is not amenable
to field burning so we represent P_B by zero.

$$\therefore P_B = 0$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 9-17-74

Source Field Burning (Sugar Cane)

E_u : Ref 075 Table 6.12-1

<u>Pollutant</u>	<u>lb/acre burned</u>
Particulate	225
CO	1,500
HC	300
NO _x	30

The waste burned consists of 4 TON/acre of cane foliage
 and 11 TON/acre grass and weed. (15 TON/acre)

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Computation Sheet For Emission Factors

Calculations Done By William Morrone Date 10-17-74

Source Field Burning (Sugar Cane)

E_N :

The greatest impact of controls on sugar cane field burning would result from measures aimed at eliminating this practice. We will assume that field burning will not be permitted to assess the greatest impact of control legislation (NSPS). Practice will be replaced.

E_N in terms of lb/acre burned
 or lb/Ton raw sugar cane

E_N part = 0 lb/Acre
 HC = 0
 CO = 0 burned
 NO_x = 0

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-17-74

Source Field Burning (Sugar Cane Processing)

E_s : Ref 148

A survey of the SIP's for Florida, Hawaii, Louisiana, Puerto Rico and Texas showed that in the area of open burning the following rules apply.

Puerto Rico	Open burning prohibited however approval <u>may</u> be obtained						
Hawaii	Agricultural burning allowed with permission & guidelines						
Texas	"	"	"	"	"	"	"
Louisiana	"	"	"	"	"	"	"
Florida	"	"	"	"	"	"	"

None of these sugar cane producing states make a specific prohibition against agricultural burning and in fact it appears that in all cases permission will be obtained as long as guideline procedures are followed during burning.

We therefore assume that there are no regulations affecting this industry and $E_s = E_u$

$$E_s \text{ Part} = 225 \text{ lb/acre}$$

$$E_s \text{ CO} = 1,500 \text{ lb/acre}$$

$$E_s \text{ HC} = 300 \text{ lb/acre}$$

$$E_s \text{ NO}_x = 30 \text{ lb/acre}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. M. Moxmore Date 1-2-75

Source Vegetable Oil Production

There are a variety of seeds that find their way into vegetable oil production and among the most noteworthy are;

- (1) soybean
- (2) cotton seed
- (3) Peanut
- (4) Flax (linseed)

Process operations may differ from seed to seed however the general process steps are similar (Ref 002 p2-1 to 2-16)

Ref 002 pg 1-2 Table 1 shows the production for the various vegetable oil; we see that soybean and cotton seed represent a significant part of the total

$$\begin{array}{r} 9300 \\ + 1300 \\ \hline 9600 \end{array}$$

TOTAL = 10700

$$\left. \begin{array}{l} \text{cottonseed} \\ \text{soybean} \end{array} \right\} \frac{9600}{10700} \approx 90\% \text{ of Total Production}$$

We will develop this industry by looking at total vegetable oil production rather than breaking it down into specific products. Factors may be developed however it is understood that they apply in general and may not be true in particular cases.

- (1) While overall growth is presented, individual growth may be higher, or lower.
- (2) emissions may vary widely due to differences in process operation.
- etc.

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Computation Sheet For Industrial Factors

