

DETERMINING INPUT VARIABLES FOR CALCULATION OF IMPACT OF NEW SOURCE PERFORMANCE STANDARDS: WORKSHEETS FOR MISCELLANEOUS SOURCES

by

The Research Corporation of New England
129 Silas Deane Highway
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Publication No. EPA-450/3-76-018-f

FOREWORD

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

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

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

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

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

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

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

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

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

DETERMINATION OF INPUT VARIABLES
FOR
EVAPORATION LOSS SOURCES

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hamer Date 9/12/74
 Source Decoising

REF (74) p III-62 STATES TOTAL ESTIMATED ANNUAL HYDROCARBON EMISSIONS RANGING FROM 1.3 TO 1.9 BILLION POUNDS PER YEAR. SINCE MOST DATA IN THIS REFERENCE ARE FROM 1968, WE WILL ASSUME THIS EMISSION TO BE IN 1968.

REF (34) p 2 TAB 1 STATES $E_U = 1.5 \frac{\#}{\text{TON METAL}}$
 CLEANED

$$\left(\frac{1.3 + 1.9}{2} \right) \left(10^9 \right) \frac{\#}{\text{YR}} = \left(1.5 \frac{\# \text{HC}}{\text{TON METAL}} \right) \left(\frac{\text{TON METAL}}{\text{YR}} \right)$$

$$\frac{\text{TONS METAL}}{\text{YR}} = 1.07 \times 10^9$$

No specific value of "K" could be located. However, ref (74) states that a large portion of degreasing operations occur in the automobile and aircraft industries (p III-62)

REF (144) INDICATES $K_{\text{AUTO}} = 0.91$ AND
 p 18 $K_{\text{MOUSE}} = 0.73$

$$K_{\text{AIRCRAFT}} = 0.73$$

We will use the average of these two values to be representative of DEGREASING OPERATIONS AS A WHOLE.

$$\begin{array}{r} 0.91 \\ 0.73 \\ \hline 2 \end{array}$$

$$\begin{array}{r} 16.4 \\ \hline 82 \end{array}$$

$$K = 0.82$$

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Computation Sheet For Industrial Factors

Calculations Done By Haze Date 9/18/74

Source Degreasers

REF (74) p II-62 states that trichloroethylene is the principal solvent used for degreasers. One method of determining the growth rate (P_c) for degreasers is to relate it to the growth of trichloroethylene. Increasing operations would be to relate it to the growth of trichloroethylene.

$$P_{c, \text{RE}} = 3.5\% \quad \text{REF (96)}$$

ANOTHER METHOD IS TO RELATE IT TO THE GROWTH IN THE PRODUCTION OF METAL PARTS WHICH MUST BE DEGREASERED. ONE LARGE INDUSTRY WHICH DOES A SUBSTANTIAL AMOUNT OF DEGREASING IS THE AUTOMOTIVE INDUSTRY. WORK DONE BY TRC ON THIS PROJECT SHOWED

$$P_{c, \text{AUTO}} = 2.9\% \quad \text{1957}$$

SEE "INDUSTRIAL FACTORS"
 FOR
 "AUTOMOBILE ASSEMBLY
 PLANTS"

WE WILL ASSUME THE AVERAGE

$$P_{c, \text{DEGREASING}} = 3.2\%$$

COMPOUND

$$A = \frac{1.07 \times 10^9 (1.032)}{(.82)} = 1.42 \times 10^9 \text{ TONS}$$

$$A = 1.42 \times 10^9 \text{ TONS TOTAL}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 10/25/74
 Source Degreasers

Def'n Of P_0

REF (37) p 34

IRS DEPRECIATION GUIDELINE FOR

"MANUFACTURE OF FABRICATED METAL PARTS" - 12 yrs

"MANUFACTURE OF OTHER MACHINES" - 12 yrs

ALSO FROM P 35

"MOTOR VEHICLE MANUFACTURING ASSETS" - 12 yrs

Assume $P_0 = f(2 \times \text{IRS GUIDELINE}) = 24 \text{ yrs}$

$$P_0 = \frac{100\%}{24 \text{ yrs}} = 4.17\%$$

$$P_0 = 0.0417$$

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Computation Sheet For Emission Factors

Calculations Done By Hansen Date 9/13/74

Source DEGREASING

HYDROCARBONS

Ref (34) p8 TAGI

$$E_N = 1.5 \frac{\#}{TON\ METAL}$$

Ref (46) p874

$\eta = 90\%$

CARBON ADSORPTION

$$E_N = 1.5(.1) = 0.15$$

$$E_N = 0.15 \frac{\#}{TON\ METAL}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By R. J. Londergan Date 10-25-74

Source Degreasing

HC: FHWA/R

From Ref. 34, p 8 TABLE 1, we know that a typical degreasing unit will clean 200,000 LB of metal /day.

This results in uncontrolled emissions of

$$(E_u = 1.5 \text{ LB/TON}) \times 100 \text{ TON/DAY} = 150 \text{ LB HC/DAY.}$$

Since many states do not have HC regulations which apply to stationary sources,* and we do not have a state-by-state distribution of degreasing process volume, we estimate E_s by the following procedure:

a) ~~FHWA/R~~ Sixteen (16) states have regulations governing HC emissions.* The typical regulation restricts emissions to either 40 LB/DAY or 85% emission control (in this case, the 40 LB/DAY limit would apply.)

b) The remaining states have no applicable regulations, hence for these $E_s^i = E_u^i$.

Assuming in order to estimate E_s that degreasing units are distributed uniformly among all states, we find

$$E_s \approx \frac{(16 \text{ STATES}) \times 40 \frac{\text{LB}}{\text{DAY}} + (34 \text{ STATES}) \times 150 \frac{\text{LB}}{\text{DAY}}}{50 \text{ STATES}} = 115 \frac{\text{LBHC}}{\text{DAY}}$$

(Continued next page)

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Computation Sheet For Emission Factors

Calculations Done By R. J. Londergan Date 10-25-74

Source Degreasing

HC . (Cont.)

Converting E_s to process weight units, we obtain

$$E_s = \left(\frac{115 \text{ LB HC}}{\text{DAY}} \right) / \left(\frac{100 \text{ TONS METAL}}{\text{DAY}} \right) \approx \frac{1.15 \text{ LB HC EMISSION}}{\text{TON METAL CLEANED}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marzone Date 8-7-74

Source Dry Cleaning

In Ref 075 pg 4.1-1 it is estimated that 18 lbs/capita per year are cleaned in moderate climates and 25 lbs/capita per year are cleaned in colder areas.

We will use an average value for the per capita usage rate.

$$\frac{18+25}{2} \equiv 22 \text{ lb/capita per year}$$

The US is probably represented more as a moderate zone on the average so that this average value may be slightly high.

A: According to a Telecom with Mrs Harris at the Bureau of the Census

$$\text{Pop resident 1974} = 211.3 \times 10^6 \text{ persons}$$

Range of Pop est 1975 213.4×10^6 to 215.9×10^6
 (a four step fertility range)

We will use an average population for 1975 of 214.6×10^6 persons

then: $\frac{22 \text{ lb cloth}}{\text{person}\cdot\text{yr}} \times 214.6 \times 10^6 \text{ persons} \times \frac{\text{Tons}}{2000 \text{ lb}}$

$A = 2.36 \times 10^6 \text{ Tons clothes/yr}$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-16-74

Source Dry Cleaning

K: Since the production capacity in tons ~~of~~ clothes are based on the population and a per capita usage factor. In this case, the utilization factor K has an interpretation of unity

$$K = 1$$

P_c : The dry cleaning of clothes is linked directly to the population. This is confirmed by using the usage factor of 22 lb/capita. for the estimate of total production capacity.

The growth of dry cleaning will then be identical to the population growth. This assumes a constant 22 lb/capita.

Ref 106	<u>Growth Rate %</u>	
	1969 - 1970	2.2
	1970 - 1971	2.17
	1971 - 1972	1.79

Ref: Telecom
 Bureau of
 Census
 Mr. Harris

1974 - 1975

2.8 high
 est 1.5
 1.8 low

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Computation Sheet For Industrial Factors

Calculations Done By 2). Marone Date 8-16-74

Source Dry Cleaning

P_c : cont'd

The recent trend in population growth has shown a definite decline in the rate.

(1960's)
 Historical info^v has report 3% pop growth rates whereas annual figures are dropping to nearly half that rate, in recent years

Growth is, oddly enough, influenced by many factors; economy, religion, morality, technology, health, politics, etc... It is difficult to predict the course of the current trend.

We believe that the growth rate has reached its minimum. As an estimate we will assume a 1.8% growth rate of 1.8% which corresponds to the lowest fertility rate est. Therefore:

$$P_c = .018 \quad \text{compounded}$$

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Computation Sheet For Industrial Factors

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

Source Dry Cleaning

Ref 037 pg 44 Section 70.2

Assume that dry cleaning obsolescence may be covered under this section of the IRS Table.

Asset guideline life 10 yrs

$P_B \text{ est } 2 \times \text{IRS} = 20 \text{ yrs}$

100% Depreciation in 20 yrs

$\frac{100\%}{20 \text{ yrs}} = 5\%/\text{yr}$
simple

$P_B = .05$ simple

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Computation Sheet For Emission Factors

Calculations Done By R.W. Marone Date 7-31-74

Source Dry Cleaning
Hydrocarbons

E_u : Reference 075 pg 4.2-2 Table 4.1-1

Uncontrolled HC emissions:

Petroleum Plants - 305 lb/Ton clothes
 Synthetic Plants - 210 lb/Ton clothes

the above source states that it is reported that 50% of the weight of clothes drycleaned today uses perchloroethylene (synthetic)

It is interesting to note that Ref 074 pg III-63 interprets incorrectly the above finding. It says that 50% of the plants use synthetic solvents however it is actually 50% of the weight of clothes and 70% of the plants.

Using the 50-50 breakdown by weight of clothes for synthetic and petroleum dry cleaning plants we calculate an average emission factor for uncontrolled dry cleaning source as;

$$E_u = \frac{305 + 210}{2} = 258 \text{ lb/ton clothes}$$

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Computation Sheet For Emission Factors

Calculations Done By William Marrone Date 8-7-74

Source Dry Cleaning

Hydrocarbons cont'd

: Ref 098 pg 4-32 Section 4.8.4 ;

water cooler — activated carbon control system is being used and is attractive to the synthetic plants in this industry. Overall efficiency achieved 97-98%.

Petroleum plants are not presently controlled to any extent basically due to economics.

Control is feasible by carbon adsorption or thermal incineration, however. We did not obtain from the literature efficiency estimates yet we may assume that at least a 95% eff could be achieved.

Since synthetic and petroleum plants handle equal weight of clothes we may estimate an average efficiency by

$$\frac{97.5 + 95}{2} = 96.25\%$$

We will use 96.5% eff

$$E_N = .035 \times E_u = .035 \times 258 \text{ lb/ton clothes}$$

$$= 9.03 \text{ lb/ton clothes}$$

$$E_N = 9 \text{ lb/ton clothes}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-10-74
Source Dry Cleaning

E_S : Hydrocarbons

Using the following data we estimate the typical plant size for both synthetic and petroleum dry cleaning plants.

- ① Average Emissions in terms of lb HC/day for an average plant based on a survey of 1000 synthetic plants and 200 petro plants
Ref 046 p879

Synthetic Plants: $30 \frac{\text{lb HC}}{\text{day}}$ for average plant

Petroleum Plant $175 \frac{\text{lb HC}}{\text{day}}$ for average plant

- ② Using uncontrolled emission factors from Ref 075 Table 4.1-1

$$E_{\text{syn}} = 210 \frac{\text{lb HC}}{\text{TON clothes}}$$

$$E_{\text{pet}} = 305 \frac{\text{lb HC}}{\text{TON clothes}}$$

- ③ 50% of the weight of clothes is dry cleaned in each type of dry cleaning plant

$$\frac{2.36 \times 10^6}{2} = 1.18 \times 10^6 \frac{\text{TON clothes}}{\text{yr}} \text{ or } \frac{1.18 \times 10^6}{365} = 3.23 \times 10^3 \frac{\text{TON clothes}}{\text{day}}$$

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Computation Sheet For Emission Factors

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

Source Dry Cleaning

Ξ_s : Hydrocarbons cont'd

$$\text{Typical Plant size: Synthetic} \quad j \quad \frac{30 \frac{\text{lb HC}}{\text{day}}}{210 \frac{\text{lb HC}}{\text{TAN clothes}}} = .143 \frac{\text{TAN cloth}}{\text{day per plant}}$$

$$\text{Petroleum} \quad j \quad \frac{175 \frac{\text{lb HC}}{\text{day}}}{305 \frac{\text{lb HC}}{\text{TAN clothes}}} = .574 \frac{\text{TAN cloth}}{\text{day per plant}}$$

$$\text{Number of Plants: Synthetic} \quad j \quad \frac{3.23 \times 10^3 \text{ TAN clothes/day}}{.143 \text{ TAN cloth/day / plant}} = 22.59 \times 10^3 \text{ plants}$$

$$\text{Petroleum} \quad j \quad \frac{3.23 \times 10^3 \text{ TAN cloth/day}}{.574 \text{ TAN cloth/day / plant}} = 5.63 \times 10^3 \text{ plants}$$

Relative Distribution by Type

$$\text{Synthetic} = \frac{22.59}{28.22} \approx 80\%$$

$$\text{Petroleum} = \frac{5.63}{28.22} \approx 20\%$$

This doesn't agree very closely with the 70/30% split identified under Eq calculation but is 75% sufficient agreement.

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Computation Sheet For Emission Factors

Calculations Done By W. Mannone Date 10-10-74

Source Dry Cleaning

E_s : hydrocarbons cont'd

We will obtain a "typical" plant size for the dry cleaning industry by applying the percentage breakdown or in a sense weighting the plant sizes between synthetic and petroleum plants.

$$\begin{aligned} \text{Typical Size} &= (.8 \times .113 + .2 \times .574) \frac{\text{Towels}}{\text{day}} \\ &= .1144 + .1148 \end{aligned}$$

$$T.S. \approx .229 \frac{\text{Tow clothes}}{\text{day}}$$

or

$$458 \text{ lb clothes / day}$$

$$\text{Emissions per plant} = .229 \frac{\text{Tow clothes}}{\text{day}} \times 258 \frac{\text{lb HC}}{\text{Tow clothes}}$$

$$\approx 59 \frac{\text{lb / day}}{} \text{ HC}$$

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Computation Sheet For Emission Factors

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

Source Dry Cleaning

is : cont'd Hydrocarbons

Since we have determined that the typical dry cleaning plant would emit 59 lb HC/day and j

- ① dry cleaning solvents (i.e. perchloroethylene; Stoddard's, etc) are non-reactive
- ② Most states have no limitation on non-reactive hydrocarbon emissions
- ③ Those states which have a regulation pertaining to non-reactive solvents either have a value identical to LA Rule 66 3000 lb/day or comparable (i.e. Connecticut 800 lb/day)
- ④ No state limits the emission of non-reactive hydrocarbons to a level less than 59 lb/day

We determine that for non-reactive treatment of dry cleaning emissions, the value of E_s would in reality be much larger than E_u . In this case, we will assume that E_s (to be applied) will be identical to E_u .

$$E_s = 258 \frac{\text{lb HC}}{\text{TON clothes}}$$

This is equivalent to 59 lb/day

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By K.Tower

Date 1/2/75

Source Graphic Arts

The printing and publishing industry is composed of more than 40,000 establishments and is recognized as the domain of the small businessmen since 80 percent of these establishments employ fewer than 20 persons. (Ref 050, p. 1)

In the printing industry the term "production rate" is rather ambiguous since the product of the industry is the placing of a printed image on paper, metal, plastic or other material. We have decided that the best parameter to use to define the industry is the ink usage for each printing process. There are five printing processes which account for the majority of ink consumption and almost all of the major pollutant of the industry — hydrocarbons. These five processes are the following:

- 1) Gravure
- 2) Flexography
- 3) Lithography
- 4) Letterpress
- 5) Metal Decorating

Therefore we have organized this industry by giving A , E_4 , E_N & E_S values for each of the five printing processes. Because of the lack of substantial data we give K , P_C & P_B values for the industry as a whole. Industrial factors are expressed as TONS of ink consumed/yr while emission factors are expressed as lbs of hydrocarbons/TON of ink consumed.

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 1/2/75

Source Graphic Arts
p.2

Ref. 050¹ states that the growth rate of ink usage is expected to remain at 5% each year. This we assume is an accurate assessment of the growth of the printing industry as a whole.

$$P_c = .050 \\ \text{compound}$$

There was no specific data relating production to capacity for the individual printing operations so we assumed that the fractional utilization rate of the printing industry the same as that given by ref. 144 for all machinery manufactures (except electrical) $\rightarrow .88$. This value represented an average value for the years 1965-1973.

$$K = 0.88$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 1/2/75
 Source Graphic Arts

Ref 050, p.8 gives the following table of ink consumption and solvent emission from the printing industry in 1968. All printing operations consume additional solvent to that supplied in the inks. The total solvent used for each printing process was obtained therefore by totaling the solvent from the ink and the solvent used for cleanup washes, additives, thinners, etc. We make the assumption that all this solvent evaporates and is emitted to the atmosphere.

Printing Process	Ink Coating (million lb)	% Solvent in Ink coating	Total Estimated Solvent Used (million lb.)
Gravure	153.0	40	177*
Flexography	66.5	80	160*
Lithography	81.5	35	114
Letterpress	143.0	35	105
Metal Decorating	60.5	60	112

*This value is different from that actually shown in the table from ref 050, which was 0. 0 appears to be in error so we calculated the actual value using $\frac{\text{solvent not in ink}}{\text{solvent in ink}}$ ratios shown in ref 050, p. 7.

$$\begin{aligned}
 A_{\text{Gravure}} &= \frac{\text{Prod. } 1968}{K} (1 + P_c) \\
 &= \frac{153.0 \times 10^6 \text{ lbs}}{.88} \left(1 + .050\right)^7 = .122 \times 10^6 \frac{\text{TONS INK}}{\text{yr}}
 \end{aligned}$$

$$A_{\text{Gravure}} = 0.122 \times 10^6 \frac{\text{TONS INK}}{\text{yr}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K.Tower Date 1/2/75

Source Graphic Arts

$$A_{Flexography} = \frac{\text{Prod. } 1968}{K} (1 + P_c)^{1975-1968}$$

$$= \frac{(66.5 \times 10^6 \text{ lbs}) (1 + .050)^7}{(.88)(2000 \text{ lbs/ton})} = .053 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$A_{Flexography} = .053 \times 10^6 \frac{\text{TONS}}{\text{YR}} \text{ INK}$

$$A_{Lithography} = \frac{\text{Prod. } 1968}{K} (1 + P_c)^{1975-1968}$$

$$= \frac{(81.5 \times 10^6 \text{ lbs}) (1 + .050)^7}{(.88)(2000 \text{ lbs/ton})} = .065 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$A_{Lithography} = .065 \times 10^6 \frac{\text{TONS}}{\text{YR}} \text{ INK}$

$$A_{Letterpress} = \frac{\text{Prod. } 1968}{K} (1 + P_c)^{1975-1968}$$

$$= \frac{(143.0 \times 10^6) (1 + .050)^7}{(.88)(2000 \text{ lbs/ton})} = .114 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$A_{Letterpress} = .114 \times 10^6 \frac{\text{TONS}}{\text{YR}} \text{ INK}$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 1/2/75

Source Graphic Arts

$$A_{Metal\ Decorating} = \frac{P_{Prod, 1968}}{K} (1 + P_c)^{\frac{1975-1968}{7}}$$

$$= \frac{(60.5 \times 10^5 \frac{\text{lbs}}{\text{yr}})(1 + .050)^7}{(.88)(2000 \frac{\text{lbs}}{\text{ton}})} = .048 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$A_{Metal\ Decorating} = .048 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

Ref. O37, p. 33, section 27.0 states that the asset guideline period for printing, publishing and allied industries is 11 yrs. Assuming twice the IRS allowable:

$$P_B = \frac{1}{(2)(11)} = .045$$

$$P_B = .045$$

simple

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/2/75

Source Graphic Arts

Referring to the previous table (ref 050, p.8), E_u values for each of the printing processes can be obtained by dividing the total estimate of solvents used by total amount of ink coating used. We assumed all the solvent used was emitted to the atmosphere.

$$E_u_{\text{Gravure}} = \frac{177 \times 10^6 \text{ lbs emissions} (2000 \frac{\text{lbs}}{\text{TON}})}{(153.0 \times 10^6 \text{ lbs Ink Used})} = 2300 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Gravure}} = 2300 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Flexography}} = \frac{160 \times 10^6 \text{ lbs emissions} (2000 \frac{\text{lbs}}{\text{TON}})}{(66.5 \times 10^6 \text{ lbs Ink Used})} = 4800 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Flexography}} = 4800 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Lithography}} = \frac{114 \times 10^6 \text{ lbs emissions} (2000 \frac{\text{lbs}}{\text{TON}})}{(81.5 \times 10^6 \text{ lbs Ink Used})} = 2800 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Lithography}} = 2800 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Letterpress}} = \frac{105 \times 10^6 \text{ lbs emissions} (2000 \frac{\text{lbs}}{\text{TON}})}{(143.0 \times 10^6 \text{ lbs. Ink Used})} = 1500 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

$$E_u_{\text{Letterpress}} = 1500 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/2/75

Source Graphic Arts

$$E_u = \frac{112 \times 10^6 \text{ lbs emissions (2000 lbs)}}{60.5 \times 10^6 \text{ lbs Ink Used}} = 3700 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

$$E_u = 3700 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

Ref 050 pg states that efficiencies of up to 99.9% can be obtained on Gravure printing processes with the use of adsorption.

$$E_N = .001 \times E_u = .001 \times 3700 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}} = 3.7$$

$$E_N = 2.3 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

Ref 050, p.6 also states that efficiencies up to 99% can be obtained on all printing processes with the use of thermal incineration.

$$E_N = 4800 \frac{\text{lbs}}{\text{Ton}} \times .01 = 48 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

$$E_N = 48 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

$$E_N = 2800 \frac{\text{lbs}}{\text{Ton}} \times .01 = 28 \frac{\text{lbs}}{\text{Ton}}$$

$$E_N = 28 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

$$E_N = 1500 \frac{\text{lbs}}{\text{Ton}} \times .01 = 15 \frac{\text{lbs}}{\text{Ton}}$$

$$E_N = 15 \frac{\text{lbs hydrocarbons}}{\text{Ton Ink Used}}$$

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Computation Sheet For Emission Factors

Calculations Done By K.Tower

Date 1/2/75

Source Graphic Arts

$$E_N = 3700 \frac{\text{lbs}}{\text{TON}} \times .01 = 37 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

Metal
Decorating

$$E_N = 37 \frac{\text{lbs hydrocarbons}}{\text{TON Ink Used}}$$

Metal
Decorating

Recent experimentation (ref. 050, p.6) shows the possibility of reducing these emissions still further with use of low solvent and water solvent inks.