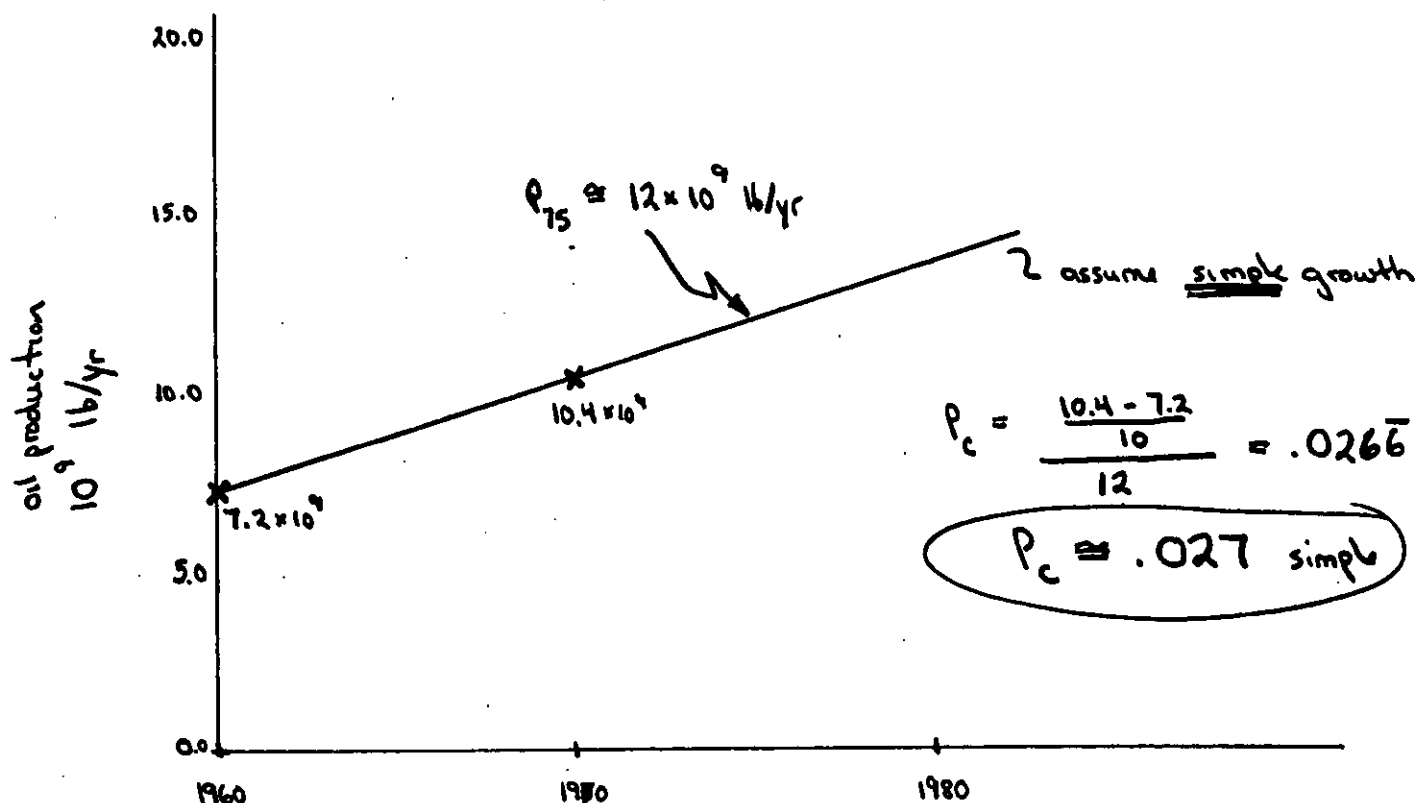
Calculations Done By W. Marone Date 1-2-75

Source Vegetable Oil Production

P_c :

Ref 002 pg 1-1

Production for 1960 and 1970



K :

Ref 002 p 8-2

states that oil seed production (input) is not expected to be much below oil process capacity
This implies a value of K near unity !!

From Ref 247 p 122 1970 capacity, 825×10^6 bushels soybeans
and from Table 48 pg 123 1970 production 761.265×10^6 bushels

$$K_{70} = \frac{761.265}{825} \approx .923$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 1-2-75

Source Vegetable Oil Production

K: cont'd

We will assume that a value of .92 is representative for all vegetable oil processing plants

$$\therefore K = .92$$

A: Using the 1975 Production value of 12×10^9 lb/yr obtained above and $K = .92$ we may calculate the 1975 Production Capacity,

$$A = \frac{12 \times 10^9 \frac{\text{lb}}{\text{yr}} \times \frac{\text{TON}}{2000 \text{ lb}}}{.92} = 6.52 \times 10^6 \text{ TON/yr}$$

$$\therefore A = 6.52 \times 10^6 \frac{\text{TON}}{\text{Yr}} \quad \text{vegetable oil produced}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Mammone Date 1-2-75

Source Vegetable Oil Production

P_B :

Ref 037 Class 20.3

Asset Guideline Period = 18 yrs

P_B est $\rightarrow 2 \times \text{IRS} = 36 \text{ yrs}$

$$\frac{100\%}{36 \text{ yrs}} \approx 2.77\%/\text{yr simple}$$

$$\therefore P_B = .028 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Moynone Date 1-2-75

Source Vegetable Oil Production

Ref 002 pg 2-3 about two-thirds (67%) of the oil mills in the US use solvent extraction directly or in combination with mechanical pressing

since this operation is the only source of HC we will develop an "emission factor (HC)" for the industry which will reflect this 67% process usage and the typical process emissions

Particulate emissions occur at various seed and meal handling and process steps. Operations are known to vary from seed to seed; mill to mill.

There was no great body of emission data for particulate emissions from the industry. Data for soybean process was obtained (Ref 247) and will be applied to the industry. This will be adequate since soybean processing incorporate most of the processing steps in vegetable oil prod. and it accounts for 80% of the total vegetable oil production. and therefore will be more than typical of the industry.

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Computation Sheet For Emission Factors

Calculations Done By W. Mearns Date 1-2-75

Source Vegetable Oil Production

Hydrocarbons

E_N : Ref 002 pg 2-13
Modern plants are identified as emitting $\frac{1}{2}$ gal or less (hexane) per ton of seed processed

From Ref 217 p153 60 lb soybean seed $\rightarrow$ 11 lb oil

$$\text{Soybean } \left\{ \frac{11 \text{ lb oil}}{60 \text{ lb seed}} \times 2000 \frac{\text{lb}}{\text{TON}} = 366 \frac{\text{lb oil}}{\text{TON seed}} \right.$$

and p117

$$\left. \begin{array}{l} 1,211 \times 10^6 \text{ lb oil prod} \\ 3,728 \times 10^3 \text{ Tons seeds crushed} \end{array} \right\} \text{cotton seed}$$

$$\frac{1,211 \times 10^6}{3,728 \times 10^3} = 325 \frac{\text{lb oil}}{\text{TON seed}}$$

These two oil represent $\approx 90\%$ of the total production with 80% of total from soybean alone

$$W_{\text{avg}} = .8(366) + .1(325) + .1(W_{\text{avg}})$$

$$.9W_{\text{avg}} = 292.8 + 32.5 = 325.3$$

$$W_{\text{avg}} = 361 \frac{\text{lb oil}}{\text{TON seed}}$$

Therefore using $\frac{1}{2}$ gal emitted (hexane) per ton seeds and the appropriate conversion we may calculate the value of E_N in terms of lb/TON oil produced

Ref 103 p443
hexane sp gr $\approx .659$
 $\# .659 \times 8.337 \approx 5.49 \frac{\text{lb}}{\text{gal}}$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 1-2-75

Source Vegetable Oil Production

Hydrocarbon cont'd

$$E_N: \quad .5 \frac{\text{gal HC}}{\text{TON seeds}} \times 5.49 \frac{\text{lb HS}}{\text{Gal}} \times \frac{\text{TON seeds}}{361 \text{ lb oil}} \times 2000 \frac{\text{lb}}{\text{TON}} = 15.2 \frac{\text{lb}}{\text{TON oil}}$$

$$\therefore E_N = 15.2 \text{ lb/TON vegetable oil produced}$$

E_u : Ref 002 pg 2-13

while giving a figure of .5 gal/ton seed for modern plants it states, that other less efficient plants emit 1 to 1½ gal per ton.

We assume that the typical plant will emit 1.25 Gal/ton seed which is $\frac{1.25}{.5} = 2.5$ times greater than the emission used in determining E_N

$$\therefore E_u = 2.5 \times E_N = 2.5 \times 15.2 = 38 \text{ lb/TON oil}$$

$$\therefore E_u = 38 \text{ lb/TON vegetable oil produced}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-2-75

Source Vegetable Oil Production

Hydrocarbon cont'd

E_s :

typical plant size for this industry was not obtained however by looking at soybean we may get a good feel for representative sizes.

Ref 247 Q132 1970 130 mills
 825×10^6 bushel capacity (60 lb/bushel)
(seeds)

$$825 \times 10^6 \frac{\text{bushel}}{\text{yr}} \times 60 \frac{\text{lb seed}}{\text{bushel}} = 49.5 \times 10^9 \frac{\text{lb seed (total)}}{\text{yr}}$$

using 130 mill and 350 d/yr operation

$$\text{Average Plant Size} = \frac{49.5 \times 10^9 \frac{\text{lb}}{\text{yr}} \times \frac{35}{350 \text{ d}} \times \frac{\text{TON}}{2000 \text{ lb}}}{130 \text{ mill}} = 544 \frac{\text{TON}}{\text{d}} \text{ seed input capacity}$$

this also represents $544 \frac{\text{TON seed}}{\text{day}} \times 361 \frac{\text{lb oil}}{\text{TON seed}} \times \frac{\text{TON}}{2000 \text{ lb}}$