Ref 050, p.8 states that based on measured emissions only lithography and metal decoration will be required to control emissions. Therefore $E_s = E_u$ for Gravure, Flexography and Letterpress printing operations.

$$E_s = 2300 \frac{\text{lbs hydrocarbons}}{\text{TON Ink used}}$$

Gravure

$$E_s = 4800 \frac{\text{lbs hydrocarbons}}{\text{TON Ink used}}$$

Flexography

$$E_s = 1500 \frac{\text{lbs hydrocarbons}}{\text{TON Ink used}}$$

Letterpress

Ref 248, p. 155 gives some coating process parameters for a metal decorating printing operation. We assume this plant to be an average plant.

127.2 $\frac{\text{lbs}}{\text{hr}}$ ink consumption

41 % solvent

$$127.2 \frac{\text{lbs}}{\text{hr}} \times .41 = 52.2 \frac{\text{lbs solvent emitted}}{\text{hr.}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 1/2/75
 Source Graphic Arts

Ref 050, p. 8 states that over half of all commercial printing is performed in four states: New York, Illinois, Pennsylvania, and California. All of these states have enacted regulations similar to the L.A. rule 66 which states that emissions of all solvents which are heated must be limited to $3 \frac{\text{lbs}}{\text{hr}}$, $15 \frac{\text{lbs}}{\text{day}}$ or be reduced by 85%.

In order to compute E_s for metal decorating we made the following assumptions:

- 1) The average metal decorating printing process emits $52.2 \frac{\text{lbs soli}}{\text{hr}}$ (ref 248, p. 1)
- 2) Since 85% reduction of $52.2 \frac{\text{lbs}}{\text{hr}}$ gives a value ($7.8 \frac{\text{lbs}}{\text{hr}}$) greater than $3 \frac{\text{lbs}}{\text{hr}}$, the applicable regulation for those states which operate under rule 66 is 85% reduction of emissions
- 3) For those states (73%) which do not have hydrcarbon regulation $E_s = E_u$. ref 84, p. 69-72.
- 4) For those states (27%) which do have hydrcarbon regulations their emission regulation is equal to E_s . ref 84, p. 69-72
- 5) 41% of ink used in an average metal decorating plant is solvent and is emitted to the atmosphere. (ref 248, p. 155)
- 6) 50% of all metal decorating plants operate under L.A. rule 66

$$E_{\text{allowable}} = \frac{(41 \text{ lbs hydrcarbons})(2000 \frac{\text{lbs}}{\text{ton}})}{100 \text{ lbs Ink used}} \times .15 = 123 \frac{\text{lbs hydrcarbons}}{\text{ton Ink used}}$$

$$E_s = .50(123 \frac{\text{lbs}}{\text{ton}}) + .50[(.27)(E_s) + .73(3700 \frac{\text{lbs}}{\text{ton}})]$$

$$E_s = 61.5 + .135 E_s + 2701 = \frac{61.5 + 2701}{.865} = 3193 \frac{\text{lbs}}{\text{TON}}$$

$$E_s = 3200 \frac{\text{lbs hydrcarbons}}{\text{TON Ink Used}}$$

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Computation Sheet For Emission Factors

Calculations Done By K.Tower

Date 1/3/75

Source Graphic Arts

For determination of E_s for lithography we only considered emissions from web offset type of printing operations.

Ref 050 p.5 gives a range of emission rates from web offset dryer exhausts. The average for a 2 color operation is 6.1 lbs/hr . The average for a 4 color operation is 14.5 lbs/hr . We assume the average emission rate for all web offset operations to be the average of these two values:

$$\text{Average Emission} = \frac{6.1 + 14.5}{2} = 10.3 \frac{\text{lbs hydrocarbons}}{\text{hr}}$$

Ref 050, p.8 gives the average % solvent in lithographic ink coating as 35%. Assuming the $10.3 \frac{\text{lbs}}{\text{hr}}$ results entirely from the solvent the following calculation can be made:

$$\text{Avg. } \frac{\text{TONS INK USED}}{\text{HR}} = \frac{10.3 \frac{\text{lbs}}{\text{hr}}}{(0.35)(2000 \frac{\text{lbs}}{\text{TON}})} = .015 \frac{\text{TONS}}{\text{HR}}$$

$85\%^{reduction}$ of $10.3 \frac{\text{lbs}}{\text{hr}}$ gives an emission rate of $1.5 \frac{\text{lbs}}{\text{hr}}$. This is below $3 \frac{\text{lbs}}{\text{hr}}$ so for those states which have enacted A. rule 66, the applicable regulation is $3 \frac{\text{lbs}}{\text{hr}}$.

In order to compute E_s for lithography we make the following additional assumption:

- 1) 50% of all plants using lithographic printing operate under L.A. Rule 66.
- 2) For the states which do not have hydrocarbon regulations (73%) $E_s = E_u$.
- 3) For the states which do have hydrocarbon regulations (27%), their emission regulation is equal to E_s .

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Computation Sheet For Emission Factors

Calculations Done By K.Tower

Date 1/3/75

Source Graphic Arts

$$E_s = .50 \left(\frac{3 \frac{\text{lbs}}{\text{hr}}}{.015 \frac{\text{TON}}{\text{HR}}} \right) + .50 \left[.27(E_s) + .73(2800 \frac{\text{lbs}}{\text{TON}}) \right]$$

$$= 100 \frac{\text{lbs}}{\text{TON}} + .135E_s + 2044 \frac{\text{lbs}}{\text{TON}}$$

$$= \frac{2144 \frac{\text{lbs}}{\text{TON}}}{.865} = 2478 \frac{\text{lbs}}{\text{TON}}$$

$$E_s = 2500 \frac{\text{lbs hydrocarbons}}{\text{TON INK USED}}$$

Lithography

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By _____ Date 9/17/74

Source Petroleum Storage & Transfer - Tanks

REF (74) pII-32 indicates the following breakdown for methods of crude oil transfer to refineries.

75.8% - Pipeline

23.0% - Water (marine)

1.2% - Tank cars & trucks

Although there are emissions inherent in pipeline transfer, they will not presently be part of this study.

Reference is made to "Industrial Factors" calculation sheet for "PETROLEUM STORAGE AND TRANSFER - TANKS" for much of the info for this transfer analysis.

Crude Oil

1968 Crude oil throughput = 10×10^9 barrels

OR 3.8×10^{10} m³

Growth (P_c) is assumed to be the same as that for "TOTAL LIQUID HYDROCARBONS" REF (95) 229.3020A

$$P_{Crude} = \sqrt{\frac{1971}{1960}} - 1.0 = \sqrt{\frac{5600}{3550}} - 1$$

$$P_{Crude} = 4.22\% \text{ compd}$$

The "K" factor will be determined from the ratio of refinery production to capacity.

$$K = \frac{11 \times 10^6}{13 \times 10^6} = 0.85$$

REF (74) PII-29

$$K = 0.85$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hornbeck Date 9/17/74

Source Petroleum S&T - Transfer

$$A_{\text{TOTAL CRUDE}} = \frac{(3.8 \times 10^9 \text{ bals})(1.0422)}{0.85} = 5.97 \times 10^9 \text{ bals}$$

HOWEVER, ONLY 23.0% + 1.2% IS HANDLED BY WATER OR TANKER.

SINCE NO INFORMATION COULD BE FOUND REGARDING THE MODES (AND %'S) OF TRANSPORT OF FINISHED PRODUCTS FROM THE REFINERY, MARINE & TANKER TRANSPORT WILL BE TREATED TOGETHER AS NON PIPELINE TRANSFER.

$$A_{\text{CRUDE TRANSFER}} = (5.97 \times 10^9)(.242) = 1.44 \times 10^9$$

$$A_{\text{CRUDE TRANSFER}} = 1.44 \times 10^9 \text{ bals}$$

NO DIRECT INFORMATION COULD BE LOCATED REGARDING WHAT FRACTION OF FINISHED PETROLEUM PRODUCTS ARE TRANSPORTED BY PIPELINE. THE FOLLOWING ANALYSIS PRESENTS AN ESTIMATION FOR THE PURPOSE OF THIS STUDY.

- ① BULK STATIONS HAVE CAPACITIES LESS THAN 2,000,000 GALS GENERALLY (REF #4 p III-48) & THE PETROLEUM PRODUCTS DELIVERED TO THESE TANKS COME VIA TANKER, TRUCK OR BOAT (REF #8 p 4-9, FIG 4-2).
- ② TERMINALS HAVE CAPACITIES GREATER THAN 2,000,000 GALS GENERALLY (REF #4 p III-48) & THE PETROLEUM PRODUCTS ARE DELIVERED TO THE TANKS BY PIPELINE (REF #8 p 4-9, FIG 4-2)

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 9/17/74

Source Petroleum Storage; Tanker-Transfer

Ref 74 p-III-45 TAB III-21 INDICATES A THROUGHPUT OF

$$804 \times 10^6 \times 10 = 2.04 \times 10^9 \text{ BBLS GASOLINE}$$

$$\frac{2,000,000 \text{ GALS}}{42 \frac{\text{GAL}}{\text{BBL}}} = 47,619 \text{ BBLS}$$

THE THROUGHPUT FOR TANKS OF 50,000 GALS OR LESS CAN BE DET'D FROM DATA ON TAB III-21

$$\begin{aligned} & (1965 \text{ TANKS}) \left(200,000 \frac{\text{BBL}}{\text{TANK}} \right) + (1143 \text{ TANKS}) \left(400,000 \frac{\text{BBLS}}{\text{TANK}} \right) \\ & + \frac{(762 \text{ TANKS}) \left(600,000 \frac{\text{BBLS}}{\text{TANK}} \right)}{2} = .393 \times 10^9 + .457 \times 10^9 + .229 \times 10^9 \\ & = 1.079 \times 10^9 \text{ BBLS} \end{aligned}$$

OF 2.04×10^9 BBLS OF GASOLINE, 1.079×10^9 BBLS ARE ROUTED THRU TANKS LESS THAN 50,000 BBLS.

$\therefore \frac{1.079}{2.04} = 53\%$ OF GASOLINE HANDLED GOES THRU TANKS LESS THAN 50,000 BBL CAPACITY OR BULK STATIONS. THE REMAINDER (47%) IS, THEREFORE, ROUTED TO TERMINALS (BY PIPELINE)

FOR THE ANALYSIS, WE WILL ASSUME THAT ALL THE PETROLEUM PRODUCTS ARE SIMILARLY ROUTED.

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 9/18/74

Source Petroleum SFT - Transfer

Motor Gasoline

$$A_{gas} = \frac{123.9 \times 10^9 \text{ gals}}{42 \frac{\text{gals}}{\text{BBL}}} = 2.95 \times 10^9 \text{ BBLs}$$

As previously determined, 53% is handled by tank, tankcar or boat. So, the value of "A" for non-pipeline transfer is

$$A_{gas} = (2.95 \times 10^9 \text{ BBLs})(.53) = 1.56 \times 10^9$$

$$A_{gasoline} = 1.56 \times 10^9 \text{ BBLs}$$

Also, determined previously,

$$K = 0.85$$

$$P_{C_{gas}} = 3.46 \% \quad \text{cmfd}$$

Aviation Gas

$$A_{avgas} = \frac{2.82 \times 10^9 \text{ gals}}{42 \frac{\text{gals}}{\text{BBL}}} = 67.1 \times 10^6 \text{ BBL}$$

$$A = 67.1 \times 10^6 (.53) = 35.6 \times 10^6 \text{ BBL}$$

$$A_{avgas} = 35.6 \times 10^6 \text{ BBL}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoyer Date 9/18/74

Source Petroleum S-T - Transfer

As determined previously,

$$K = 0.85$$

$$P_{C_{AV}} = 9.4\% \text{ cmho}$$

SPECIAL MATERIALS

$$A_{TNT} = \frac{1.4 \times 10^9 \text{ GALS}}{42 \frac{\text{GAL}}{\text{BBL}}} \times .53 = 17.7 \times 10^6 \text{ BBLs}$$

$$A_{\text{MATERIAL}} = 17.7 \times 10^6 \text{ BBLs}$$

As determined
previously,

$$K = 0.85$$

$$P_{C_{SP. MAT}} = 0.7\% \text{ cmho}$$

JET FUEL

$$A_{JET FUEL} = \frac{11.6 \times 10^9 \text{ GALS}}{42 \frac{\text{GAL}}{\text{BBL}}} \times .53 = 146 \times 10^6 \text{ BBLs}$$

$$A_{JET FUEL} = 146 \times 10^6 \text{ BBLs}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/18/74

Source Petroleum Sht - Transfer

As previously der'd

$$K = 0.85$$

$$P_{C_{jet}} = 9.4\% \text{ fuel}$$

CMPO

Kerosine & distillate fuel oil will not be analyzed due to their low vapor pressures.

P_B

For crude transfer:

10/11/74

DATA ON P_I OF THESE CALC'S GIVE BREAKDOWN AS FOLLOWS

75.8% (pipeline) ← not applicable to this study
 23.0% (marine)
 1.2% (TANK CARS & TRUCKS)

From ref (37) p 29

IRS depreciation guideline = 6 yrs for trailer mounted containers

Assume twice = 12 yrs

IRS depreciation guideline = 18 yrs for vessels, barges, tugs

Assume twice = 36 yrs

$$P_B = \frac{1}{\left(\frac{23}{34.2}\right)(36) + \left(\frac{1.2}{34.2}\right)(12)} = \frac{1}{34.21 + .60} = 0.029$$

$$P_{B_{CRUDE}} = 0.029$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 10/11/74

Source Petroleum S&T - Transfer

For all other fluids, we have no % breakdown
 as to transfer by marine or road conveyance.
 Assume, therefore 50/50.

Same refs as p 6 of these calc's

$$P_B = \frac{1}{36(.5) + 12(.5)} = \frac{1}{18+6} = \frac{1}{24}$$

$$P_B_{\text{ALL OTHER FLUIDS}} = 4.17\% = .0417$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hause Date 9/18/74

Source Petroleum Storage & Transfer - Transfer

Since we are dealing with transfer, working losses will be the major source of emissions. It is recognized THAT THERE WILL BE SOME BREATHING LOSSES DURING TRANSIT BUT THESE ARE CONSIDERED TO BE NEGIGIBLE.

EU & EN for working losses for the fluids of concern have been previously determined for storage tanks. We will assume that tank cars, trucks & marine vehicles are "portable storage tanks" and, therefore, subject to the same emissions.

Summary:

	EU	EN
	# %	
✓ Motor Gasoline	0.116	0.0116
Crude Oil	0.084	0.048
✓ Aviation Gas	0.116	0.055
✓ Special Naptha	0.116	0.056
✓ Jet Fuel	0.116	0.054

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 10/11/74

Source Petroleum S/T - Transfer

E_S

Use SAME assumptions & references used for
 "Petroleum Storage & Transfer - Tanks" Emission Factors

$$E_{S_{GAS}} = \left(\frac{22}{51}\right)(.016) + \left(\frac{29}{51}\right)(.116) = .005 + .066 = .071$$

$$E_{S_{GAS,INE}} = 0.071 \text{ #/BBL}$$

$$E_{S_{ANGAS}} = \left(\frac{22}{51}\right)(.055) + \left(\frac{29}{51}\right)(.116) = .0237 + .066$$

$$E_{S_{ANGAS}} = 0.090 \text{ #/BBL}$$

$$E_{S_{SP.NAP.}} = \left(\frac{22}{51}\right)(.056) + \left(\frac{29}{51}\right)(.116)$$

$$E_{S_{SP.NAP.}} = 0.09 \text{ #/BBL}$$

$$E_{S_{JETFUEL}} = 0.09 \text{ #/BBL}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 10/11/74
 Source Petroleum S & T - Transfer

$$E_{\text{S}_{\text{CRUDE}}} = \left(\frac{18}{51} \right) (.048) + \left(\frac{33}{51} \right) (.084)$$

$$E_{\text{S}_{\text{CRUDE}}} = 0.071 \text{ #/BBL}$$

Summary Of Es: #/BBL

	EXISTING	NEW
GASOLINE	.071	.0116
CRUDE	.071	.048
AV GAS	.090	.055
SP. NAP.	.090	.056
JET FUEL	.090	.054

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 9/18/74

Source Petroleum Storage & Transfer - Refueling

Values of K , A , P_c have been determined for gasoline in previous calculations by TRC for this study. They are summarized below

$$A = 2.95 \times 10^9 \text{ sec}$$

$$K = 0.85$$

$$P_{c,gas} = 3.46\% \text{ compd}$$

This P_c is based on the following assumptions:

- (1) Automobile gas mileage remains constant between 1975 & 1985
- (2) Number of miles driven per year per car remains constant between 1975 & 1985

These assumptions are, however, subject to the uncertainties of the energy crisis, auto mfg, & state of the economy?

P_B REF (37) P 29 Depreciation for autos = 3 yrs
 Assume twice the IRS allowable = 6 yrs

$$(6 \text{ yrs}) / (12,000 \frac{\text{mi}}{\text{yr}}) = 72,000 \text{ mi} \quad P_B = \frac{t}{6} = 0.167$$

$$P_B = 0.167$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 9/18/74

Source Petroleum Storage & Transfer - Refueling

REF (75) p 4.4-2 TAB 4.4-1 STATES

$$E_U = 12 \frac{\#}{1000\text{gal}}$$

$$(0.012)(12 \frac{\#}{\text{gal}}) = 0.504 \frac{\#}{\text{gal}}$$

$$E_U = 0.504 \frac{\#}{\text{gal}}$$

REF (31) p 26

Overall efficiencies of 85% can be expected from good vapor collection & recovery systems.

$$E_N = 0.504(1.15) =$$

$$E_N = 0.0756 \frac{\#}{\text{gal}}$$

There are no stateregs for automobile refueling 10/11/74

$$\therefore E_S = E_U = .504$$

$$E_{S_{EXIST}} = 0.504 \frac{\#}{\text{BBL}}$$

$$E_{S_{NEW}} = 0.0756 \frac{\#}{\text{BBL}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hause Date 9/18/74

Source Petroleum Storage & Transfer - Service Stations

Ref (3) p III-10 states 1968 gasoline throughput of 83×10^9 GACS

Values of K & P_c have been previously determined to be

$$K = 0.85$$

$$P_{\text{gasoline}} = 3.46\% \text{ CMO}$$

"Industrial Factors" calculation sheet for "Petroleum Storage & Transfer - Tanks"

$$A = \left(\frac{83 \times 10^9 \text{ GACS}}{42 \frac{\text{GAL}}{\text{BBL}}} \right) \left(1.0346 \right)^2 \left(\frac{1}{0.85} \right) = 2.95 \times 10^9 \text{ BBLs}$$

$$A_{\text{gasoline}} = 2.95 \times 10^9 \text{ BBLs}$$

Ref 37 p 31

IRS depreciation guideline = 16 yrs
 USE twice the guideline = 32 yrs

$$P_d = \frac{1}{32}$$

$$P_d = 0.031$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 9/18/74

Source Petroleum Storage & Transfer - Service Stations

REF (75) p 4.4-2 TAB 4.4-1

$$E_U = 9 \frac{\#}{1000\text{gal}} \quad (\text{FOR 50/50 breakdown of splash, submerged fill})$$

$$0.009 \frac{\#}{\text{gal}} \times \frac{42 \frac{\text{gal}}{\text{BBL}}}{\text{BBL}} = 0.378 \frac{\#}{\text{BBL}}$$

$$E_U = 0.378 \frac{\#}{\text{BBL}}$$

REF (75) p 4.4-2 TAB 4.4-1 STATES

$$E_N = 0.8 \frac{\#}{1000\text{gal}} \quad \text{WITH VAPOR REVEN SYSTEM}$$

$$(0.0008 \frac{\#}{\text{gal}}) \left(42 \frac{\text{gal}}{\text{BBL}} \right) = 0.0336 \frac{\#}{\text{BBL}}$$

R-91?

$$E_N = 0.0336 \frac{\#}{\text{BBL}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoyer Date 10/10/74
 Source Petroleum Storage & Transfer - Service Stations

Detail of \bar{E}_S : Use same ref's & assumptions used
 for "Petroleum Storage & Transfer - Tanks" Emission Factors

$$\bar{E}_S = \left(\frac{22}{51}\right)(.0336) + \left(\frac{29}{51}\right)(.378) = .0145 + .2149$$

$$\bar{E}_{S_{\text{EXIST}}} = 0.229 \frac{\#}{BBL}$$

$$\bar{E}_{S_{\text{NEW}}} = 0.034 \frac{\#}{BBL}$$

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 7/13/74

Source Petroleum Storage & Transfer - Tanks

PETROLEUM PRODUCTS ARE STORED IN TANKS OF VARIOUS SIZES & AT VARIOUS LOCATIONS ALONG THEIR PATHS OF DISTRIBUTION. OUR ANALYSIS WILL COVER THE STORAGE OF THE FOLLOWING PETROLEUM PRODUCTS:

- (1) PETROLEUM
- (2) MOTOR GASOLINE
- (3) AVIATION GASOLINE
- (4) SPECIAL NAPHTHA
- (5) JET FUEL (NAPHTHA + KEROSENE)
- (6) KEROSENE
- (7) DISTILLATE FUEL OIL

RESIDUAL FUEL OIL WILL NOT BE INCLUDED DUE TO ITS LOW VAPOR PRESSURE.