98 $\frac{\text{TON}}{\text{day}}$ oil production capacity

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 1-2-75

Source Vegetable Oil Production

Hydrocarbon cont'd

E_s : an uncontrolled ^{average} plant emits : $38 \frac{\text{lb}}{\text{TON oil}} \times 98 \frac{\text{TON oil}}{\text{day}} = 3724 \frac{\text{lb}}{\text{day}}$

Making the interpretation that hexane is non-reactive we may review Ref 004 & 148 to determine a value for E_s .

Ref 002 Appendix gives location of most vegetable oil plants by state

31 states have vegetable oil plants. Of these 31 states, only one (Kentucky) has a regulation applicable to non-reactive solvents [3000 lb/day]. All other states are therefore assumed to permit E_u for non-reactive solvents.

Kentucky	3 plants	$E_{s_i} = 3000 \text{ lb/day limit}$
U.S. Total	246 plants	$E_{s_i} = E_u = 3724 \text{ lb/day}$

$$E'_s = \frac{3}{246} (3000) + \frac{243}{246} (3724) = 3715 \text{ lb/day}$$

and using $98 \frac{\text{TON oil}}{\text{day}}$; $E_s = \frac{3715 \text{ lb/day}}{98 \text{ TON/day}} = 37.9 \frac{\text{lb}}{\text{TON oil}}$

$\therefore E_s = 37.9 \text{ lb/TON vegetable oil produced}$

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Computation Sheet For Emission Factors

Calculations Done By W. Mannon Date 1-3-75

Source Vegetable Oil Production

Particulate

Emission Factors were not found in the literature however limited data was obtained in Ref 247 Appendix G for emission from various soybean processing operations

We will assume that an emission factor derived from the data may be applied to the whole vegetable oil industry especially since soybean oil represent 80% of the industry.

The data in Ref 247 App G gives emissions in terms of lb Part / ^{raw seed} processed or lb Part / bushel for the various process after specified control devices (generally cyclones). Control efficiency was not reported. We will synthesize an emission factor for the sum of the operations and assume an efficiency of 85% overall as probable for the plant tested. in order to arrive at a value of E_u .

The following conversion factor are used [Ref pg 2 Emission Factor of this industry]

- (1) 11 lb oil / bushel
- (2) 361 lb oil / raw seeds

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 1-3-75

Source Vegetable Oil Production

Particulate

cont'd

Ref 247 App G Table G-2 & G-3

E_u :

<u>Operation</u>	<u>Controlled Emission Factor Reported</u>	<u>Corrected ^{lb}/ton oil</u>
Hull toaster	.0025 lb/bu	.455
Flake Roll Aspir	.0038 lb/bu	.691
Primary Dehulling	.0095 lb/bu	1.727
Hull Screen & Conveyor	.00063 lb/bu	.115
Meal Cooler	.0056 lb/bu	1.018
Meal Dryer	.00031 lb/bu	.056
White Flake Cooling	.95 lb/TON seed	5.263
Forsberg Screens	.021 lb/TON seed	.116
		9.441

$$E' \cong 9.44 \text{ lb/TON oil}$$

This factor is believed to cover most emission sources from vegetable oil processing. Applying the assumed overall efficiency (85%) for the unknown plants above we may estimate E_u ;

$$E_u = \frac{9.44}{1-.85} \cong 63 \text{ lb/TON}$$

$$\therefore E_u = 63 \text{ lb/TON vegetable oil produced}$$

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Computation Sheet For Emission Factors

Calculations Done By 21. Monrone Date 1-3-75

Source Vegetable Oil Production

Particulate cont'd

E_N :

Ref 247 . Table 55 pg 137

The application of fabric filter, cyclone, and wet scrubber controls to various soybean processing operation achieve efficiencies as high as 99% or better

We assume that a level of 99% is achievable throughout the vegetable oil industry

$$\therefore E_N = .01 \times E_u = .01 \times 63 = .63 \text{ lb/ton oil}$$

$$\therefore E_N = .63 \text{ lb/TON veget. oil produced}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 1-3-75

Source Vegetable Oil Production

Particulate cont'd

From pg 4 of "Emission Factors" (HC) for this industry we see that the average plant size is about

544 $\frac{\text{TON}}{\text{day}}$ seed input or 98 $\frac{\text{TON}}{\text{day}}$ oil production

assuming 24 $\frac{\text{hr}}{\text{day}}$ then; Average Size $\approx 22.7 \frac{\text{TON}}{\text{hr}}$ seed input
 $\approx 4.1 \frac{\text{TON}}{\text{hr}}$ oil production

Process Weight Rate $22.7 \frac{\text{T}}{\text{hr}}$ or 45,400 lb/hr

Ref 002 Appendix

gives the distribution of vegetable oil processing plants such that we may tally the number per state. 31 states are shown to have processing mills. For the list presented there are 246 plants

We will ~~determine~~ ^{determine} an allowable emission (E_{si}) for each state from the Process Weight Table [Ref 084 5/148] using a process weight rate of 45,400 lb/hr input and then synthesize a E_s by weighting each state E_{si} by the fraction of the total mills in that state.

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 1-3-75

Source Vegetable Oil Production

Particulate cont'd

E_s State	No Plants	A_i	E_{si} lb/hr Allowable	$E_{si} \times A_i$
Alabama	9	.0366	24.0	.8784
Arizona	4	.0163	33.0	.5379
Arkansas	15	.0610	24.0	1.4640
California	20	.0813	31.5 +	2.5610
Delaware	1	.0040	*	.0040 $\times E_{s \text{ avg}}$
Florida	1	.0040	24.0	.0960
Georgia	12	.0488	33.0	1.6104
Illinois	27	.1098	33.0	3.6234
Indiana	4	.0162	33.0	.5346
Iowa	14	.0569	33.0	1.8777
Kansas	3	.0122	33.0	.4026
Kentucky	3	.0122	33.0	.4026
Louisiana	10	.0406	33.0	1.3398
Maryland	1	.0040	31.5	.1260
Mass	1	.0040	31.5	.1260
Minn	4	.0162	33.0	.5346
Miss	20	.0813	33.0	2.6829
Mo.	7	.0284	33.0	.9372
Neb	2	.0081	24.0	.1944
N.J.	3	.0122	30.0	.3660
N.M.	3	.0122	31.5	.3843
N.Y.	4	.0162	29.0	.4698
N.C.	8	.0325	33.0	1.0725
Ohio	5	.0203	33.0	.6699
Okla	3	.0122	33.0	.4026
Penn	1	.0040	*	.0040 $\times E_{s \text{ avg}}$
R.I.	1	.0040	33.0	.1320
S.C.	11	.0447	33.0	1.4751
Tenn	10	.0406	24.5	.9947
Tex	35	.1423	61.0	8.6803
Vir	4	.0162	33.0	.5346

TOTAL 246

* conc registration from $E_{si} = E_{s \text{ avg}}$
+ Ref 156 pg 37

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Computation Sheet For Emission Factors

Calculations Done By W. Marnone Date 1-3-75

Source Vegetable Oil Production

Particulate cont'd

E_s :

$$E_{sAug} = .008 E_{sAug} + \sum E_{si} \cdot A_i$$

$$E_{sAug} = .008 E_{sAug} + 35.1113$$

$$.992 E_{sAug} = 35.1113$$

$$E_{sAug} \cong 35.4 \text{ lb/hr}$$

With $4.1 \frac{\text{TON oil}}{\text{hr}}$ peak cap

$$E_s = \frac{35.4 \text{ lb Pt/hr}}{4.1 \frac{\text{TON oil}}{\text{hr}}} = 8.63 \text{ lb/TON vegetable oil produced}$$

$$E_s = 8.63 \text{ lb/TON vegetable oil produced}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hoyer Date 1/31/75

Source Whiskey

Ref (12) p 15

1970 Production = 917.5×10^6 gallons

From p 8-2 "The distilled spirits industry is currently operating near capacity...."