OUR ANALYSIS WILL COVER THE STORAGE OF THESE LIQUIDS AT

- (1) THE REFINERY
- (2) BULK STATIONS & TERMINALS

The major ref for this work is 74. Unless otherwise specified only page & table numbers will be quoted.

THE FOLLOWING TABLE SUMMARIZES INFO FROM REF 74

PRODUCT	1968 CAPACITY (REFINERY)	1968 TANKS IN. ¹	THROUGHPUT ²
MOTOR GASOLINE	~ 1	17	83
CRUDE OIL	137	~ 6	~
AV GAS /	14.0	5.8	1.28
SP. NAPHTHA	...	5	1.134
JET FUEL /	48.6	17.4	5.31
KEROSENE /	16.3	29.6	—
DIST. FUEL OIL /	346.2	169.5	—

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 9/13/74

Source Petroleum Storage & Transfer - Tanks

(1) $\times 10^6$ BBL

(6) REF (74) P III - 37

(2) $\times 10^9$ GAL

(7) " " P III - 38

(3) P III - 43

$$(304 \times 10^6)(13)(42) = 166 \times 10^7 \text{ gal.}$$

(4) BASED ON

THROUGHPUT TO CAPACITY RATIO FOR CRUDE OIL

REF (74) P III - 37

$$\text{THROUGHPUT} = 3.8 \times 10^9 \text{ BBLs}$$

$$= 160 \times 10^9 \text{ gals}$$

(5) P III - 50 off TAB III-24, 25

We will use REF (95) 229.3020A, B TO DETERMINE GROWTH RATES. DATA REFLECTS CONSUMPTION. WE WILL ASSUME THAT CAPACITY & THROUGHPUT INCREASE @ THE SAME RATE AS CONSUMPTION INCREASES.

(1) More gasoline - REF (95) 229.3020A

$$P_{C_{gas}} = \sqrt{\frac{1971}{1960}} - 1.0 = \sqrt{\frac{2213.2}{1511.7}} - 1.0 = 3.46\%$$

$$P_{C_{gasoline}} = 3.46\% \text{ compound}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Horne Date 9/13/74

Source Petroleum Storage & Transfer - Tanks

(2) DISTILLATE FUEL OIL - STEADY GROWTH PER REF 95 p 229.3020A

$$P_c = \sqrt{\frac{1971}{1960}} - 1.0 = \sqrt{\frac{971.3}{685.3}} - 1.0 = 3.2\%$$

$$P_{c_{DISTILLATE\ OIL}} = 3.2\% \text{ CMPO}$$

(3) KEROSINE

$$P_{c_{KER}} \approx 0 \quad \text{REF 95} \quad 229.3020A$$

(4) JET FUEL

$$P_c = \sqrt{\frac{1971}{1960}} - 1.0 = \sqrt{\frac{368.7}{136.0}} - 1.0 = 9.4\%$$

$$P_{c_{JET\ FUEL}} = 9.4\% \text{ CMPO}$$

(5) SPECIAL NAPHTHA

$$P_c = \sqrt{\frac{1971}{1969}} - 1.0 = \sqrt{\frac{29.8}{27.6}} - 1.0 = .7\% = P_{c_{SPECIAL\ NAPHTHA}} \text{ CMPO}$$

(6) No data on AVIATION GAS - ASSUME TO BE SAME AS JET FUEL

$$P_{c_{AV\ GAS}} = 9.4\% \text{ CMPO}$$

(7) CRUDE OIL

Assume growth to be the same as that for TOTAL LIQUID HYDROCARBONS: REF 95 229.3020A

$$P_{c_{CRUDE}} = \sqrt{\frac{1971}{1960}} - 1.0 = \sqrt{\frac{5600}{3550}} - 1.0 = 4.22\%$$

$$P_{c_{CRUDE}} = 4.22\% \text{ CMPO}$$

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Computation Sheet For Industrial Factors

Calculations Done By Harper Date 9/13/74

Source Petroleum Storage & Transfer - Tanks

Determination Of 1975 Capacities & Throughput

Assume that capacity & throughput grow @ THE SAME RATE

(1) GASOLINE

$$A_{\text{gas}} = (375.7)(1.0346)^7 = 476.7 \times 10^6 \text{ BBLs}$$

$\times 10^6$
BBLs

A_{gasoline} = 476.7 × 10⁶ BBLs
CAPACITY

$$A_{\text{gas}}_{\text{TP}} = (8.3 \times 10^9 \text{ gals})(1.0346)^7 = 105.3 \times 10^9 \text{ gals}$$

A_{gasoline} = 105.3 × 10⁹ gals
TP

← PRODUCTION, NOT CAPACITY
SEE P7

(2) DISTILLATE FUEL OIL

$$A_{\text{oil}} = (515.7 \times 10^6)(1.032)^7 = 642.9$$

A_{oil} = 642.9 × 10⁶ BBLs
CAP

(3) KEROSENE

A_{kerosene} = 75.8 × 10⁶ BBLs
CAP

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Computation Sheet For Industrial Factors

Calculations Done By HORRER Date 9/13/74

Source Petroleum Storage Tanks - TANKS

(4) JET FUEL

$$A_{JET} = \frac{(66)(1.094)}{10^6}^7 = 123.8 \times 10^6$$

$$A_{JET} = 123.8 \times 10^6 \text{ gals}$$

$$A_{JET} = \frac{(5.31 \times 10^9)(1.094)}{10^6}^7 = 9.9 \times 10^9 \text{ gals}$$

$$A'_{JET} = \frac{9.9 \times 10^9}{10^6} \text{ gals}$$

PRODUCTION NOT CAPACITY
 SEE P7

(5) SPECIFIC NAPHTHA

$$A_{SP. NAP.} = \frac{(17.3 \times 10^6)(1.007)}{10^6}^7 = 18.2 \times 10^6$$

$$A_{SP. NAP.} = 18.2 \times 10^6 \text{ BBL}$$

$$A'_{SP. NAP.} = \frac{(1.134 \times 10^9)(1.007)}{10^6}^7 = 1.19 \times 10^9$$

$$A'_{SP. NAP.} = 1.19 \times 10^9 \text{ gals}$$

PRODUCTION NOT
 CAPACITY SEE P7

(6) AVIATION GAS

$$A_{AVGAS} = \frac{(19.8 \times 10^6)(1.094)}{10^6}^7 = 37.1 \times 10^6$$

$$A_{AVGAS} = 37.1 \times 10^6 \text{ BBL}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 9/13/74

Source Petroleum Storage & Transfer - Tanks

$$A_{\text{Augas}} = \frac{(1.28 \times 10^9)}{\text{TP}} (1.094)^7 = 2.40 \times 10^9$$

$$A'_{\text{Augas}} = \frac{2.40 \times 10^9}{\text{TP}} \text{ gals}$$

PRODUCTION NOT CAPACITY see p 7

(7) Crude oil

$$A_{\text{Crude}} = \frac{1.11}{\text{CAP}} \frac{10^6}{10^6} (1.0422)^7 = 1.24 \times 10^6$$

$$A'_{\text{Crude}} = \frac{1.24 \times 10^6}{\text{CAP}} \text{ bbls}$$

$$A'_{\text{Crude}} = \frac{(160 \times 10^9)}{\text{TP}} (1.0422)^7$$

$$A'_{\text{Crude}} = 214 \times 10^9 \text{ gals}$$

REF (74) P III - 33

"Approximately 70% of U.S. crude oil is produced in the states of and offshore of Texas, Louisiana and California."

Storage losses can occur by two mechanisms

- ① Breathing losses
- ② working losses

Breathing losses are a function of tank outage, size, rate, met conditions, etc. A 'K' value must be equal to unity for the model to work since storage is a static not dynamic condition.

Working losses, on the other hand represent a dynamic situation where a 'K' factor can actually be determined. Throughput, the occurrence which results in working losses, can be considered as production. Maximum recovery capacity could be considered as maximum throughput capacity.

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 9/16/74

Source Petroleum Storage & Transfer

$$\text{For refineries, } K = \frac{\text{PRODUCTION}}{\text{CAPACITY}} = \frac{1.3 \times 10^6}{13 \times 10^4} = 0.85$$

REF(74) p III-29

$$K_{\text{working losses}} = 0.85$$

$$K_{\text{growing losses}} = 1.0$$

All "A" values previously calculated for throughput must be divided by 0.85 to get capacity.

$$A_{\text{gas}} = \frac{105.3 \times 10^9}{0.85} =$$

$$A_{\text{gasoline}} = \frac{123.9 \times 10^9}{0.85} \text{ gals} \quad , \left(2.95 \times 10^9 \text{ BBLs} \right)$$

$$A_{\text{jetfuel}} = \frac{9.9 \times 10^9}{0.85} = 11.6 \times 10^9$$

$$A_{\text{jetfuel}} = \frac{11.6 \times 10^9}{0.85} \text{ gals} \quad , \left(276 \times 10^6 \text{ BBLs} \right)$$

$$A_{\text{sp.wap}} = \frac{1.19 \times 10^9}{0.85} = 1.4 \times 10^9$$

$$A_{\text{sp.wap.}} = \frac{1.4 \times 10^9}{0.85} \text{ gals} \quad , \left(33.3 \times 10^6 \text{ BBLs} \right)$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 7/16/74

Source Petroleum Storage & Transfer - Tanks

$$A_{AVGAS} = \frac{2.4 \times 10^9}{.85} = 2.82 \times 10^9 \text{ gals}$$

$$A_{AV.GAS} = 2.82 \times 10^9 \text{ GALS} \cdot (67.1 \times 10^6 \text{ BBLs})$$

$$A_{ACRUE} = \frac{214 \times 10^9}{.85} = 252 \times 10^9$$

$$A_{ACRUE} = 252 \times 10^9 \text{ GALS} \cdot (6.00 \times 10^9 \text{ BBLs})$$

P_B

REF (37) p 31

IRS guideline for storage tanks = 16 yrs
 Assume twice the guideline = 32 yrs

$$P_B = \frac{1}{32}$$

$$P_B = 0.031$$

All fluids

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Computation Sheet For Emission Factors

Calculations Done By Hornor Date 2/16/74
 Source Petroleum Storage & Transfer

GASOLINE

Ref (74) p III-51

For breathing losses:

- (a) 25% FIXED ROOF TANKS @ 0.4 #/day / 1000 gal
- (b) 75% FLOATING ROOF TANKS @ 4.8 #/day / 1000 BBLs

For working losses:

- (c) 11 #/1000 gal

@ 42 gal/BBL

$$\left[(4.8)(.75) + (0.4)(.25)(42) \right] \times 365 \frac{\text{days}}{\text{yr}} \times \frac{1}{1000} \times 1 \text{yr} =$$

day
BBL

$$EU = 2.85 \frac{\#}{BBL}$$

$$EU_{\text{gasoline}} = 2.85 \frac{\#}{BBL}$$

$$EU_{\text{gas}} = .011 \frac{\#}{gal} \times \frac{42 \text{ gal}}{\text{BBL}} = 0.462 \frac{\#}{BBL}$$

However, THERE ARE ESSENTIALLY NO WORKING LOSSES FROM FLOATING ROOF TANKS

$$EU = 0.462(.25) + 0(.75) = .116$$

$$EU_{\text{gasoline}} = 0.116 \frac{\#}{BBL}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 9/10/74

Source Pumpkin - Tanks

Avianowgas - same as gasoline

$$EU_{AVGAS} = 2.85 \text{ #/gal}$$

$$EU_{AVGAS} = 0.116 \text{ #/gal}$$

Special Naphthas - same as gasoline

$$EU_{SP.NAP.} = 2.85 \text{ #/gal}$$

$$EU_{AVGAS} = 0.116 \text{ #/gal}$$

Jet Fuel

Both naphtha & kerosene are used as jet fuel.

Ref (2) p III-52 gives breakdown & emission factors

$$\frac{23.9}{23.9+42.1} = 36\% \text{ NAP.}$$

$$\frac{42.1}{23.9+42.1} = 64\% \text{ KER}$$

$$\begin{aligned}
 & 0.1 \frac{\text{#}}{\text{day} \cdot 1000 \text{ gal}} - \text{fixed (25\%)} \\
 & 4.8 \frac{\text{#}}{\text{day} \cdot 1000 \text{ gal}} - \text{floating (75\%)} \\
 & 1.7 \frac{\text{#}}{\text{day} \cdot 1000 \text{ lb/l}} - \text{fixed (25\%)} \\
 & 1.6 \frac{\text{#}}{\text{day} \cdot 1000 \text{ gal}} - \text{floating (75\%)}
 \end{aligned}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoyer Date 9/15/74

Source Petrokum - Tanes

$$EU = \left\{ (.36) \left[(0.4)(.25)(42) + (4.8)(.75) \right] + (.64) \left[1.7(.25) + 1.6(.75) \right] \right\} \frac{365}{1000}$$

$$= \left\{ (.36) [4.2 + 3.6] + (.64) [1.25 + 1.2] \right\} \frac{365}{1000}$$

$$\frac{365}{1000} (2.808 + 1.04) = 1.40$$

$$EU = \frac{1.40}{\text{NET FUEL GALLONS}} \#/\text{BBL}$$

$EU_{\text{jet fuel}}$ is same as gasoline Ref 54
 WK for naphtha P III-52

EU for kerosene as jet fuel = 0
 WK

$$EU = (0.116) \#/\text{BBL}$$

SINCE VALUE OF THROUGHPUT
 WAS FOR NAPHTHA ONLY

$$EU_{\text{JET FUEL}} = 0.116 \#/\text{BBL}$$

Kerosene

1.7 #/day · 1000 BBL - 25%

1.6 #/day · 1000 BBL - 75%

$$EU = \frac{365}{1000} \left[(1.7)(.25) + 1.6(.75) \right] = \left(\frac{425 + 1.2}{1000} \right) 365 = 0.593 \#/\text{BBL}$$

$$EU_{\text{kerosene}} = 0.593 \#/\text{BBL}$$

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 9/16/74

Source Petroleum - Tanks

$$E_{U_{\text{RESERVE}}} = 0$$

VAPOR PRESSURE TOO LOW
 TO BE CONSIDERED
 REF(74) p. III-53

Distillate oil - same as kerosine " " "

$$E_{U_{\text{DIST. OIL}}} = 0.593 \frac{\#}{\text{BBL}}$$

$$E_{U_{\text{DIST. OIL}}} = 0$$

Crude oil

(a) @ TERMINALS, ETC Ref (74) p. III-38

Breathing losses:

$$\frac{(1135.7 + 1272.6)(10^3)(300)}{304 \times 10^6} = 2.38 \frac{\#}{\text{BBL}}$$

(b)

@ Refinery

$$\frac{(1341.2 + 510)(10^3)(300)}{137 \times 10^6} = 3.99 \frac{\#}{\text{BBL}}$$

$$\frac{137}{137+304} = 31 \% @ \text{REFINERY}$$

$$\frac{304}{137+304} = 69 \% @ \text{TERMINALS, ETC}$$

$$E_{U_{\text{CRUDE}}} = 3.99(.31) + 2.38(.69)$$

$$E_{U_{\text{CRUDE}}} = 2.879 \frac{\#}{\text{BBL}}$$

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Computation Sheet For Emission Factors

Calculations Done By Harper Date 9/16/74

Source Petroleum Storage & Transfer - Tanks

Working losses

REF (79) p. III-40

$$E_w = 8.0 \frac{\#}{1000 \text{ gal}} \\ = \frac{(8.0)(42)}{1000} = 0.336 \frac{\#}{\text{barrel}}$$

Since there are no working losses from securing
 ROOF TANKS,

$$E_w = (0.336)(.25) + .15\% = 0.084$$

$$E_w^{\text{crude working}} = 0.084 \frac{\#}{\text{barrel}}$$

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 9/13/74

Source Petroleum Storage & Transfer - Tanks

The following table outlines the potential % control achieved on H/C emissions from storage tanks. Ref (34)
 TAB 1 PG-7

	<u>Refinery</u>	<u>Terminal</u>
GASOLINE	90% ①	90% ①
CRUDE	50% - 70% ②	30% - 40% ②
AV GAS		
SP. NAP.		
JET FUEL		
KEROS.		
DIST. OIL		30 - 40% ②

① VAPOR RECOVERY

② FLOATING ROOF

Since NO ADDITIONAL, SPECIFIC info could be located, we will assume refinery control for the remaining fluids to be the same as for crude & terminal control for the remaining fluids to be the same as for crude oil & asphalt oil.

Motor Gasoline

Since Z = 90% @ the refinery & @ the terminal, there is no need to provide the "controlled" emission factors.

$$E_{N_1} = 0.1 (2.85) = 0.285$$

$$E_{N_W} = 0.1 (0.116) = 0.0116$$

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Computation Sheet For Emission Factors

Calculations Done By _____ Date 9/17/74

Source Petroleum S/T - Tanks

$$E_{NGAS} = 0.285 \text{ #/BBL}$$

$$E_{NGAS} = 0.0116 \text{ #/BBL}$$

Crude oil

ASSUME AVG refinery control = 60%
 ASSUME AVG terminal control = 35%

Ref to p1 of "INDUSTRIAL FACTORS" calc. sheet for following values

$$\frac{137}{137+304} = 31 \% \text{ CAPACITY @ RRF (burning losses)}$$

$$\frac{304}{137+304} = 69 \% \text{ " @ terminal (" ")}$$

$$\frac{173}{173+166} = 51 \% \text{ THRUPUT @ RRF (working bases)}$$

$$\frac{166}{173+166} = 49 \% \text{ " @ terminal (" ")}$$

$$E_{NGAS_BREATH} = (0.31)(1-.6)(3.99) + (.69)(1-.35)(2.38)$$

$$= 0.495 + 1.067 = 1.562$$

SEE P4 OF THESE CARDS

$$E_{NGAS_BREATH} = 1.56 \text{ #/BBL}$$

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Computation Sheet For Emission Factors

Calculations Done By Hansen Date 7/17/74

Source Petroleum 5%T - Tanks

$$\begin{aligned} \text{ENCRUDE}_{\text{WK}} &= (0.31)(1-.6)(.084) + (.69)(1-.35)(.084) \\ &= .0104 + .0377 = .0481 \end{aligned}$$

$$\text{ENCRUDE}_{\text{WK}} = 0.0481 \text{ #/gal}$$

AVIATION GAS

Assume $\eta = 60\%$ @ REFINERY
 $\eta = 35\%$ @ TERMINALS

Refer to "Industrial Factors" calc. sheet for following values (ρ_1)

$$\frac{14.0}{14.0+5.8} = .71 \quad \% \text{ CAA } @ \text{REF.}$$

$$\frac{5.8}{14.0+5.8} = .29 \quad \% \text{ CAA } @ \text{TERM.}$$

$$\begin{aligned} \text{ENAVGAS}_{\text{REFINERY}} &= (.71)(1-.6)(2.85) + (.29)(1-.35)(2.85) \\ &= 0.809 + .537 = 1.346 \end{aligned}$$

$$\text{ENAVGAS}_{\text{TERM.}} = 1.35 \text{ #/gal}$$

$$\begin{aligned} \text{ENAVGAS}_{\text{WK}} &= (.71)(1-.6)(0.116) + (.29)(1-.35)(0.116) \\ &= .0329 + .0219 = .0548 \end{aligned}$$

$$\text{ENAVGAS}_{\text{WK}} = 0.0548 \text{ #/gal}$$

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Computation Sheet For Emission Factors

Calculations Done By _____ Date 9/13/74

Source Petroleum Sulfur - Taxes

SPECIAL NAPHTHES

$\eta = 60\%$ @ refinery

$\eta = 35\%$ @ terminals

$$\frac{11.6}{11.6+5.7} = 67 \text{ % cap @ ref.}$$

$$\frac{5.7}{11.6+5.7} = 33 \text{ % cap @ term.}$$

$$\begin{aligned} \text{Ensp. NAP}_{\text{wk}} &= (.67)(.4)(.116) + \\ &(.33)(.65)(.116) = \\ &=.0311 + .0249 = \\ &.056 \end{aligned}$$

$$\text{Ensp. NAP}_{\text{wk}} = 0.056 \frac{\#}{\text{BBL}}$$

$$\begin{aligned} \text{Ensp. NAP}_{\text{ex.}} &= (.67)(1-.6)(2.85) + (.33)(1-.35)(2.85) \\ &= 0.764 + .537 = 1.30 \end{aligned}$$

$$\text{Ensp. NAP}_{\text{ex.}} = 1.30 \frac{\#}{\text{BBL}}$$

Jet Fuel

$\eta = 60\%$ @ refinery

$\eta = 35\%$ @ terminals

$$\frac{48.6}{48.6+17.4} = 74 \text{ % cap @ ref.}$$

$$\frac{17.4}{48.6+17.4} = 26 \text{ % cap @ term.}$$

} THIS ASSUMES THAT
 THE VAPOR PRESSURE
 OF JET FUEL IS
 SUFFICIENTLY HIGH TO
 QUALIFY IT FOR NSPS
 (EXISTING)

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Computation Sheet For Emission Factors

Calculations Done By Hornak Date 9/7/74

Source Petroleum 5 ft. TANKS

$$\begin{aligned} E_{\text{N, JET}} &= (.74)(1-.6)(1.40) + (.26)(1-.35)(1.40) \\ &= .4144 + .2366 = .651 \end{aligned}$$

$$E_{\text{N, JET FUEL}} = 0.651 \frac{\#}{\text{BBL}}$$

$$\begin{aligned} E_{\text{N, WK}} &= (.74)(.4)(0.116) + (.26)(.65)(0.116) \\ &= 0.0343 + .0196 = .0539 \end{aligned}$$

$$E_{\text{N, WK}} = 0.0539 \frac{\#}{\text{BBL}}$$

Kerosene

$$\begin{cases} \eta = 60\% @ \text{REF} \\ \eta = 35\% @ \text{TERM.} \end{cases}$$

This assumes that future NSPS would apply to this in the same manner as existing NSPS

$$\frac{46.2}{46.2+29.6} = 61 \% \text{ CAP. @ REF.}$$

$$\frac{29.6}{46.2+29.6} = 39 \% \text{ CAP. @ TERM}$$

$$\begin{aligned} E_{\text{N, KER}} &= (.61)(.4)(.593) + (.39)(.65)(.593) \\ &= .1447 + .1503 = 0.295 \end{aligned}$$

$$E_{\text{N, KEROSINE}} = 0.295 \frac{\#}{\text{BBL}}$$

$$E_{\text{N, KEROSINE}} = 0 \frac{\#}{\text{BBL}}$$

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Computation Sheet For Emission Factors

Calculations Done By _____ Date _____

Source _____

DISTILLATE FUEL OIL

$$\begin{aligned} \eta &= 60\% @ \text{REF.} \\ \eta &= 35\% @ \text{100M.} \end{aligned}$$

} THIS ASSUMES THAT future NSPS WOULD APPLY TO THIS IN THE SAME MANNER AS EXISTING NSPS.

$$\frac{346.2}{346.2 + 169.5} = 67 \% \text{ CAP @ REF.}$$

$$\frac{169.5}{346.2 + 169.5} = 33 \% \text{ CAP @ 100M.}$$

$$\begin{aligned} EN &= (.67)(.1)(.593) + (.33)(.65)(.593) = \\ &= .1589 + .1272 = 0.286 \end{aligned}$$

$$EN_{\text{DISTILLATE}} = 0.286 \text{ %}$$

$$EN_{\text{DIST. OIL}} \approx 0$$

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Computation Sheet For Emission Factors

Calculations Done By Henne Date 7/17/74
 Source Petroleum St. & Tr. - tanks

Summary

	<u>Eu</u>		<u>*1000</u>	<u>Eu</u>	
	BREATHING	WORKING		BREATHING	WORKING
/ Motor Gasoline	2.85	0.116	0.285	0.0116	
/ Crude Oil	2.88	0.084	1.56	0.048	
/ Aviation Gas	2.85	0.116	1.35	0.055	
/ Specific Naphtha	2.85	0.116	1.30	0.056	
/ Jet Fuel	1.40	0.116	0.65	0.054	
Kerosine	0.593	—	0.295	—	
Distillate Oil	0.593	—	0.286	—	

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 10/11/74
Source Petroleum S&T - Tanks

Determination Of Es

REF 84 TAB III pg 9 - 72

Of the 51 states (including DC), 21 have no regs for H/C storage & transfer. 30 have storage regs & 25 have transfer regs. Of these, 3 specifically do not include crude oil & 4 additional have regs only for new sources

So:

(of 51)

- ① For crude storage, 23 states have applicable regs
- ② For crude transfer, 18 (of 51) states have applicable regs
- ③ For all other fluids or concern, 27 have storage regs & 22 have transfer regs.

If we assume,

- ① Equal geographical distribution of sources
 - ② $Es = En$ for those states with appropriate regs
- Then, since "STATE AND LOCAL REGULATIONS ARE SIMILAR TO THE PROPOSED STANDARD." REF (44) p 34.

$$Es_{exist} = f(Eu \text{ for states w/o regs} + En \text{ for states with regs}) \quad [NSPS] \text{ STD.}$$

$$Es_{new} = En \quad (\text{due to NSPS already promulgated})$$

EXCEPT FOR KEROSENE & DISTILLATE OIL WHOSE VAPOR PRESSURES WE ASSUME TO MAKE THEM EXEMPT

A Crude Oil

$$Es_{crude oil} = \left(\frac{23}{51}\right)(2.88) + \left(\frac{18}{51}\right)(1.56) = 1.581 + .704 = 2.29 \frac{\#}{BBL}$$

EXISTING BREATHING ↑ ↑
P12 P12
OF THESE CALCS

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 10/11/74
 Source Petroleum SHT-Tanks

$$E_{S_{\text{CRUDE}}} = 2.29 \frac{\#}{BBL}$$

EXIST
WKG

$$E_{S_{\text{CRUDE}}} = \left(\frac{18}{51}\right)(.048) + \left(\frac{33}{51}\right)(.084) = .0169 + .0544 = .0713$$

$$E_{S_{\text{CRUDE}}} = 0.071 \frac{\#}{BBL}$$

EXIST
WKG

(B) for gasoline:

$$E_{S_{\text{gas}}} = \left(\frac{27}{51}\right)(.285) + \left(\frac{24}{51}\right)(2.85) = .1509 + 1.341 = 1.492$$

$$E_{S_{\text{gas}}} = 1.49 \frac{\#}{BBL}$$

EXIST
WKG

$$E_{S_{\text{gas}}} = \left(\frac{22}{51}\right)(.0116) + \left(\frac{29}{51}\right)(.116) = .005 + .066 = .071$$

$$E_{S_{\text{gas}}} = 0.071 \frac{\#}{BBL}$$

EXIST
WKG

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Computation Sheet For Emission Factors

Calculations Done By Hoyer Date 10/11/74

Source Pedestrian 3/4-Tanks

(C) AVIATION GAS

$$E_{S_{BREATH}} = \left(\frac{27}{51}\right)(1.35) + \left(\frac{24}{51}\right)(2.85) = .7147 + 1.3412$$

$$E_{S_{AVGAS BREATH EXIST}} = 2.06 \frac{\#}{BBL}$$

$$E_{S_{WKG}} = \left(\frac{22}{51}\right)(.055) + \left(\frac{29}{51}\right)(.116) = .0237 + .066$$

$$E_{S_{AVGAS EXIST WKG}} = 0.090 \frac{\#}{BBL}$$

(D) SPECIAL NAPHTHA

$$E_{S_{BREATH}} = \left(\frac{27}{51}\right)(1.30) + \left(\frac{24}{51}\right)(2.85) = .688 + 1.341$$

$$E_{S_{SPNAP EXIST BREATH}} = 1.34 \frac{\#}{BBL}$$

$$E_{S_{WKG}} = \left(\frac{22}{51}\right)(.056) + \left(\frac{29}{51}\right)(.116) = .0242 + .066$$

$$E_{S_{SPNAP EXIST WKG}} = 0.090 \frac{\#}{BBL}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 10/11/74
 Source Petroleum S+T - Tanks

(E) JET FUEL

$$E_{S_{\text{BREATH}}} = \left(\frac{27}{51}\right)(.65) + \left(\frac{24}{51}\right)(1.40) = .3441 + .6588$$

$$E_{S_{\text{JET FUEL}}}^{\text{EXIST BREATH}} = 1.00 \#/\text{BBL}$$

$$E_{S_{\text{WKG}}} = \left(\frac{22}{51}\right)(.054) + \left(\frac{29}{51}\right)(.116)$$

$$E_{S_{\text{JET FUEL}}}^{\text{EXIST WKG}} = 0.09 \#/\text{BBL}$$

(F) Kerosine

$$E_{S_{\text{BREATH}}} = \left(\frac{27}{51}\right)(.295) + \left(\frac{24}{51}\right)(.593) = .1562 + .2791$$

$$E_{S_{\text{KER}}}^{\text{EXIST BREATH}} = 0.435 \#/\text{BBL}$$

(G) Distillate Oil

$$E_{S_{\text{BREATH}}} = \left(\frac{27}{51}\right)(.286) + \left(\frac{24}{51}\right)(.593) = .1514 + .2791$$

$$E_{S_{\text{DO}}}^{\text{EXIST BREATH}} = 0.431 \#/\text{BBL}$$

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Computation Sheet For Emission Factors

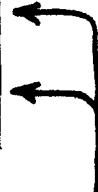
Calculations Done By Hopper Date 10/11/74

Source Petroleum 5-ft-Tanks

Summary Of Es: #/bbl

	EXISTING		NEW	
	BREATHING	WORKING	BREATHING	WORKING
MOTOR GASOLINE	1.49	.071	.285	.0116
CRUDE OIL	2.29	.071	1.56	.048
AV GAS	2.06	.09	1.35	.055
SP. NAPHTHA	1.34	.09	1.30	.056
JET FUEL	1.00	.09	.65	.054
KEROSENE	.435	—	.435	—
DISTILLATE OIL	.431	—	.431	—

← ASSUMED TO BE INCLUDED IN PRESENT NSPS



VAPOR PRESSURES ASSUMED TO BE TOO LOW FOR PRESENT NSPS & STATE REGS

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hoyer Date 1/20/75

Source Industrial Surface Coating

Ref (261) states 1972 Production of Paints, Varnishes, Lacquers
 for industrial use = 2362×10^6 liters

$$(2362 \times 10^6)(0.2642) = 624 \times 10^6 \text{ gals in 1972}$$

Ref (79) pvi-89 states

$$1966 \text{ Production} = 398 \times 10^6 \text{ gals}$$

$$1970 \text{ Production} = 445 \times 10^6 \text{ gals}$$

Using the data from 1966 \rightarrow 1972

$$P_c = \sqrt[6]{\frac{624}{398}} - 1.0 = 0.0778$$

$$\boxed{P_c = 0.078} \quad \text{compound}$$

Our analysis will cover all industrial surface coating except

- ① AUTOMOTIVE INDUSTRY (Covered under "Automobile Ass'y Plants")
- ② TRADE SALES SURFACE COATING

From Ref (261) the major categories are

- ① Sheet, strip & coil coating (~40%)
- ② Paper & paperboard coating (~40%)
- ③ Fabric TREATMENT (~16%)
- ④ Major appliances (~2%)
- ⑤ Other (~2%)

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Computation Sheet For Industrial Factors

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Source Industrial Surface Coating

Of the 236.2×10^6 liters produced in 1972, 213×10^6 liters went to the automotive industry, the remaining 21.9×10^6 liters to be considered within this study.

$$1975 \text{ Production} = (21.9 \times 10^6)(0.2642)(1.078)^3 = 711.3 \times 10^6 \text{ gallons}$$

No specific K could be found for this category. Since it reflects such a wide spectrum of the mfg industry, we will assume a gen'l K for "Advanced processed goods" from Ref(144) p51.

Avg of the years 1965 - 1973 = 82%.

$$K = 0.82$$

$$A = \frac{711.3 \times 10^6}{0.82} = 867.4 \times 10^6$$

$$A = 867.4 \times 10^6 \text{ gals}$$

Ref(50) states 10,000 new spray booths each year out of 50,000 - 100,000 establishments

Po will be based on twice the allowable IRS depreciation guideline for the "Mfg of machines.... Mfg of Electrical Equip't" of 12 yrs

$$P_D = \frac{1}{2(12)} = 0.042$$

$$P_D = 0.042 \quad \text{simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/20/75

Source Industrial Surface Coating

Ref(75) p 4.2-1 gives uncontrolled emission factors for

POINT —	1120	} * / TON
Varnish Surface —	1000	
Lacquer —	1540	
Enamel —	840	
Primer —	1320	

Previous work (See "Industrial Factors - Paint & Industrial Factors Varnish") determines the following

$$\left. \begin{array}{l} 631 \times 10^6 \text{ gallons paint (1975)} \\ 1.099 \times 10^6 \text{ tons VARNISH (1975)} \end{array} \right\} \text{TOTAL LIQUID (Trade & Industrial)}$$

From Ref(26), the total surface coating production (1972) was
 4124×10^6 liters of which 2362×10^6 liters was industrial

$$\frac{2362}{4124} = 57\%$$

$$\begin{aligned} 631 \times 10^6 (.57) &= 360 \times 10^6 \text{ GALS PAINT} \\ \frac{1.099 \times 10^6 (.57)(2000)}{7.0} &= 179 \times 10^6 \text{ gals VARNISH} \end{aligned}$$

Ref(75) p 4.2-1

Ref(50) p 4 indicates

$$\% \text{ Lacquer} = \frac{62.2}{154.5} = 40.3\% \text{ of paint}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/20/75
 Source INDUSTRIAL Surface Coating

$$(360 \times 10^4) (.403) = 145 \times 10^6 \text{ gallons lacquer}$$

$$\Sigma = 684 \approx 711$$

Assume that enamel + primer are part of paint

$$\% \text{ Paint, enamel, primer} = \frac{360}{684} = 52.6\%$$

$$\% \text{ Varnish} = \frac{179}{684} = 26.2\%$$

$$\% \text{ Lacquer} = \frac{145}{684} = 21.2\%$$

From Ref ⑦5 p 4.2-1 the weight of paint is $10-15 \frac{\text{lb}}{\text{gal}}$ (Assume Avg = 12.5)
 The weight of varnish = $7 \frac{\text{lb}}{\text{gal}}$

Converting emission factors,

Paint	$7 \frac{\text{lb}}{\text{gal}}$
Varnish	$3.5 \frac{\text{lb}}{\text{gal}}$
Lacquer	$9.63 \frac{\text{lb}}{\text{gal}}$
Enamel	$5.25 \frac{\text{lb}}{\text{gal}}$
Primer	$8.25 \frac{\text{lb}}{\text{gal}}$

$$\frac{7.0 + 5.25 + 8.25}{3} = \text{Avg of paint, enamel \& primer}$$

" 6.83

$$E_{U_{HC}} = (.526)(6.83) + (.262)(3.5) + (.212)(9.63) = 3.593 + .917 + 2.042$$

$$E_{U_{HC}} = 6.55 \frac{\text{lb}}{\text{gallon}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 1/20/75

Source INDUSTRIAL SURFACES COATING

EN_{HC}

There is no "typical" size coating operation to which a specific control method can be applied. There are many control techniques which could be used depending on the nature of the emission, THE HOURLY RATE & THE SIZE OF THE PROCESS. Some of these control methods are:

- ① Afterburners (99% r)
- ② Activated carbon (90% r) ← Ref(75) p 4.2-1
- ③ Reformulation to non-reactive solvents
- ④ Electrocoating (97-98%) ← Ref(50) p 1

Based on the typical controls that could be applied to the industry, we will estimate that a control of @ least 90% could be attained.

$$E_N = (1-0.90)/(6.55) = 0.655$$

$$E_{N_{HC}} = 0.655 \text{ lb/gallon}$$

ES

From Ref(84) 13 states have solvent regs, which are, generally speaking, similar to CAAPCD Rule 66 (Ref(56))

$$E_S = f \left[\left(\frac{13}{50} \right) (E_{66}) + \left(\frac{37}{50} \right) (E_U) \right]$$

Rule 66 indicates 3 lb/hr or 15 lb/day or 85% control

15 lb/day represents the tightest level if one assumes a 16 hr/day schedule. If we also assume 6 days/wk operation & 6.8 TPF/booth (Ref(50) p 18)

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 1/20/75

Source Industrial Surface Coating

$$\left(15 \frac{\text{LB}}{\text{day}} \right) \left(\frac{6 \text{ days}}{\text{wk}} \right) \left(52 \frac{\text{wk}}{\text{yr}} \right) \cdot \frac{\text{LB}}{\text{YR} \cdot \text{BOOTH}} = 4680$$

Ref (50) p 18 indicates an average uncontrolled emission of 6.8 $\frac{\text{tons}}{\text{YR} \cdot \text{booth}}$. If this represents 50% of the total amount used (Ref (75) p 4.2-1), then the annual pounds usage per booth is

$$\left(\frac{6.8}{.5} \right) = 13.6 \frac{\text{tons}}{\text{YR} \cdot \text{booth}}$$

$$E_S = \frac{4680}{13.6} = 344 \text{ LB/ton}$$

$$\text{"Avg" weight of "Avg" product} = (.526 + .212)(12.5) + (.262)(7.0) = 9.225 + 1.834 \\ \text{11.1 LB/GAL}$$

$$E_{S_{HC}} = \frac{344 \frac{\text{LB HC}}{\text{TON LB}}}{\frac{2000 \text{ LB/LB}}{\text{TON LB}}} \times 11.1 \frac{\text{LB/LB}}{\text{GAL}} = 1.909 \text{ LB/GAL}$$

$$E_{S_{HC}} = 1.909$$

$$E_{S_{HC}} = \left(\frac{13}{50} \right) (1.909) + \left(\frac{37}{50} \right) (0.55) = 0.496 + 4.847 = 5.34$$

$$E_{S_{HC}} = 5.34 \text{ LB/GAL}$$

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Computation Sheet For Industrial Factors

Calculations Done By HARPER Date 1/17/75

Source TEXTILE Processing

Textile Processing consists of many varied & separate processes & uses 100's of various chemical compositions. To define this category we will evaluate the operations

- ① Heat Setting / Finishing
- ② Texturizing
- ③ Dyeing
- ④ Carpet Mfg.

Ref (229) serves as the major reference

Heat Setting / Finishing

In 1974 230×10^6 kg/yr of polyester broadwoven & knit fabric were finished
 343×10^6 kg/yr of polyester/cotton finished fabric

$$\frac{(343 + 230) \times 10^6}{2000} \text{ kg} \times 2.2 \frac{\text{lb}}{\text{kg}} = 0.630 \times 10^6 \text{ tons/yr}$$
Ref (229) p 69

From Ref (229) pg 11 we can determine P_C . Although a simple or compound growth is not specified, values in this report have all been on a compd basis. We will assume this table to be no different.

$$(1 + P_C)^2 - 1 = .86$$

$$P_C_{HS+F} = 0.081$$
compd

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Computation Sheet For Industrial Factors

Calculations Done By HARPER Date 1/17/75

Source Textile Processing

$$1975 \text{ Prod} = (0.630 \times 10^6) (1 + .081) = 0.681 \times 10^6 \text{ tons}$$

specific value of K could be found. Ref (144) p 48 TAB I gives the avg K for textile mfg (1965-1973) as 86%. We will use that value

$$K = 0.86$$

← We will assume this K for all operations treated in this study.

$$A = \frac{0.681 \times 10^6}{0.86} = 0.792 \times 10^6$$

$$A = 0.792 \times 10^6 \text{ tons}$$

HS+F

Ref (57) p 32 gives the IRS allowable depreciation of 12yrs for the "Finishing and Dyeing" of "textile mill products"
Assuming twice the allowable

$$P_B = \frac{1}{(2)(12)} = 0.0417$$

$$P_B = 0.0417$$

Simple

← We will assume this P_B for all operations treated in this study.

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 1/17/74

Source Textile Processing

TEXTUREZING

Ref (229) p 63

ESTIMATED 1974 "PRODUCTION CAPABILITY" (CAPACITY) = $.77 \times 10^9$ KG

Ref (229) p 91

$$(1 + P_c)^{-1} = .20$$

$$\frac{P}{C} = 0.023$$

CMPD

$$A = \frac{(.77 \times 10^9)(2.2)}{2000} (1 + .023) = 0.866 \times 10^6$$

$$A_t = 0.866 \times 10^6 \text{ TONS}$$

DYEING

Ref (229) p 64

1974 Production = 230×10^3 KG/YR

p 95 indicates that $P_c = 0$ for dyeing

$$P_c = 0.0$$

for A K = 0.86

$$A = \frac{(230 \times 10^3)(2.2)}{(2000)(.86)} = 294 \frac{\text{TONS}}{\text{YR}}$$

This value is so low, we will not include it in the study.