Assume, therefore,

$$K = 0.95$$

From Ref (12) p 8-3

$$P_c = 0.06$$

Assume simple

$$A = \left(\frac{917.5 \times 10^6}{.95} \right) [1 + (5)(.07)] = 1303.8 \times 10^6 \text{ gallons}$$

$$A = 1.304 \times 10^6 \text{ THOUSAND GALLONS}$$

Ref (12) p 8-3 5 plant closings in 1969

The number of plants in 1969 (p 1-5) was 155. Assuming equal size

$$P_b = \frac{5}{155} = 0.032$$

$$P_b = 0.032$$

simple

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hoyer

Date 11/3/75

Source Whiskey

Hydrocarbons

Ref (112) p61 gives a total HC emission factor of 183 grams/m³ of grain. Using the following conversion factors, we can get lb/1000 gals

5.14 gallons/bushel grain (Ref 112 p57)

28.378 BU/m³

454 grams/LB

$$\frac{\left(183 \frac{\text{GRAMS HC}}{\text{M}^3}\right) \left(1000 \text{ GALS}\right)}{\left(28.378 \frac{\text{BU}}{\text{M}^3}\right) \left(\frac{454 \text{ GRAM}}{\text{LB HC}}\right) \left(\frac{5.14 \text{ GALL}}{\text{BU}}\right)} = 2.76 \text{ LB/1000 GALS}$$

$$E_{\text{HC}} = 2.76 \text{ LB/1000 GALS}$$

NO CONTROLS ARE USED, HOWEVER A CARBON ADSORPTION UNIT APPEARS TO BE FEASIBLE. ASSUMING AN $\eta = 98\%$

$$E_{\text{NHC}} = (1 - .98) (2.76) = 0.0552$$

$$E_{\text{NHC}} = 0.055 \text{ LB/1000 GALS}$$

Since there are no applicable REGS, $E_S = E_U$

$$E_{\text{SHC}} = 2.76 \text{ LB/1000 GALS}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/31/75

Source Whiskey

Particulars

Ref (15) p 6.5-2 TAB 6.5-1

$$E_{Up} = (3+5) \text{ LB/TON GRAIN} \quad (\text{Handling \& drying})$$

Converting

$$\frac{\left(8 \frac{\text{LB P}}{\text{TON GR}}\right) \left(56 \frac{\text{# GRAIN}}{\text{BU}}\right) (10 \text{ US GALS})}{\left(2000 \frac{\text{LB GRAIN}}{\text{TON GRAIN}}\right) \left(5.14 \frac{\text{GAL}}{\text{BU}}\right)} = 43.6 \text{ LB/1000 GALS}$$

$$E_{Up} = 43.6 \text{ LB/1000 GALS}$$

From Ref (12) p 4-2 Cyclone separators & baghouses have been identified as applicable control systems for whiskey mfg. on p 4-3

$$\eta_{\text{cyclone}} \approx 90\%$$

$$\eta_{\text{baghouse}} \approx 95\%$$

Assuming that 95% is attainable across the board

$$E_{Np} = (1 - .95)(43.6) = 2.18 \text{ LB/1000 gals}$$

$$E_{Np} = 2.18 \text{ LB/1000 gals}$$

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Computation Sheet For Emission Factors

Calculations Done By Hogre Date 1/31/75

Source Whiskey

From Ref (12) p 1-5

In 1970 917.5×10^6 gallons from 155 plants
 From Ref (236) p 1-25 Plants operate 24 hrs/day, 7 days/wk

$$\frac{917.5 \times 10^6}{(155)(8760)} = 675.7 \frac{\text{gal}}{\text{hr-plant}}$$

$$\frac{\left(675.7 \frac{\text{gal}}{\text{hr}}\right) \left(56 \frac{\text{lb}}{\text{bu}}\right)}{5.14 \frac{\text{gal}}{\text{bu}}} = 7362 \frac{\text{lb}}{\text{hr}} \text{ grain handled}$$

This value is independent of the number of fermenters

Ref (12) p 1-5

$$\frac{94}{155} = 61\% \text{ of plants in Cal. \& Kentucky}$$

Using Ref (84), (148), (156) (LARGED) & the grain P AWC curve for the remaining 39% & Assuming Cal & Ky @ 30 1/2% each

Assume =

$$\begin{aligned} \text{Cal} &= 8.28 \text{ lb/hr} \\ \text{Ky} &= 9.8 \text{ lb/hr} \\ \text{Others} &= 10.0 \text{ lb/hr} \end{aligned}$$

$$E_{sp} = \frac{[8.28(.305) + (9.8)(.305) + 10.0(.39)] 2000}{675.7} = \frac{(2.525 + 2.989 + 3.9)(2000)}{675.7}$$

$$E_{sp} = 37.9 \text{ lb/1000 gms}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By K. Tower

Date 2/3/75

Source Pharmaceuticals

There is very little specific information regarding hazardous chemical emissions from pharmaceutical plants. We define mercury as the primary hazardous chemical emission. However it should be noted that potentially there are more, but no emission information could be found on emissions other than mercury.