In addition, emissions (HC) avg 0.04 % from fabric - which is also insignificant

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date 1/17/75

Source Textile Processing

Carpet Mfg.

Ref (229) p 70

1974 Production = 1360×10^6 kg

Ref (229) p 91

$$(1+P_c)^8 - 1 = 0.51$$

$$P_c = 0.053 \text{ compound}$$

$$A = \frac{(1360 \times 10^6)(2.2)}{(2000)(.86)} (1+0.053) = 1.832 \times 10^6$$

$$A_{cm} = 1.832 \times 10^6 \text{ tons}$$

Summary

	K	$A \times 10^6$	P_c^{**}	P_B^{***}
Heat Setting/Finishing	0.86	0.792	0.081	0.0417
Texturizing		0.866	0.0	
Carpet Mfg		1.832	0.053	

* compd
** simple

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Computation Sheet For Emission Factors

Calculations Done By Horrer Date 1/17/75

Source Textile Mfg

Hydrocarbon emission factors for this source category must be used with reluctance (Ref 229) we concur.

Heat Setting / Finishing

For polyester broadwoven & knit fabric, $E_U = 17.0 \text{ kg/1000 kg (20 LB/TON)}$

For polyester/cotton, $E_U = 1.80 \frac{\text{kg}}{1000\text{kg}} (3.60 \text{ LB/ton})$

1974 Prod. Poly. bw & knit = $230 \times 10^6 \text{ kg}$

1974 Prod. Poly/Cotton = $343 \times 10^6 \text{ kg}$

573

$$E_{U_{HS+T}} = \left(\frac{230}{573} \right) (20) + \left(\frac{343}{573} \right) (3.60) = 8.03 + 2.15 = 10.18$$

$$E_{U_{HC}} = 10.18 \frac{\text{LB}}{\text{TON MATL}}$$

Ref (229) p 72, "Demisters on finishing operations appear to provide the best overall control of condensable hydrocarbons"

Ref (229) p 81

$\eta = 77\% \text{ for Poly/cotton}$
 $= 98\% \text{ for Poly}$

$$E_N = f \left[\left(\frac{230}{573} \right) (.98) + \left(\frac{343}{573} \right) (.77) \right] = .393 + .461 = .854$$

$$E_{N_{HS+T}} = (1 - .854)(10.18) = 1.486$$

$$E_{N_{HC}} = 1.486 \frac{\text{LB}}{\text{TON MATL}}$$

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Computation Sheet For Emission Factors

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Source Textile Processing

Although this industry has solvent HC emissions, most State's regulate by means of "nuisance" laws - opacity & odor. Ref (229) p 69 indicates that this is effective to approx 70%

$$\therefore E_S = (1 - .70)(10.18) = 3.054$$

$$E_{S\text{HC}} = 3.054 \frac{\text{lb}}{\text{ton MAT'L}}$$

Texturizing

Ref (229) p 63

$$E_{U\text{HC}} = 2.3 \frac{\text{kg}}{1000 \text{ kg}} (4.6 \frac{\text{lb}}{\text{ton}})$$

$$E_{U\text{HC}} = 4.60 \frac{\text{lb}}{\text{ton MAT'L}}$$

Ref (229) p 72

".... texturizing plants utilizing electrostatic precipitators are designated 'best controlled' plants."

Ref (229) p 79 $R = 95\%$

$$E_{U\text{HC}} = (1 - .95)(4.60) = 0.23$$

$$E_{U\text{HC}} = 0.23 \frac{\text{lb}}{\text{ton MAT'L}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hayce Date 1/17/75

Source TEXTILE PROCESSING

$$E_S = f(\text{OPACITY, odors}) \quad \text{Ref } 229 \text{ p } 63 \quad E_S = f(80\%)$$

$$E_S = (1 - .8)(4.60) = 0.92$$

$$E_{S \text{ HC}} = 0.92 \text{ LB/TON MATL}$$

Carpet Mfg.

Ref 229 p 70, 71

$$E_U = (0.1 + 0.3) \frac{\text{kg}}{1000 \text{ kg}} = 0.8 \text{ LB/TON MATL}$$

$$E_{U \text{ HC}} = 0.80 \text{ LB/TON MATL}$$

No specific control methods are mentioned for carpet mfg. However, we will assume that ESP's would do the job @ 95% n as in the industry.

$$E_N = (1 - .95)(0.80) = 0.04$$

$$E_{N \text{ HC}} = 0.04 \text{ LB/TON MATL}$$

$$E_S = f(\text{OPACITY, odors}) = f(10\%) \quad \text{Ref } 229 \text{ p } 70$$

$$E_S = (1 - .10)(0.80) = 0.72$$

$$E_{S \text{ HC}} = 0.72 \text{ LB/TON MATL}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/17/75
Source Textile Processing

Summary

	<u>Eu</u>	<u>En</u>	<u>Es</u>
Setting/Finishing	10.18	1.426	3.054
Texturing	4.60	0.23	0.92
Carpet Mfg	0.80	0.04	0.72

APPENDIX 4-G

DETERMINATION OF INPUT VARIABLES
FOR
THE PETROLEUM INDUSTRY

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/30/74

Source FCCU - Petroleum Refineries

Ref (49) p 482 states that the capacity of FCC units in 1968 was

$$(3.609 \times 10^6 \frac{\text{BBL}}{\text{DAY}})(330 \frac{\text{days}}{\text{YR}}) = 1.19 \times 10^9 \frac{\text{BBLs FEED}}{\text{YR}}$$

From Ref (44) p 22. Growth is estimated to be about 685,000 BBL FEED over the next five year period (1973 basis)

On a yearly basis (Assuming equal yearly growth), upgrading the 1968 data

$$1.19 \times 10^9 + 7 \left(\frac{685,000}{5} \right) (330) = 1.506 \times 10^9 \frac{\text{BBLs FEED}}{\text{YR}} = A$$

$$A = 1.506 \times 10^9 \frac{\text{BBLs FEED}}{\text{YR}}$$

Growth rate in the production of total primary liquid hydrocarbons can be der'd from Ref (95) p 229. 3020A. This has been growing at a steady compound rate.

Using 1971 & 1960 data

$$P_C = \sqrt{\frac{5600}{3550}} - 1.0 = 4.22\%$$

$$P_C = 0.0422$$

compound

From Ref (74) p III-39

$$K = \frac{\text{Production}}{\text{Capacity}} = \frac{11 \times 10^6}{13 \times 10^6} = 0.85$$

$$K = 0.85$$

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Computation Sheet For Industrial Factors

Calculations Done By Homer Date _____

Source _____

Ref (37) p 31 IRS allowable depreciation = 16 yrs for

"Petroleum refining: Includes assets used for the distillation,
 fractionation and catalytic cracking of crude petroleum
"

Assuming twice the IRS guideline

$$P_B = \frac{1}{2(16)} = 0.031$$

$$P_B = 0.031$$

simpler

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/30/74
 Source 7000

Particulars

Ref (75) p 9.1-3 TAB 9.1-1

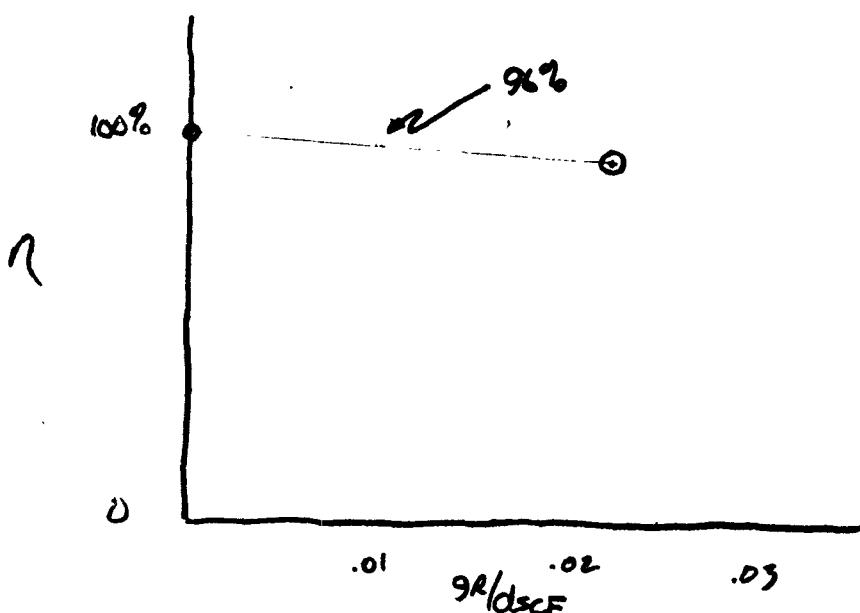
$$E_{UPART} = 242 \frac{\text{lb}}{1000 \text{ gscf}} = 0.242 \frac{\text{lb}}{\text{gscf}}$$

$$E_{UPART} = 0.242 \frac{\text{lb}}{\text{gscf}}$$

Ref (4) p 17 states NSPS Reg'n = 0.022 gscf

This corresponds to an efficiency (ESP) of about 93%.

Page 19 (same Ref) states that two control equipment designs guarantee a level of 0.01 gscf



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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/30/74

Source FCCU

$$E_N = (1-.96)(.242) = 0.0097$$

ELECTROSTATIC
PRECIPITATOR

$$E_{NP} = 0.0097 \text{ LB/BBL FEED}$$

As stated $E_{SP, NEW} = f(93\% \text{ r})$

$$E_{SP, NEW} = (1-.93)(.242) = 0.0169$$

$$E_{SP, NEW} = 0.0169 \text{ LB/BBL FEED}$$

$E_{existing}$

The process weight rate is defined as the catalyst recirculation rate. Ref (41) p 19 indicates a typical rate of

$$50 \text{ tons/min} \times 60 \text{ min/hr} = 3000 \text{ tons/hr}$$

$$3000 \frac{\text{tons}}{\text{hr}} \times 2000 \frac{\text{lb}}{\text{ton}} = 6 \times 10^6 \text{ lb/hr}$$

Ref (41) p 42 ff gives 1971 breakdown of geographical capacity distribution. Of the 39 states with oil refineries, 76% of the total capacity is located in 8 states.

TEXAS - 27.3%

Penn. - 5.1%

CAL - 13.5%

IND. - 4.7%

Louis. - 10.2%

Ohio - 4.3%

ILL. - 6.6%

N.J. - 4.1%

75.8%

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/30/74

Source FCCU

We will base E_S on the 76% per State basis & 24% using the generalized PWR curve.

From Ref (84) & (148), the allowable emissions are

TEXAS - 300 lb/HR

CAL - 40 (Ref (156) LAAPCD)

LOUISIANA - 96

ILL. - 100 (special reg)

Penn - .0292 $\text{lb}/\text{hr} \approx E_N = .0097 \text{ lb}/\text{BBL}$

So, for the 50,000 $\frac{\text{BBL}}{\text{day}}$ unit

$$\frac{(.0097)(50,000)}{24} = 20 \text{ lb}/\text{HR} \leftarrow \text{PENN}$$

IND.

$$E_S = (1 - .9997)(.242) = .000073 \text{ lb/BBL}$$

$$(.000073)(50000)/24 = 0.152 \text{ lb/hr} \leftarrow \text{INDIANA}$$

This value seems UNREASONABLY stringent. Therefore assume equal to New Jersey which is the most stringent of ALL THE OTHER STATES

INDIANA - 30 lb/HR

Ohio - 96 lb/HR

N.J. - 30 lb/HR

All others - 107 lb/HR

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/30/74

Source FCCU

$$\begin{aligned} E_{Sp_{PEST}} &= \sqrt{[(300)(.273) + (40)(.135) + (96)(.102) + (100)(.066)} \\ &\quad + (20)(.051) + (30)(.047) + (96)(.043) + (30)(.041) \\ &\quad + (107)(.242)]} \\ &= 81.9 + 5.4 + 9.8 + 6.6 + 1.0 + 1.4 + 4.1 + 1.2 + 25.9 \\ &= 137.3 \text{ lb/hr} \end{aligned}$$

For the 50,000 bbl/day unit

$$\frac{(137.3)(24)}{(50,000)} = 0.066 \text{ lb/bbl feed}$$

$$E_{Sp_{PEST}} = 0.066 \text{ lb/bbl feed}$$

CO

Ref 75 p 9.1-3 TAB 9.1-1

$$E_{U_{CO}} = 13,700 \text{ lb/1000 bbls} = 13.7 \text{ lb/bbl feed}$$

$$E_{U_{CO}} = 13.7 \text{ lb/bbl feed}$$

Ref 44 p 17 Using a waste heat boiler, NSPS requires 99.5% efficiency

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/30/74

Source FCCU

$$E_{NCO} = (1 - .995)(.17) = 0.0685 \text{ lb/sec}$$

$$E_{NCO} = 0.0685 \frac{\text{lb/sec}}{\text{FED}}$$

$$E_{SCO}_{\text{new}} = f(\text{NSPS}) = E_{NCO} = 0.0685$$

$$E_{SCO}_{\text{new}} = 0.0685 \frac{\text{lb/sec}}{\text{FED}}$$

Since there are no regs for CO from existing plants, $E_S = E$

$$E_{SCO}_{\text{exist}} = 13.7 \frac{\text{lb/sec}}{\text{FED}}$$

SO_x

SO_x emissions occur during regeneration of the catalyst.
 From Ref 75 p 9.1-3 TAB 9.1-1 indicates an uncontrolled emission factor

$$E_{USO_x} = 493 \frac{\text{lb}/1000 \text{sec}}{\text{FED}} = 0.493 \frac{\text{lb/sec}}{\text{FED}}$$

$$E_{USO_x} = 0.493 \frac{\text{lb/sec}}{\text{FED}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/31/78

Source FCCU

(Ref ⑦1 p72)

Since there is no demonstrated control, & emissions appear to be low, we will set $E_N = 0.0$ as we have done in the past

$$E_{N_{SO_x}} = 0.0$$

Since the SO_x emissions are the result of catalyst regeneration wherein sulfur + sulfides are oxidized, we will assume that "fuel burning" regs apply

From Ref ⑦5 pg. 1-5, the weight of crude is 336 LB/BBL

$$\text{wt \% S} = \frac{0.493}{336} = 0.15\%$$

Since this is below State reg's regarding % S, $E_S = E_U$

$$E_{S_{SO_2}} = 0.493 \text{ LB/BBL}$$

sulfides

There are substantial emissions of H_2S from FCC units. Since there are NSPS for process gas combustion, we will treat H_2S emissions within THAT context.

Trace Metals

No specific info could be located regarding trace metal emissions. However, Ref ④3 p 95 states:
 "... chemical composition of the solids discharged from the FCC regenerators differ little from the composition of equilibrium catalyst..."

Ref ④3 p 86 TAB 41 gives % composition of equilibrium catalyst.

12.9% is aluminum. We will apply this % to the particulate emission factors, until better information becomes available.

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/31/74

Source FCU

$$E_{U_{TM}} = (.129)(.242) = .0312$$

$$E_{U_{TM}} = .0312 \text{ LB/BBL FEED}$$

$$E_{N_{TM}} = (.129)(.0097) = .0013$$

$$E_{N_{TM}} = 0.0013 \text{ LB/BBL FEED}$$

Regs for particulates would result in "de facto" control of trace metals

$$E_{S_{TM}} = (.129)(.0169) = .0022$$

$$E_{S_{TM}} = 0.0022 \text{ LB/BBL FEED}$$

Since an ESP could, generally, be retrofitted to existing installations, $E_{Hd} = E_N$

$$E_{Hd} = 0.0013 \text{ LB/BBL FEED}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date: 1/2/75

Source Pete. Ref. - FCCU

NH₃

Ref 75 p9.1-3 TAB 9.1-1

$$E_U_{NH_3} = 54 \frac{lb}{1000 gal} = .054 \frac{lb}{gal}$$

$$E_U_{NH_3} = 0.054 \frac{lb}{gal}$$

It is conceivable, although impractical, (due to the low emission rate) to install a water scrubber in series with the amine scrubber (for N₂S - see Process Gas Combustion) to remove the NH₃.

Since this would be a transfer of technology, we will assume $\epsilon_{NH_3} = 0.987$. THIS IS CONCEIVABLE CONSIDERING THE HIGH SOLUBILITY OF NH₃ IN WATER.

$$E_N_{NH_3} = (1 - 0.987)(0.054) = .0011$$

$$E_{NH_3} = 0.0011 \frac{lb}{gal}$$

Since a scrubber could be, generally, retrofitted to an existing installation, we will assume $\epsilon_{NH_3} = \epsilon_N$

$$\epsilon_{NH_3} = 0.0011 \frac{lb}{gal}$$

Since there are no specs for NH₃ emissions, $E_S = E_U$

$$E_{S_{NH_3}} = 0.054 \frac{lb}{gal}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 5/23/75

Source Gasoline Additive Mfg.

Ref (276) p88 gives K of 0.62 in 1973

Assume this value to remain constant

Ref (276) p88 shows estimated 1975 production Q,
 $A_{1975\text{Lead}} = 382 \times 10^6 \text{ lbs}$

$$\frac{382 \times 10^6}{(3000)(.62)} = 0.308 \times 10^6 \text{ tons} = \text{TOTAL 1975 CAPACITY}$$

Ref (277) App. B VARIOUS STATES

92% by NaPb Alloy Process
 8% by Electrolytic Process

$$A_{NaPb} = (0.308 \times 10^6)(.92) = 283 \times 10^6$$

$$A_{NaPb} = 0.283 \times 10^6 \text{ tons LEAD}$$

$$A_{Elect.} = (0.08)(0.308 \times 10^6) = 0.025 \times 10^6$$

$$A_{Elect.} = 0.025 \times 10^6 \text{ tons LEAD}$$

Ref (278) p88 "Thus production units would be retired or expected during the 1970's . . ."

Assume

$$P_0 = 0.0$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hornier Date 5/23/75

Source Gasoline Additive Mfg.

Ref(276) ρ_{91} gives 80% TEC, 20% TMC A SODIUM LEAD ALLOY PROCESS

$$EU_{TEC} = 4 \text{ lb/ton}_\text{prod} \quad EU_{TMC} = 150 \text{ lb/ton}_\text{prod}$$

$$EU_{pb} = (4)(.8) + 150(.2) = 3.2 + 30 = 33.2$$

$$EU_{recovery} = 55 \text{ lb/ton}_\text{furnace} \quad \text{Ref(276) p92}$$

$$EU_{pb} = 55 + 33.2 = 88.2$$

$$EU_{pb} = 88.2 \text{ lb/ton}_\text{process}$$

EN

Since the recovery furnaces are similar to 2° heat furnaces
 We will assume an $R = 97\%$ using a baghouse or high energy
 scrubber (see "EMISSION FACTORS - 2° LEAD")

$$(55)/(1-.97) = 1.65$$

From Ref (276) p 93

$$R_{TEC} = 70\% \quad (\text{Packed bed scrubber})$$

$$R_{TMC} = 99.5\% \quad (" . . .)$$

$$\begin{aligned} EN &= (4)(.8)(1-.7) + 150(1-.995)(.2) + 1.65 \\ &= 0.96 + 1.35 + 1.65 = 3.96 \end{aligned}$$

$$(EN = 3.96 \text{ lb/ton}_\text{process})$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 5/23/75

Source Gasoline Additive Mfg.

Since we are only concerned with End of baghouses / scrubber
 could in most cases be retrofit to existing installations

$$E_{11d} = 3.96 \text{ lb/ton reactor}$$

Ref (277) Vol II "Section IX-B"

$$E_S = 10.78 \text{ lb/ton reactor}$$

B Electrolytic Process

The electrolytic process does not use a lead recovery furnace.
 Emission factors will be ASSUMED identical to NaPb alloy process
 w/o the furnace.

$$E_{U_Pb} = 88.2 - 55 = 33.2$$

$$E_{U_Pb} = 33.2 \text{ lb/ton reactor}$$

$$E_{11d} = 3.96 - 1.65 = 2.31$$

$$E_{11d} = 2.31 \text{ lb/ton}$$

$$E_S = 4.1 \text{ lb/ton}$$

Ref (277) Vol II Sec IX-B

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Computation Sheet For Industrial Factors

Calculations Done By Hause Date 12/31/74

Source Petroleum Refineries - TCCU & HCCU

Ref (43) p 85 States

".... the FCC type dominates and no TCC or HCC units have been sold for about 10 years in this country."

∴ The growth rate of this equipment is, therefore, assumed to be negative or zero (Assume zero)

$$P_c = 0$$

Ref (43) p 84 tab 38 gives % breakdown of catalytic crackers

$$\left. \begin{array}{l} \text{FCC} = 85.4\% \\ \text{TCC} = 11.4\% \\ \text{HCC} = 3.2\% \end{array} \right\} \text{1972 BASIS}$$

$$A_{TCC} = \frac{\text{FCC}}{1972 \text{ CAPACITY}} \times .114$$

$$A_{HCC} = \frac{1972 \text{ FCC Capacity}}{.854} \times .032$$

$$1972 \text{ FCC Capacity} = 1.19 \times 10^9 \text{ BBLs} + 4 \left(\frac{685,000}{5} \right) (330) = 1.371 \times 10^9 \text{ BBLs}$$

$$A_{TCC} = \frac{1.371 \times 10^9}{.854} \times .114 = 1.83 \times 10^8 \text{ BBLs}$$

$$A_{TCC} = 1.83 \times 10^8 \text{ BBLs}$$

$$A_{HCC} = \frac{1.371 \times 10^9}{.854} \times .032 = 5.14 \times 10^7 \text{ BBLs}$$

$$A_{HCC} = 5.14 \times 10^7 \text{ BBLs}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 12/31/74

Source PETR. REFINERIES - TCCU & HCCU

Assume same K as for FCC units

$$K = 0.85$$

Since $P_c \leq 0$, obsolete units would be replaced by FCC units.

$$\therefore P_B = 0$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/31/74

Source PETR. REFINERIES - TCCU & HCCU

From Ref (75) p 9.1-3 TA3 9.1-1

$$EU_p = .017 \text{ lb/BBL FEED}$$

$$EU_{NH_3} = 0.006 \text{ lb/BBL FEED}$$

$$EU_{SO_2} = 0.60 \text{ lb/BBL FEED}$$

$$EU_{CO} = 3.8 \text{ lb/BBL FEED}$$

Controls for H/C & CO emissions could be assumed to be the same as for FCC units

$$EN_p = (1-.96)(.017) = .0007$$

ELECTROSTATIC
PRECIPITATOR

$$EN_p = 0.0007 \text{ lb/BBL FEED}$$

$$EN_{CO} = (1-.995)(3.8) = 0.019$$

$$EN_{CO} = 0.019 \text{ lb/BBL FEED}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 5/2/75

Ref (75) p 9.1-3 Source PETR. Ref's - FCCU & HCCU
Ref 9.1-1 An ammonia

$$EU_{NH_3} = 0.006 \text{ lb/BBE}$$

Ref (43) p 85 "Each of the above types of catalytic cracking units [FCC, TCC & HCC] employs the same general process principles and feed stocks to produce similar products."

We will assume control similar to that for NH_3 emissions from FCCU - water scrubber, even though emissions are extremely low. (See "EMISSION FACTORS - PETR. REF. - FCCU").

$$E_{NH_3} = (1 - .98)(.006) = 0.00012$$

$$E_{NH_3} = 0.0001 \text{ lb/BBE}$$

Since there are no reg's for NH_3 , $E_s = EU$

$$E_{NH_3} = 0.006 \text{ lb/BBE}$$

TRACE METALS

Assume that the trace metal emissions are a function of the particular emissions & the % of metals within the catalyst. See "EMISSION FACTORS" - PETR. REF - FCCU"

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 5/5/75

Source Reactor Ref's - FCCU & FCCU

$$E_{UTM} = (0.129)(E_{FCCU})$$

Ref (7) p 9.1-3 TAB 9.1-1 $E_{FCCU} = 0.017 \frac{LB}{MMBBL}$

$$E_{UTM} = (0.129)(0.017) = 0.0022$$

$$E_{UTM} = 0.0022 \frac{LB}{MMBBL}$$

Using the control info from "Emission Factors - Ref. Ref - FCCU"

$$\eta_{ESP} = 93\%$$

$$E_{III, D_{TM}} = (0.0022)(1 - .93) = 0.00015$$

$$E_{III, D_{TM}} = 0.00015 \frac{LB}{MMBBL}$$

We will assume $E_{S_{TM}}$ to be the same as for FCCU (See oak sheets)

$$E_{S_{TM}} = 0.0022 \frac{LB}{MMBBL}$$

(COINCIDENTLY SAME AS E_{UTM})

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/31/74

Source Petroleum Refinery - Process Gas Combustion

Ref 44 p 27:

"FOR A TYPICAL 200,000 BBL/DAY REFINERY PRODUCING 30×10^6 DSCF OF PROCESS GAS"

FOR A 1975 CAPACITY OF 1.506×10^9 BBL FEED, WE WOULD HAVE,

$$\frac{200,000}{30 \times 10^6} = \frac{1.506 \times 10^9}{X}$$

SEE "INDUSTRIAL FACTORS - PETROLEUM REFINERY - FCCU"

$$X = 2.259 \times 10^{12} \text{ FT}^3 \text{ PROCESS GAS}$$

$$A = 0.226 \times 10^{12} \text{ FT}^3 \text{ PROCESS GAS}$$

4R

Assume K TO BE EQUAL TO THAT FOR FCCU

$$K = 0.85$$

Assume P_C & P_S TO BE EQUAL TO THAT FOR FCCU

$$P_C = 0.0422$$

compound

$$P_S = 0.031$$

simple

K, P_C & P_S WERE DET'D FOR REFINERIES, IN GEN'L; SO THEY WOULD BE APPLICABLE TO PROCESS GAS COMBUSTION AS WELL AS FCCU.

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Horne Date 1/2/78

Source Petr. Ref- Process Gas Combustion

From Ref(75) p 9.1-3 TAB 9.1-1

PARTICULATES

$$E_{NP} = 0.02 \text{ lb/1000 FT}^3 \text{ gas}$$

Controls for particulate emissions from the combustion of gases are NOT employed. Because of this & the seemingly low emission rate, we will set $E_N = 0.0$ to determine the hypothetical impact of 100% control for control priority purposes.

$$\bar{E}_{NP} = 0.0$$

← This is changed. See p7

Ref (44) p 93ff indicates that in 1971

253 refineries had a capacity of 12.681×10^6 BBL/S. DAY

$$\frac{\text{Ave Plant Capacity}}{253} = \frac{12.681 \times 10^6}{253} = 50,118 \frac{\text{BBL}}{\text{DAY} \cdot \text{PLANT}}$$

TYP AMT of process gas burned = X

$$\frac{200,000}{30 \times 10^6} = \frac{50,000}{X} \quad X = 7.5 \times 10^6 \frac{\text{dscf}}{\text{day}}$$

From Ref (246) P 14-8 HV of process gas $\approx 1500 \text{ BTU/FT}^3$

$$\frac{.02 \times 10^{-3} \frac{\text{LB}}{\text{FT}^3}}{1500 \frac{\text{BTU}}{\text{FT}^3}} = .0133 \frac{\text{lb}}{10^6 \text{ BTU}}$$

Since E_U is less than any State reg, (Ref (34) & (42)), $E_S = E_U$

$$E_{SP} = 0.02 \text{ lb/1000 FT}^3 \text{ gas}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/2/75

Source Pete. Ref - Process Gas Combustion

SO₂

Ref (44) p25 STATED "... process gas that may contain more than 5 percent hydrogen sulfide by volume."

$$\frac{\left(\frac{.05 \text{ FT}^3 \text{ H}_2\text{S}}{\text{FT}^3 \text{ GAS}} \right) \left(34 \frac{\# \text{ H}_2\text{S}}{\text{mole H}_2\text{S}} \right)}{387 \frac{\text{FT}^3 \text{ H}_2\text{S}}{\text{mole H}_2\text{S}}} = .00439 \quad \frac{\# \text{ H}_2\text{S}}{\text{FT}^3 \text{ GAS}}$$



$$\frac{\text{WT SO}_2}{\text{WT H}_2\text{S}} = \frac{64}{34} = 1.882$$

$$.00439 \times 1.882 \times 1000 = 8.26 \text{ } \frac{\text{lb}}{1000 \text{ ft}^3}$$

$$E_{\text{SO}_2} = 8.26 \text{ } \frac{\text{lb}}{1000 \text{ ft}^3}$$

NSPS controls require Amine scrubbing of the gas to remove H₂S prior to combustion to a level equal to 20 gr/100 scf of gas on the basis of SO₂

$$\frac{0.2 \text{ gr}}{\text{ft}^3} \times 1000 \text{ ft}^3 = 0.0286 \text{ } \frac{\text{lb}}{1000 \text{ ft}^3}$$

$$\frac{8.26 - 0.0286}{8.26} = 99\%$$

$$E_{N\text{SO}_2} = 0.0286 \text{ } \frac{\text{lb}}{1000 \text{ ft}^3}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/2/75

Source Pet. Ref - Process Gas Comb.

$$E_{SO_2} = E_{NSPS} = 0.0286 \frac{\text{lb}}{1000 \text{ ft}^3 \text{ gas}}$$

$$E_{SO_2} = 0.0286 \frac{\text{lb}}{1000 \text{ ft}^3 \text{ gas}}$$

From p. 2 of these calc's

Texas - 27.3%
 CAL - 13.5%
 Louis - 10.2%
 ILL - 6.6%

PENN - 5.1%
 IND - 4.7%
 OHIO - 4.3%
 NJ. - 4.1%

From Ref 74 & 148

TEXAS - Ground level reg'n *

CAL - 200#/HR Ref 156

$$\left(\frac{7.5 \times 10^6 \text{ ft}^3}{\text{day}} \right)$$

$$\frac{\left(\frac{7.5 \times 10^6 \text{ ft}^3}{\text{day}} \right)}{\left(\frac{24 \text{ hrs}}{\text{day}} \right)} = 3.125 \times 10^5 \frac{\text{ft}^3}{\text{hr}}$$

$$\frac{200}{3.125 \times 10^5} \times 1000 = 0.64 \frac{\text{lb}}{1000 \text{ ft}^3 \text{ gas}} *$$

Louisiana 2000 ppm

Ref 44 p 25 0.2 gr/scf of gas burned \approx 17 ppm SO₂ in the exhaust

$$\frac{.2}{17} = \frac{x}{2000} \quad x = 23.5 \text{ gr/scf} \quad \frac{23.5}{7000} \times 1000 = 3.36 \frac{\text{lb}}{1000 \text{ ft}^3 \text{ gas}} *$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 1/2/75

Source PETR. REF. - Process Gas Com.

III. - Ground level reg for gas

PENN - No reg for gas

IND. 6×10^{-6} BTU

$$6 \times 10^{-6} \frac{\text{LB}}{\text{BTU}} \times \frac{1500 \text{ BTU}}{\text{FT}^3} \times 1000 = 9 \frac{\text{LB}}{1000 \text{ FT}^3} *$$

$$\text{Ohio } (1 \times 10^{-6})(1500)(1000) = 1.5 \frac{\text{LB}}{1000 \text{ FT}^3} *$$

$$\text{N.J. } (.3 \times 10^{-6})(1500)(1000) = 0.45 \frac{\text{LB}}{1000 \text{ FT}^3} *$$

$$\begin{aligned} E_{\text{SO}_2} &= (.135)(.64) + (.102)(.36) + (.047)(9.0) \\ &\quad + (.043)(1.5) + (.041)(.45) + E_{\text{SO}_2} \text{ EXIST } (\frac{1}{.368}) \end{aligned}$$

\uparrow
 Assumes all other states
 to the avg

$$E = .0864 + .343 + .423 + .065 + .632 E$$

$$E_{\text{SO}_2} = .9174 + .632 E = 2.49$$

$$E_{\text{SO}_2} = 2.49 \frac{\text{LB}}{1000 \text{ FT}^3}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 1/2/75

Source PETR. Ref- Process Gas Combustion

NO_x

Ref (75) p 9.1-3 TAB 9.1-1

$$E_{U_{NO_x}} = 0.23 \text{ lb/1000 ft}^3$$

No specific reference to NO_x control could be located. However,
 Ref (242) p 7-6 Fig 38 indicates an approximate reduction of 50%
 using "optimized design" for natural gas fired "packaged firetube
 boiler". Using this %,

$$E_{U_{NO_x}} = (1-0.5)(0.23) = 0.115 \text{ lb/1000 ft}^3$$

$$E_{U_{NO_x}} = 0.115 \text{ lb/1000 ft}^3$$

From Ref (84) & (48)

$$E_{S_{NO_x}} = 0.2 \text{ lb/1000 ft}^3 \text{ for gaseous fuels}$$

$$0.2 \times 10^{-6} \frac{\text{lb}}{\text{Btu}} \times 1500 \frac{\text{Btu}}{\text{ft}^3} \times 1000 \text{ ft}^3 = 0.3 \text{ lb/1000 ft}^3$$

Since this is greater than EU, E_S = EU

$$E_{S_{NO_x}} = 0.23 \text{ lb/1000 ft}^3$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/2/75

Source Pet. Ref - Process Gas Comb.

HC

Ref(75) p 9.1-3 TAB 9.1-1

$$E_{U_{HC}} = 0.03 + .003 = .033 \text{ LB/1000FT}^3$$

$$E_{U_{HC}} = 0.033 \text{ LB/1000FT}^3$$

Since there are no demonstrated controls for H/C emissions, we will purposely set $E_N = 0.0$ as we have done in similar cases.

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

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

$$E_{S_{HC}} = 0.033 \text{ LB/1000FT}^3$$

CO Ref (75) p 9.1-3 indicates negligible emissions

NH₃ Same ref indicates negligible emissions

Sulfides:

It is assumed that all sulfides (primarily H₂S) are oxidized to SO₂. Since the Eu for SO₂ used this assumption, any sulfides that might not have been oxidized were actually "covered" under SO₂ emissions.

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Computation Sheet For Emission Factors

Calculations Done By Hansen Date 1/21/75

Source Pet. Ref - Process Gas Comb.

Summary	lb/1000 ft ³	<u>Eu</u>	<u>En</u>	<u>Es</u>	See NOTE below
Pt	.02		0.0	<u>EXIST</u>	<u>NEW</u>
SO _x	8.26		.0286	2.49	.0286
NO _x	.23		.115		.23
HC	.033		0.0		.033

During our analysis of Process Gas Combustion, the use of a wet (H_2O) scrubber was employed to eliminate NH_3 from a process gas stream prior to combustion. Such a device would have the effect of reducing particulate emissions as well. Since we are assuming a transfer of technology, we will choose an efficiency = 85%

$$E_{N_p} = (1 - .85)(.02) = 0.003$$

$$E_{N_p} = 0.003 \text{ lb}/1000 \text{ ft}^3$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 1/2/75.

Source PETROLEUM REFINERY - VACUUM DISTILLATION

Ref (44) p 42

The capacity for vacuum distillation (1971) is reported as

$$4.741 \times 10^6 \frac{\text{BBLs}}{\text{SD}}$$

$$4.741 \times 10^6 \times 330 = 1.565 \times 10^9 \text{ BBLs/yr}$$

From previous calculations regarding FCC units (See "Petroleum Refinery - FCCU - Industrial Factors").

$$P_c = 0.0422$$

compound

$$K = 0.85$$

$$P_b = 0.031$$

simple

Since these values were developed for refineries, in gen'l, they are assumed to be applicable to the vacuum distillation process

$$A = (1.565 \times 10^9) (1 + .0422)^4 = 1.846 \times 10^9$$

$$A = 1.846 \times 10^9 \frac{\text{BBLs VACUUM DISTILLATE}}{\text{YR}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/21/75
 Source Petroleum Refinery - Vacuum Dist.

Ref (75) pg.1-1

$$E_{U_{HC}} = 130 \frac{\text{lb}/1000 \text{ gal}}{\text{DISTILLATE}} = 0.130$$

VACUUM
JETS

$$E_{U_{HC}} = 0.130 \frac{\text{lb}/\text{gal}}{\text{DISTILLATE}}$$

VACUUM
JETS

Same ref. indicates negl. emissions if controlled by fine burner. We will assume $\eta = 99.9\%$

$$E_{N_{HC}} = (1 - .999) (.130) = 0.0001$$

$$E_{N_{HC}} = 0.0001 \frac{\text{lb}/\text{gal}}{\text{DISTILLATE}}$$

There are no regs for HC emissions of this nature. $\therefore E_S = E_U$

$$E_{S_{HC}} = 0.130 \frac{\text{lb}/\text{gal}}{\text{DIST.}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 1/2/75

Source Petroleum Refinery - Miscellaneous Point Sources

There are many small emission points throughout a petroleum refinery. Singly, they may be quite small - but in the aggregate they could represent a significant quantity of HC emissions.

We will treat them as a single class, apply an assumed EN & determine if NSPS might be warranted.

We have previously developed K, P_C & P_B for refineries.
 (See "Pet. Refineries - FCCU") We will use these same values for this Misc. category

$$K = 0.85$$

$$P_C = 0.0422$$

compound

$$P_B = 0.031$$

simple

Ref (41) p 42

$$1971 \text{ Capacity} = 12.681 \times 10^6 \frac{\text{BBL}}{\text{SD}}$$

$$(12.681 \times 10^6)(330)(1 + .0422)^4 = 4.937 \times 10^9 \frac{\text{BBLs}}{\text{YR}}$$

$$A = 4.937 \times 10^9 \frac{\text{BBLs}}{\text{YR}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/3/75

Source Pete. Ref. - Misc. Point Sources

Ref 75 p 9.1-4,5 Tab 9.1-1 lists the following misc. ^{HC}₁ emissions in terms of ^{LB/BBL}_{REFINERY CAPACITY}

Blowdown Systems - 0.300

VAPOR RECOVERY SYSTEM - 0.005
 OR FLARING

PROCESS DRAINS - 0.210

PIPELINE VALVES & FLANGES - 0.028

VESSEL RELIEF VALVES - 0.011

PUMP SEALS - 0.017

COMPRESSOR SEALS - 0.005

Misc. - 0.010

$\sum = 0.586$

$$EU_{HC} = 0.586 \text{ LB/BBL}$$

If we assume that "good housekeeping", vapor recovery, etc. can be 50% effective in reducing emissions,

$$EN = (1-.5)(.586) = 0.293$$

$$EN_{HC} = 0.293 \text{ LB/BBL}$$

Except for storage tank rgs, which have been covered elsewhere in this study, THERE ARE NO APPLICABLE rgs. So, $ES = EU$

$$ES_{HC} = 0.586 \text{ LB/BBL}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 10-4-74

Source Sulfur Recovery - Refinery Fuel Gas

This study will be concerned with sulfur recovery by Claus Plants at refineries treating several H_2S , CS_2 and CO_2 streams. All factors will therefore be based on the Claus plants.

K: Ref 150 pg 92

average capacity factor for refinery
 Claus plant is about 66%

$$K = .66$$

A: Ref 150 pg 92 Note (6)

Claus sulfur plants are on the average 92% eff in converting H_2S in feed to Sulfur. Average sulfur in petroleum naphtha is 92%.

Using the 1975 Claus capacity of 8,167 metric ton/day developed on the same page of Ref 150 we may recalculate this "recovered sulfur" capacity into capacity in terms of sulfur feed.

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 10-4-74

Source Sulfur Recovery - Refinery Fuel Gas

: cont'd

1 metric ton = 1.1023 TON

365 day /year basis

$$\begin{aligned} \text{1975 Sulfur Feed Capacity} &= \frac{\text{1975 Recovery Cap (metric TON)} \times 365 \text{ Day}}{.92 \text{ yr}} \times 1.1023 \text{ TON/MTON} \\ &= \frac{8167 \text{ MT/yr}}{.92} \times 365 \text{ D/yr} \times 1.1023 \text{ MT} \end{aligned}$$

$$1975 \text{ Feed Cap} = 3,571,638 \text{ TON/yr} \quad \text{sulfur feed to Claus}$$

$$A = 3.57 \times 10^6 \text{ TON/yr} \quad \text{sulfur feed to Claus}$$

It is important to note that the units for A have been developed in terms of sulfur feed to the Claus plant rather than sulfur recovered. The reasoning for this is reflected by the fact that the total sulfur recovered for this industry is tied directly to the overall system efficiency. In this way, the value of A is directly a function of the emission factors. This would mean that the 1975 value of "A" (TON/yr sulfur recovered) would apply to

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Computation Sheet For Industrial Factors

Calculations Done By W. Manrone Date 10-4-74

Source Sulfur Recovery - Refinery Fuel Gas

A: cont'd

an efficiency of 92% when applying Eu however, once we tried to apply increased levels of control (E_s or E_N) we would in fact be artificially changing the value of "A". We have eliminated this problem by making the capacity basis in terms of feed.

P_c :

Referring to the Industrial Factor section of "Petroleum Storage & Transfer - Tanks" by Tom Hopper we may abstract the growth factor for crude oil production. We assume the growth factor for crude petroleum is indicative of sulfur recovery. ~~1.042~~

Growth = 4.22% compound

$$P_c = .042 \text{ compound}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date _____

Source Sulfur Recovery - Refinery Fuel Gas

P_B :

We assume that depreciation for sulfur recovery plants within petroleum refinery may be estimated by using the asset guideline life for petroleum refinery in general

Ref 037 pg 31 Section 13.3

Asset guideline period 16 yrs

$$P_B \text{ est} \Rightarrow 2 \times \text{IRS} = 32 \text{ yrs}$$

$$\frac{100\%}{32 \text{ yrs}} = 3.1\%/\text{yr} \approx 3\%/\text{yr simple}$$

: $P_B = .03 \text{ simple}$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-4-74
 Source Sulfur Recovery - Refinery Fuel Gas

E_u :

Ref 180 "Table 1" pg F-6

Gives the following vol % of sulfide compound
 in Claus plant (typical) emissions.