We also assume that the emission of mercury (Hg) will correspond to the growth in the production of the pharmaceutical industry as a whole. Ref 095x gives a graph showing growth in the production of pharmaceuticals. From this graph we determine the growth rate of the pharmaceutical industry according to the following equation:

$$P_c = \sqrt[n_{66-1954}]{\frac{\text{Production 1966}}{\text{Production 1954}}} - 1.0$$

$$= \sqrt[12]{\frac{185 \times 10^6 \text{ lbs}}{66 \times 10^6 \text{ lbs}}} - 1.0 = .0897$$

$$P_c = .090$$

Compound

No specific information regarding the fractional utilization of the pharmaceutical industry so we assume it corresponds to the figure given by Ref 144, p.48, Table 1 for the chemical manufacturing industry as a whole $\rightarrow .83$

$$K = 0.83$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 2/3/75

Source Pharmaceuticals

Ref 095X gives the 1966 production of pharmaceuticals as 185×10^6 lbs/yr. We calculate A as follows:

$$A = \frac{\text{Prod}_{1975}}{K} = \frac{\text{Prod}_{1966} (1 + P_c)^{1975-1966}}{K}$$

$$= \frac{(185 \times 10^6 \text{ lbs})(1.090)^9}{(0.83)(2000 \text{ lbs/TON})} = .242 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$A = .24 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

From Ref 037, p.33, the allowable IRS guideline for "manufacture of chemicals and allied products..." is 11 years. Assuming twice the allowable:

$$P_B = \frac{1}{2(11)} = 0.045$$

$$P_{B \text{ simple}} = 0.045_{\text{simple}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower

Date 2/3/75

Source Pharmaceuticals

Ref 230, p. 7-9, Table 7-3 states that within the pharmaceutical industry 400 lbs Hg are emitted to the atmosphere for every ton of Hg used. Ref 270, p. 28 states that the U.S. consumed 5.5×10^6 lbs Hg in 1966 and that 5% of this amount was used by the pharmaceutical industry (Ref 270, p. 22). In addition the U.S. capacity for the production of pharmaceuticals is $.24 \times 10^6$ TONS (in 1966) as previously calculated. The uncontrolled emission factor for Hg can be calculated as follows:

$$E_u = \frac{\left(400 \frac{\text{lbs Hg emitted}}{\text{TON Hg used}}\right) \left(5.5 \times 10^6 \text{ lbs Hg}\right) (.05)}{\left(.24 \times 10^6 \text{ TONS pharmaceuticals}\right) \left(2000 \frac{\text{lbs}}{\text{TON}}\right)} = .229 \frac{\text{lbs Hg emitted}}{\text{TON Pharm. produced.}}$$

$$E_u = .229 \frac{\text{lbs Hg emitted}}{\text{TON Pharm. produced}}$$

Ref 216, p. 501 states that mercury vapors may be controlled by adsorption on iodine-impregnated carbon. No typical efficiencies could be found, however we will assume an 80% efficiency is possible.

$$E_N = \left(.229 \frac{\text{lbs}}{\text{TON}}\right) \times (0.20) = .046 \frac{\text{lbs}}{\text{TON}}$$

$$E_N = .046 \frac{\text{lbs Hg emitted}}{\text{TON Pharm. produced}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 2/4/75

Source Pharmaceuticals

There are no specific state regulations limiting there emission of mercury into the atmosphere. We therefore assume $E_s = E_u$.

$$E_s = .229 \frac{\text{lbs Hg emitted}}{\text{TON Pharm. produced}}$$

Since carbon adsorption system can generally be retrofit to existing plants we assume $E_{1110} = E_N$

$$E_{1110} = .046 \frac{\text{lbs Hg emitted}}{\text{TONS Pharm. produced}}$$

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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. The document contains Appendix 4C of Volume II - Calculation Sheets for the Food and Agricultural Industry.			
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