	<u>F</u>	<u>MW</u>	<u>F x MW</u>
H ₂ S	.85 % vol	34	28.9
SO ₂	.42 % vol	64	26.9
COS	.05 % vol	60	3.0
CS ₂	.04 % vol	76	3.04
S ₈	.05% vol	256	12.8
			<u>74.64</u>

Components by weight percent of sulfur compounds present

$$\text{H}_2\text{S} = \frac{28.9}{74.64} = .387 \text{ or } 38.7\%$$

$$\text{SO}_2 = \frac{26.9}{74.64} = .360 \text{ or } 36.0\%$$

$$\text{COS} = \frac{3.0}{74.64} = .040 \text{ or } 4.0\%$$

$$\text{CS}_2 = \frac{3.04}{74.64} = .041 \text{ or } 4.1\%$$

$$\text{S}_8 = \frac{12.8}{74.64} = .172 \text{ or } 17.2\%$$

100% ✓

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 10-7-74

Source Sulfur Recovery - Refinery Fuel Gas

u: cont'd

using this weight percent we may state that for a volume of exhaust contributing 100 lbs of sulfur compounds we will obtain

38.7 lb H ₂ S
36.0 lb SO ₂
4.0 lb COS
4.1 lb CS ₂
<u>17.2 lb S₈</u>
100 lb sulfur compounds

taking the MW ratio of S to MW of each compound we may calculate the lb Sulfur attributable to each individual compound and a total gas stream containing 100 lb of sulfur compounds

	$\frac{MW_S}{MW_C}$	$\frac{lbS}{36.4}$
H ₂ S	.941	
SO ₂	.500	18.0
COS	.533	2.1
CS ₂	.842	3.5
S ₈	1.00	<u>17.2</u>
		77.2 lb S

This implies 77.2 lb S
100 lb Sulfur compounds

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 10-7-74
 Source Sulfur Recovery - Refinery Fuel Gas

E_u : cont'd

$$\text{eq } 36.4 \text{ lb S in H}_2\text{S} / 77.2 \text{ lb S} = .472$$

Ratioring once again (lb S for component / lb S total) we obtain a % breakdown of sulfur in the total exhaust attributable to each sulfur compound making up the waste stream.

% S of Total Exhaust
 attributable to this compound

H ₂ S	47.2
SO ₂	23.3
COS	2.7
CS ₂	4.5
S ₈	22.3
	100.0 ✓

Assuming, as we did above under Production Capacity-A determination, a 92% sulfur removal in a typical Claus plant then;

100 lb of Sulfur Feed \rightarrow 8 lb of Sulfur emitted
 to Claus Plant

or 2000 lb (Ton) of Sulfur Feed \rightarrow 160 lb of sulfur emitted.
 to Claus Plant

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Computation Sheet For Emission Factors

Calculations Done By Z.W. Marzzone Date 10-7-74
 Source Sulfur Recovery - Refinery Fuel Gas

: cont'd

On the basis of a ton of S Feed to a Claus plant we will have 160 lb of S being emitted and using the wt % breakdown of S by component we may calculate the emission factors for all sulfur compounds

160 S attributable to:

$$\begin{array}{rcl}
 \text{H}_2\text{S} & .472 \times 160 & = 75.5 \\
 \text{SO}_2 & .233 \times 160 & = 37.3 \\
 \text{COS} & .027 \times 160 & = 4.3 \\
 \text{CS}_2 & .045 \times 160 & = 7.2 \\
 \text{S}_8 & .223 \times 160 & = 35.7 \\
 & & \hline
 & & 160 \checkmark
 \end{array}$$

We will present the emission factors in terms of the two components SO_2 and H_2S (representing sulfide compds)

$37.3 \frac{\text{lb S}}{\text{TON S Feed}}$ in SO_2 and $122.7 \frac{\text{lb S}}{\text{TON S Feed}}$ in Sulfides

$$\frac{\text{MW SO}_2}{\text{MW S}} = \frac{64}{32} = 2$$

$$\frac{\text{MW H}_2\text{S}}{\text{MW S}} = \frac{34}{32} = 1.06$$

$74.6 \frac{\text{lb SO}_2}{\text{TON sulfur feed}}$

$130 \frac{\text{lb sulfide}}{\text{Ton sulfur Feed}}$ as H_2S

or $75 \frac{\text{lb SO}_2}{\text{TON sulfur Feed}}$

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Computation Sheet For Emission Factors

Calculations Done By W. Mannone Date 10-7-74
Source Sulfur Recovery - Refinery Fuel Gas

E_u : cont'd

summary

E_u

SO_x

75 lb /TON of Sulfur Feed
to Claus Plant

Sulfides
as H_2S

130 lb H_2S /TON of Sulfur Feed
to Claus Plant

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-7-74
 Source Sulfur Recovery - Refinery Fuel Gas

∴ Ref 150 pg 92 (1)

"Tail gas processes are, on the average, about 94 percent efficient and thus will raise the overall level of sulfur recovery (Claus plant plus tail-gas process) to about 99.5 %, and this represents best available technology."

We will use this value of 99.5% overall sulfur removal efficiency. Referring to pg 41-90 of Ref 150 we see that most of the tail gas processes reduce the emissions to SO_2 solely.

$$\therefore E_N \text{ H}_2\text{S} = 0$$

therefore all sulfur emitted is in form of SO_2

SO_x Emission

1 TON Sulfur Feed and 99.5% recovery

$$2000\text{lb} \times .005 = \frac{10 \text{ lb S}}{\text{TON Feed to Claus}}$$

$$\frac{\text{MW SO}_2}{\text{MW S}} = \frac{64}{32} = 2:1$$

$$2 \times 10 = \frac{20 \text{ lb SO}_2}{\text{TON S in Feed}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-7-74
 Source Sulfur Recovery - Refinery Fuel Gas

E_N : cont'd

Summary

	E_N
SO _x	20 lb / TON S Feed to Claus Plant
Sulfides	0 lb H ₂ S / TON S Feed to Claus P.

E_{IIId} : Sulfides

Tail gas processes are designed to be functional on Claus plants and it should not matter whether the plant is new or existing. We assume that the overall efficiency for existing plants will be identical as for new plants or $E_{IIId} = E_N$

$$E_{IIId} = 0 \quad H_2S$$

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Computation Sheet For Emission Factors

Calculations Done By W. Mannone Date 10-10-74

Source Sulfur Recovery - Refinery Fuel Gas

E_S : Ref 084 Table XVII and update from Ref 148

- ① Alaska, Colorado, Illinois, Indiana, Kansas, Minn, Missouri, Mont, New Mexico, New York, N. Dakota, and Wisconsin do not have applicable regulation for sulfur recovery plants. We assume

$$E_{Sc} = E_u = .08 \text{ lb S / lb S input} \quad (\text{in terms of total sulfur feed})$$

$$\therefore E_{Si} = .08 \text{ lb S / lb S input} \quad (\text{old \& new})$$

- ② Arkansas reg is based on ground level SO_2 conc. We assume Ark will have an emission factor based on the avg E_S to meet the regulation. $E_{Si} = E_S^A$ (old & new)

- ③ Mich regulation specifies .01 lb S/lb S input for Wayne Co only. No state reg appears. According to Ref 150 pg 24-25 $69/89 \approx 78\%$ of capacity is in Wayne Co. We assume 22% has no reg and that $E_{Sc} = E_u = .08$

$$E_{Si_m} = .78(.01) + .22(.08)$$

$$E_{Si} = .0078 + .0176$$

$$E_{Si} = .025 \text{ lb S / lb S input}$$

(old & new)

- ④ California has no state regulation, only reg in the 50 counties. We will assume $E_{Si} = E_S^A$ as applicable to Calif. (old & new)

- ⑤ Delaware and New Jersey specify effluent SO_2 concentrations. We assume both the states to represent the average $E_{Sc} = E_S^A$. (old & new)

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Computation Sheet For Emission Factors

Calculations Done By 2). Marion Date 10-10-74
 Source Sulfur Recovery - Refinery Fuel Gas

E_{S_i} cont'd

⑥ Texas specifies a SO_2 lb/hr limitation based on the stack effluent - scfm. Ret 149 pg 56 states that Texas law requires an efficiency of 94 to 97% which is equivalent to Louisiana. We use $E_{S_i} = .01 \text{ lb S/lb S input}$ the same as for La. (old & now)

⑦ Pennsylvania regulation is given by $A = .32 E^{-0.5}$ where
 E is plant rating in long tons S/day and A is lb SO_2 / lb S input

$$\text{Penn } \frac{342 \text{ MTD}}{5 \text{ plants}} = 68.4 \frac{\text{MTD}}{\text{plant}} \quad 1.106 \text{ MTD} = 1 \text{ LTD}$$

or

$$1 \text{ MTD} = .904$$

$$68.4 \frac{\text{MTD}}{\text{plant}} \times \frac{.904 \text{ LTD}}{1 \text{ MTD}} = 61.8 \text{ LTD}$$

$$A = .32 (61.8)^{-0.5}$$

$$A = .04 \text{ lb } SO_2 / \text{lb S input}$$

$$\frac{MW_S}{MW_{SO_2}} = \frac{32}{64} = \frac{1}{2} \quad \therefore A = .02 \text{ lb S / lb S input}$$

We therefore have $E_{S_i} = .02 \text{ lb S / lb S input}$ (old & now)

⑧ Utah regulation requires 80% control of emissions $S > 250 \text{ T/yr}$

$$\left(12 \frac{\text{MTD}}{\text{plant}} \times 1.1023 \text{ T} \right) \times \frac{3650}{\text{yr}} \times \frac{160 \text{ lb S}}{\text{Tons S input}} \times \frac{1000 \text{ lb}}{200 \text{ lb}} = 336 \text{ T/yr S emitted}$$

Ret 150
 pg 27
 1 plant = 12 MTD

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Computation Sheet For Emission Factors

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

Source Sulfur Recovery - Refinery Fuel Gas

E_S :

⑧ cont'd

Since $E > 250 \text{ T/yr}$ emissions we apply
 the 80% control requirement

$$E_u = .08 \text{ lb S/lb S input}$$

$$E_{Sc} = .2 \times .08 \text{ lb S/lb S input}$$

$$E_{Sc} = .016 \text{ lb S/lb S input}$$

⑨

Old & New lb S/lb S input

Louisiana	.01
Ohio	.01
Mississippi	.06
Virginia	.05

76%

WAM 10-10-74
11 of 14

Sulfur Recovery - Refinery Fuel Gas

	Sulfur Cap MTPD	Frac. Industrial Capacity A_i	Allowable E lb S/lb S input old & new
Alabama	—		
Alaska	9	.0011	.08
Arizona	—		
Arkansas	25	.0031	E_s^A
Colorado	18	.0023	.08
California	2,510	.3138	E_s^A
Conn.	—		
Delaware	775	.0969	E_s^A
D.C.	—		
Florida	—		
Georgia	—		
Hawaii	—		
Idaho	—		
Illinois	569	.0711	.08
Indiana	414	.0518	.08
Iowa	—		
Kansas	44	.0055	.08
Kentucky	—		
Louisiana	570	.0713	.01
Maine	—		
Maryland	—		
MASS.	—		
Michigan	89	.0111	.025
Minn.	170	.0213	.08
Miss.	30	.0038	.06
Missouri	80	.0100	.08
Montana	113	.0141	.08
Nebraska	—		
Nevada	—		
N.Hampshire	—		
N.Jersey	617	.0771	E_s^A
N.Mexico	30	.0038	.08
New York	50	.0062	.08
N.Carolina	—		
N.Dakota	200	.0250	.08
Ohio	89	.0111	.01

OK! Foundation

21.000

bbb'L

TOTAL

Sulfur Recovery - Refining Fuel Gas

2605

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Computation Sheet For Emission Factors

Calculations Done By W. Maron Date 10-10-74

Source Sulfur Recovery - Refinery Fuel Gas

E_s : cont'd

<u>State</u>	<u>$E_{si} \times A_i$</u>
Alaska	.00009
Arkansas	.0031 E_s^A
Colorado	.0002
California	.3138 E_s^A
Delaware	.0969 E_s^A
Illinois	.0057
Indiana	.0041
Kansas	.0004
Louisiana	.0007
Michigan	.0003
Minnesota	.0017
Mississippi	.0002
Missouri	.0008
Montana	.0011
New Jersey	.0771 E_s^A
New Mexico	.0003
New York	.0005
N. Dakota	.0020
Ohio	.0001
Pennsylvania	.0009
Texas	.0015
Utah	.00002
Virginia	.0003
Wisconsin	.0002

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Computation Sheet For Emission Factors

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

Source Sulfur Recovery - Refinery Fuel Gas

$$E_s^A = \sum E_{si} \times A_i$$

$$E_s^A = \sum E_{si} \times A_i = .0211 + .4909 E_s^A$$

$$(1 - .4909) E_s^A = .0211$$

$$.5091 E_s^A = .0211$$

$$E_s^A = .041 \text{ lbS/lbs input}$$

We assume the same breakdown of H₂S and SO₂ as shown under E_n determination.

23.3% S (in SO₂) makeup of total : $.233 \times .041 = .0096 \text{ lbS/lbs input}$

76.7% S (as H₂S) makeup of total : $.767 \times .041 = .0314 \text{ lbS/lbs input}$

$$\frac{\text{mw SO}_2}{\text{mw S}} = \frac{64}{32} = \frac{2}{1} \Rightarrow 2 \times .0096 = .0192 \text{ lb SO}_2 / \text{lb S input}$$

$$\frac{\text{mw H}_2\text{S}}{\text{mw S}} = \frac{34}{32} = \frac{1.06}{1} \Rightarrow 1.06 \times .0314 = .0333 \text{ lb H}_2\text{S} / \text{lb S input}$$

OR 2000 lb

$$E_s = 38.4 \text{ lb SO}_2 / \text{TON S input}$$

$$E_s = 66.6 \text{ lb H}_2\text{S} / \text{TON S input}$$

APPENDIX 4-H

DETERMINATION OF INPUT VARIABLES
FOR
THE WOOD PRODUCTS INDUSTRY

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-20-74

Source Paper Board

Assume that the paper industry in general will be gearing to the same supply/demand picture discussed in "Wood Pulp - Kraft" by W. Marrone and that all portions will be operating under the same capacity utilization ratio.

$$K = .98$$

Ref 144 pg 5-36

under Paper & Paper Products we obtain 1973 production quantities

as	Paper board	$2,111 \times 10^3$	TONS
	Wet-Mash Board	155×10^3	TONS
	Construction Paper/Board	$5,559 \times 10^3$	TONS
		<u>$35,348 \times 10^3$</u>	TONS

Ref 199 pg 34.

1.5% /yr capacity growth is predicted for period 1973 - 1985 which we assume will be representative of the industry for 1975 - 1985

$$P_c = .015 \text{ compound}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-20-74
 Source Pulpboard

A: cont'd

$$P_{73} = 35,348,000 \text{ TON/yr}$$

$$P_{75} = P_{73} (1 + P_c)^2 = 35.35 \times 10^6 (1 + .015)^2$$

$$P_{75} \approx 36.42 \times 10^6 \text{ TON/yr} \text{ pulpboard}$$

$$A = \frac{P_{75}}{K} = \frac{36.42 \times 10^6}{.98} = 37.2 \times 10^6 \frac{\text{TON}}{\text{Yr}}$$

$$A = 37.2 \times 10^6 \frac{\text{TON}}{\text{Yr}}$$

P_B : Ref 037 Class 26.1

Asset Guidance period = 16 yrs

P_B ext $\Rightarrow 2 \times \text{IRS} = 32 \text{ yrs}$

$\frac{100\%}{32 \text{ yrs}} = 3.1\%/\text{yr}$ simple

$$P_B = .031 \text{ simple}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 12-20-74

Source Pulp Board

E_u : Particulates

Ref 075 Table 10.2-1

	<u>lb/Ton prod</u>
Paperboard	new
Fiberboard	.6

Not knowing the breakdown of pulpboard (which is paper board and fiber board), we make the assumption that Ref 144 S-36 lists "paper board" as paperboard and "wet-machine board" and "construction paper and board" as fiberboard.

Therefore

$$\frac{5559 + 135}{35,348} = 16\% \text{ for fiberboard}$$

$$\frac{29,654}{35,348} \approx 84\% \text{ for paperboard}$$

An emission factor is developed which is a weighted average

$$E = .16 (.6) + .84 (0) = .096 \text{ lb/TON}$$

$$\therefore E_u = .096 \text{ lb/TON}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-20-74
 Source Pulp board

E_N :

Ref 075 pg 10.2-1 indicates that the particulate emissions are attributable to drying operations.

Control for this source was not specified nor obtained from the literature.

It is conceivable that emissions from one dryer are very low (especially ~~in terms of conc~~) so that add-on controls would be impractical and not very feasible.

We make an assumption that a control system can be applied and that 85% efficiency would be attained

$$E_N = .15 \times E_u = .15 \times .096 = .014 \text{ lb/ton}$$

$$E_N = .014 \text{ lb/ton paperboard}$$

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Computation Sheet For Emission Factors

Calculations Done By 21 Marrone Date 12-20-74
 Source Pulp board

=
3:

Particulate

as was determined, the uncontrolled emissions from fiberboard drying is .6 lb/TON product
 and our synthesized emission level is .096 lb/TOW product.

Specific information on plant location, typical plant size, etc was not obtained however by assuming the generalized process weight table applies we may see that this source emits particulate matter in quantities well below the level specified by the Process Weight curve.

By looking at allowable emissions at several points on the G.P.W.C we may establish the lb/TIN product allowed

<u>Process Wt Rate</u> <u>lb/hr</u>	<u>lb/hr allowed</u>	<u>lb/TON</u>
50	.03	1.2
100	.53	10.6
1,000	2.50	5.0
10,000	11.50	2.3
100,000	40.00	.8

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-20-74
 Source Pulpboard

E_s cont'd

Since we expect the process weight for a paperboard operation to be in the above range and most likely near the 50-1000 range the $E_s > E_u$ in which case we set $E_s = E_u$

$$E_s = .096 \text{ lb / ton pulpboard}$$

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Computation Sheet For Industrial Factors

Calculations Done By A. Marrone Date 12-30-74

Source Plywood / Veneer

?
c:

Ref 146 p53 - 55

1973 production softwood plywood 18.2×10^9 sq ft

Ref 245 pg 63 states that hardwood prod constant for past 20 yrs
 therefore growth mainly due to softwood production
compound growth rate in the period 1973 - 1980 is expected
 to average 2.1 to 2.8 percent with 1980 output at
 approximately 21 to 22×10^9 sq ft

We make an assumption that the simple arithmetic
 average growth (2.45%) rounded to 2.5% would typify
 this industry.

assume hardwood
 low growth
 has negligible effect
 on overall growth

$$\therefore P_c = .025 \text{ compound}$$

K:
 Ref 146
 p 54

1973 production of 18.2×10^9 sq ft was about 95%
 of nominal capacity.

Capacity utilization is assumed to be equivalent for hardwood
 and softwood plywood and that the factor of 95%
 in 1973 is representative

$$K = .95$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-30-74.
 Source Plywood/Veneer

A:

Using data in Ref 245 pg 62-63

$$\begin{aligned} P_{68} & \text{ Hardwood Plywood } & 2 \times 10^9 \text{ sq ft} \\ P_{72} & " " & 2.2 \times 10^9 \text{ sq ft} \end{aligned}$$

" hardwood plywood production fairly constant over past 20 yrs."

We will assume hard wood production will grow at same rate as softwood even though growth appears negligible

$$P_{73} = P_{72} = 2.2 \times 10^9 \text{ sq ft hardwood plywood}$$

$$P_{73} = 18.2 \times 10^9 \text{ sq ft softwood plywood}$$

$$P_{73} = 20.4 \times 10^9 \text{ sq ft plywood}$$

$$P_{75} = P_{73} (1 + P_c)^2$$

$$P_{75} = 20.4 \times 10^9 (1.025)^2 \approx 21.5 \times 10^9 \text{ sq ft}$$

$$A = \frac{P_{75}}{K} = \frac{21.5 \times 10^9}{.95} \approx 22.6 \times 10^9$$

$$A = 22,600 \times 10^6 \text{ sq ft}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 12-30-74

Source Plywood / Veneer

P_B :

Ref 037 Class 24.4

Asset Guideline Period 10 yrs

P_B est \rightarrow 2 x IRS 20 yrs

$$\frac{100\%}{20 \text{ yrs}} = 5\%/\text{yr simple}$$

$$P_B = .05 \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 12-30-74

Source Plywood Veneer

Particulate

Ref 245 Table 8 pg 77

E_u : exclude power boiler, topaz burner (waste disposal) emissions]
 Emissions from Sanding Operation $33 - 99 \text{ TON}/10^6 \text{ sq ft}$

We will use the arithmetic average $66 \text{ TON}/10^6 \text{ sq ft}$

$$66 \frac{\text{TON}}{10^6 \text{ ft}^2} \times 2000 \frac{\text{lb}}{\text{TON}} \times 10^{-6} = .132 \frac{\text{lb}}{\text{ft}^2} \text{ plywood}$$

$$\therefore E_u = .132 \frac{\text{lb}}{\text{ft}^2} \text{ plywood}$$

E_N : Control for plywood sanding was not explicitly given
 Ref 047 pg 115 stated that cyclones may be applied
 to this operation with efficiency about 90%.

It is suspected that baghouses could be applied
 easily and an assumed efficiency of 99% be achieved

$$E_N = .01 \times E_u = .0013 \frac{\text{lb}}{\text{ft}^2} \text{ plywood}$$

$$E_N = .0013 \frac{\text{lb}}{\text{ft}^2} \text{ plywood}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-30-74
Source Plywood / Veneer

Particulate cont'd

E_s :

Ref 245 pg 62

In 1968	175 softwood plants	15×10^9 sq ft
	242 hardwood plants	2×10^9 sq ft
	<u>417</u> Plants Total	17×10^9 sq ft / yr

$$\text{Average Plant Size} = \frac{17 \times 10^9}{417} = 40.76 \times 10^6 \text{ sq ft / yr}$$

$$\text{Assume Plant Schedule } 16 \frac{\text{hr}}{\text{day}} \times 350 \frac{\text{d}}{\text{yr}} = 5600 \frac{\text{hr}}{\text{yr}}$$

Board Size $\frac{3}{8}$ " thickness (.375")

Density referring to Ref. 101 pg 23-62 to 23-63

For softwood range specific gravity, .32-.66
use .50

$$\text{density} = .5 \times 62.4 \frac{\text{lb}}{\text{ft}^3} = 31.2 \frac{\text{lb}}{\text{ft}^3}$$

$$\text{Process wt rate} = \frac{.375 \text{ in}}{12 \frac{\text{in}}{\text{ft}}} \times 40.76 \times 10^6 \frac{\text{ft}^2}{\text{yr}} \times \frac{\text{yr}}{5600 \text{ hr}} \times 31.2 \frac{\text{lb}}{\text{ft}^3} \approx 7097 \frac{\text{lb}}{\text{hr}}$$

$$\text{use PWR} = 7100 \frac{\text{lb}}{\text{hr}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 12-30-74

Source Plywood / Veneer

Particulate cont'd

E_s : Ref 148 § 80 process curves for each state

Ref 245 Table D-1 to Fig 3 gives Plywood / Veneer Plants by State.

Taking the number of plants by state that have Plywood & Veneer production and subtracting the plants that do both we obtain a corrected number which represents the total distribution by state of Plywood / Veneer Plants. Using the allowable emissions for each state ($PWR = 7100 \text{ lb/hr}$) and the value of A_i we may calculate $E_{si} = \sum E_{si} \times A_i$

$$PWR = 7100 \frac{\text{lb}}{\text{hr}}$$

$$E_s = \sum E_{si} \times A_i$$

assuming that the number of plants in each state has at the average the representative process wt rate and we may represent the production distribution by state by the distribution of no of plants.

and;

$$\text{Allow Emis } \frac{\text{lb}}{\text{TON}} = \frac{\frac{\text{lb/hr Allow}}{\text{lb/hr Process wt}} \times 2000}{\text{lb}} \frac{\text{lb}}{\text{TON}}$$

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Computation Sheet For Emission Factors

Calculations Done By 2. Marrone Date 12-30-74
 Source Plywood/Veneer

Particulate cont'd

E_s :

<u>State</u>	<u>No Plants</u>	<u>A_i</u>	<u>lb/ton Allowable Emiss.</u>	<u>A_i x Allow</u>
Alabama	17	.0361	2.20	.0794
Arkansas	13	.0276	2.18	.0602
Arizona	1	.0021	2.68	.0056
California	29	.0616	2.28*	.1404
Colorado	1	.0021	2.18	.0046
Florida	8	.0170	2.25	.0383
Georgia	16	.0340	2.68	.0911
Idaho	5	.0106	2.68	.0284
Illinois	2	.0042	2.68	.0113
Indiana	19	.0403	2.68	.1080
Iowa	2	.0042	2.68	.0113
Kentucky	4	.0084	2.68	.0225
Louisiana	14	.0297	2.68	.0796
Maine	4	.0084	2.20	.0185
Maryland	3	.0064	2.31	.0148
Michigan	8	.0170	2.68	.0455
Minnesota	4	.0084	2.68	.0225
Mississippi	15	.0318	2.68	.0852
Missouri	2	.0042	2.68	.0113
Montana	4	.0084	2.68	.0225
New Hampshire	2	.0042	2.68	.0113
New Jersey	2	.0042	8.45	.0355
New York	7	.0149	2.42	.0360
North Carolina	53	.1125	2.68	.3015
Ohio	2	.0042	2.68	.0113
Oklahoma	1	.0021	2.68	.0056
Oregon	120	.2548	2.30	.5860
Pennsylvania	9	.0191	**	.0191 x E _s Avg
South Carolina	26	.0552	2.68	.1479
Tennessee	6	.0127	2.68	.0340
Texas	12	.0255	3.04	.0775

Cont'd

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-30-74
 Source Plywood / Veneer

Particulate E_s : cont'd

<u>State</u>	<u>No Plants</u>	<u>A_i</u>	<u>lb/ton</u> <u>Allowable Emission</u>	<u>A_i * Allow</u>
Vermont	6	.0127	2.30	.0292
Virginia	19	.0403	2.68	.1080
Washington	10	.0212	+	.0212
West Virginia	3	.0064	1.97	.0126
Wisconsin	22	.0467	2.18	.1018
TOTAL	471			

* used Part 156 pg 37 for Anydrous Rule.

** Reg in terms of conc. $E_{s_i} = E_{s_{avg}}$

+ Reg not appear $E_{s_i} = E_u$

$$E_{s_{avg}} = \sum E_{s_i} \times A_i$$

$$E_{s_{avg}} = 2.399 + .0191 E_{s_{avg}} + .0212 E_u$$

$$(1 - .0191) E_{s_{avg}} = 2.399 + .0212 E_u$$

NOTE:

$$E_u = .132 \frac{lb}{ft^2} \times \frac{12 in/ft}{.375 ft} \times \frac{ft^2}{31.2 lb} \times \frac{2000 lb}{ton} = 271 \text{ lb/ton}$$

$$E_{s_{avg}} = \frac{2.399 + .0212(271)}{.9809}$$

$$E_{s_{avg}} = 8.3 \text{ lb/ton}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 1-2-75

Source Plywood / Veneer

articulate
 E_s : cont'd

$$E_s = 8.3 \frac{\text{lb}}{\text{TON}} \times \frac{\text{TON}}{2000 \text{ lb}} \times 31.2 \frac{\text{lb}}{\text{ft}^3} \times \frac{375 \text{ ft}}{12} = .004 \frac{\text{lb}}{\text{sq ft}}$$

$$E_s = .004 \frac{\text{lb}}{\text{sq ft}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 1-2-75
Source Plywood / Veneer

Hydrocarbons

Ref 245 pg 77 Table 8

E_u : Emission of HC 5 - 10 lb / 10,000 ft² plywood

We use arithmetic over 7.5 lb / 10,000 ft² plywood

$$E_u = .00075 \text{ lb/ft}^2 \text{ plywood}$$

E_N : The emission from the veneer dryer are reported (Ref 170 p 968) to be 63% condensable and 37% volatile.

The above reference describes a control device which condenses the exhaust stream mainly to eliminate the "blue-haze" visible emission. Overall maximum eff 50%.

Incineration should effectively destroy the volatile compounds
We assume that 99% efficiency may be achieved for veneer dryer HC control

$$E_N = .01 \times E_u = .000075 \text{ lb/ft}^2 \text{ plywood}$$

E_s : Regulation applicable to veneer dryers (084 & 148) do not exist so that $E_s = E_u$

$$E_s = .00075 \text{ lb/ft}^2 \text{ plywood}$$

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Computation Sheet For Industrial Factors

Calculations Done By 2). Marrone Date 12-18-74

Source Wood Pulping - Kraft (Sulfate)

K :

Ref 199 pg 34 - 35

discusses the expected condition in the industry of domestic supply less than demand in the future.

Inability of this industry to commit capital for capacity expansion rapid enough should continue this condition. Capacity utilization will be hard pressed to operate near unity on pg 35 the industry's average operating rate was 96% for 1972 and the prediction for 1973 was for 100% to be pushed and exceeded.

We will assume that the trend predicted will definitely require capacity utilization greater than 95% and at times near 100%. We choose a value of 98% (near the average of the range) as representative of this industry.

$$K = .98$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-18-74

Source Wood Pulping - Kraft (Sulfate)

A: Ref 047 pg 109

Production breakdown by process type for 1968

	<u>10³ Tons Pulp</u>	<u>% of Total</u>
Mechanical	5,900	15.6%
Kraft (Sulfate)	24,300	64.1%
Sulfite	2,500	6.6%
Neutral Sulfite-Semi-Chem	3,500	9.2%
Other	1,700	4.5%

Ref 009 pg 1-1 also gives figures which appear to be identical

Ref 144 pg 5-36

Wood pulp production figures 1972 & 1973

<u>Process</u>	<u>1972</u>		<u>1973</u>	
	<u>10³ TONS</u>	<u>%</u>	<u>10³ TON</u>	<u>%</u>
Sulfate (Kraft)	31,826	68.1	32,460	67.3
Sulfite	2,173	4.6	2,293	4.8
Ground wood, exploded [Mech]	7,141	15.3	7,808	16.2
Semicchemical (NSCC)	3,971	8.5	4,003	8.3
Other	1,656	3.5	1,672	3.5
TOTAL	<u>46,767</u>		<u>48,238</u>	

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Source Wood Pulping - Kraft (Sulfate)

A: cont'd

Ref 199 pg 34-35 gives a projected growth rate in wood pulp production of 1.2%/yr which we assume representative of the Kraft process (all other processes also - which makes the intrinsic assumption that the production % remain constant).

$$\therefore P_c = .012 \text{ compound}$$

Taking the 1975 Kraft production from data in Ref 144 pg 5-36 (previous page) and the values of P_c and K above we may calculate the 1975 production capacity

$$\begin{aligned} P_{75} &= P_{73} (1 + P_c)^2 \\ &= 32,460,000 \frac{\text{TON}}{\text{YR}} (1 + .012)^2 \end{aligned}$$

$$P_{75} \approx 33,244,000 \text{ TON/YR pulp}$$

$$A = \frac{P_{75}}{K} = \frac{33,244,000}{.98} = 33,922,000$$

$$A = 33,922,000 \text{ TON/YR}$$

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Source Wood Pulping - Kraft (Sulfate)

A: cont'd

and then rounding

$$A = 33.9 \times 10^6 \text{ TON yr}^{-1}$$

wood pulp

P_B :

Ref 037 Class 26.1 pg 32

Asset guideline period = 16 yrs

P_B est = $2 \times \text{IRS}$ = 32 yrs

$\frac{100\% \text{ depreciation}}{32 \text{ yrs}} = 3.1\%/\text{yr simple}$

$$P_B = .031 \text{ simple}$$

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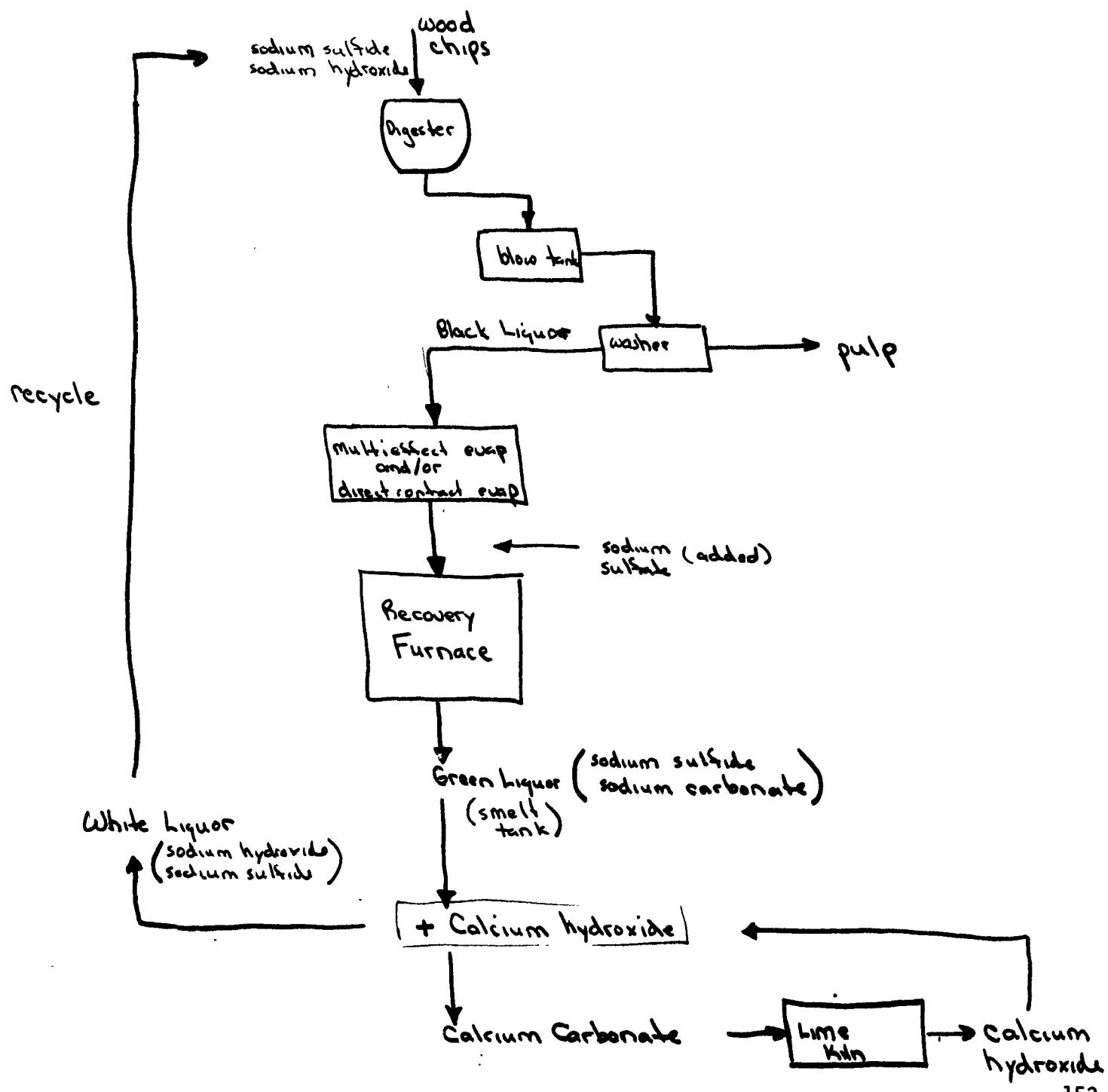
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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-18-74

Source Wood Pulping - Kraft (Sulfate)

Generalized Representation of Kraft (Sulfate) Process:



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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-19-74
 Source Wood Pulpimg - Kraft (Sulfate)

The emissions from this industry are generally attributable to the following sources;

- ① blow tanks
- ② washers & screen
- ③ multi-effect evaporator
- ④ recovery furnace w/wo direct contact evaporator
- ⑤ smelt tank
- ⑥ lime kiln

Actual emissions, whether considered controlled or uncontrolled, are a highly dependent on the mill design and operating conditions. In essence, the last four sources above are process units which are concerned with byproduct recovery and to a loose degree - emissions control. Reclamation of materials essential to pulping liquors has made this recovery design so integral with the Kraft Pulping process.

Since emissions vary greatly from plant to plant due to inherent differences in plant design and practices and control measures employed often time are not add-on but rather process modifications then a different approach to specifying E_u and E_N for this industry will be taken.

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Source Wood Pulping - Kraft (Sulfate)

Uncontrolled emissions will be considered to be those emissions representative of most Kraft mills which employ the above processes. Emissions are also considered before any add-on control system.

Ref 075 Table 10.1-1

Emission Table E_u

<u>Source</u>	<u>Particulate</u>	<u>SO_x</u>	<u>CO</u>	<u>Sulfide</u>
Blow Tank	—	—	—	3.10
Washers & Screens	—	—	—	.22
Multi-effect Evap	—	—	—	.90
Recovery Furnace & Direct Cont Evap	151.0	5.0	60	12.90
Smelt Tank	2.0	—	—	.07
Lime Kiln	45.0	—	10	1.60
	<hr/>	<hr/>	<hr/>	<hr/>
	198.0	5.0	70.0	18.79

∴

$$E_u(\text{Part}) = 198 \text{ lb/TON pulp}$$

$$E_u(\text{SO}_x) = 5 \text{ lb/TON pulp}$$

$$E_u(\text{CO}) = 70 \text{ lb/TON pulp}$$

$$E_u(\text{Sulfide}) = 18.8 \text{ lb/TON pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-19-74
 Source Wood Pulping - Kraft (Sulfate)

E_u : contd Ref 187 pg 12-16

hydrocarbons are attributable to the following sources

lb/day

	Acetone	Methanol	Alpha-Pinene
Digester Blow Gas	13	27	118
Don-Con - Evaporator	neg	neg	neg
Condensate Off - Gas	—	50	20
Biox Liquor Oxid off Gas	85	708	91
Washer hood vent	25	92	116
Washer seal tank vent	11	146	715
Knotter hood vent	14	95	20
TOTAL	148	1118	1080

$$E_u = \frac{148 + 1118 + 1080}{500 \text{ ton/day}} = \frac{2346}{500} = 4.69 \frac{\text{lb}}{\text{ton pulp}}$$

$E_u^{(4c)} = 4.69 \frac{\text{lb}}{\text{ton pulp}}$

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Source Wood Pulping - Kraft (Sulfate)

Control of Kraft mills involves particulate, odor, economy strategies which may at times play one against the other. We have chosen to assess control impact on this industry by considering the achievable emission levels through the utilization of the best technologies for total pollutants from a Kraft Plant.

Ref 187 pg 9 - 18

Describes the emissions for a new Kraft mill incorporating the latest technological developments in odor (sulfide) and dust control. 500 T/day pulp

The overall system consists of:

- (1) high efficiency black liquor oxidation
- (2) non-condensable gas burning
- (3) stripping and burning off gas from condensate
- (4) high efficiency electrostatic precipitators and wet scrubber on recovery furnace
- (5) Venturi scrubber on lime kiln
- (6) smelt dissolver tank is equipped with demister

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 12-19-74

Source Wood Pulping - Kraft (Sulfate)

E_N : cont'd

Ref 187 pg 17 Table XI

Sulfide From this well designed plant $\approx 643 \text{ lb/day}$ discharged after all control optio

$$E_N(\text{sulfide}) = \frac{643 \text{ lb/day}}{500 \text{ ton/day}} = 1.29 \text{ lb/ton pulp}$$

$$\therefore E_N(\text{sulfide}) = 1.29 \text{ lb/ton pulp}$$

Particulate

Ref 187 pg 16-17

	<u>controlled</u>	
Recovery Furnace	651 lb/day	electrostatic precip & scrub
lime kiln	2000 lb/day	venturi scrubber
smelt tank	166 lb/day	
	<u>2817 lb/day</u>	

$$E = \frac{2817 \text{ lb/day}}{500 \text{ ton/day}} = 5.63 \text{ lb/ton}$$

$$\therefore E_N(\text{part}) = 5.63 \text{ lb/ton pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 12-19-74

Source Wood Pulping - Kraft (Sulfate)

: cont'd

SO_x : Ref 187 pg 14 Table IV

For test program shown, the SO₂ emission from the recovery furnace and direct contact evaporator during high-eff black liquor oxidation ranged between 404 - 1200 lb/day. The average is about 800 lb/day well-controlled plant

$$E_N = \frac{800 \text{ lb}}{\frac{500 \text{ ton}}{\text{day}} \text{ pulp}} \approx 1.6 \text{ lb/ton}$$

$$E_N = 1.6 \text{ lb/ton pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Massone Date 12-19-74

Source Wood Pulping - Kraft (Sulfate)

E_N : cont'd

Hydrocarbon

Ref 187 pg 18 Table XIII

After control of digester blow gas, noncondensable evaporator off-gas, and condensate off-gas, the emissions remaining are

135	lb/day	Acetone
1041	lb/day	Methanol
<u>942</u>	lb/day	Alpha Pinene
<u>2118</u>	lb/day	TOTAL

$$E = \frac{2118}{500} \cong 4.24 \text{ lb/ton pulp}$$

This does not represent a significant reduction in hydrocarbon emissions ($E_u = 4.69 \text{ lb/ton pulp}$)

We assume that the feasibility of controlling these sources and specifically hydrocarbon components has not been proven.

$$E_N = 4.24 \text{ lb/ton pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-19-74
 Source Wood Pulping - Kraft (Sulfate)

E_N : cont'd

~~CO~~

Ref 102 pg 4-24 to 4-25

If sufficient air is supplied in the recovery furnace and the furnace is operated as designed the negligible CO will be emitted.

CO controls for lime kilns are not proven however proper kiln operation and design will reduce CO emissions.

We will assume that the recovery furnace may be completely controlled by improved design and operation and that kilns will attain at least a 50% reduction.

$$E = \frac{100-100}{100} (60 \frac{\text{lb}}{\text{ton}}) + \frac{100-50}{100} (40 \frac{\text{lb}}{\text{ton}})$$

$$E = 0 + 5 = 5 \frac{\text{lb}}{\text{ton}}$$

$$E_N = 5 \frac{\text{lb}}{\text{ton}} \text{ pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Harrone Date 12-19-74

Source Wood Pulping - Kraft (Sulfate)

E_{IIId} :

Sulfide

As we discussed, controls in the Kraft process are effected mainly through plant modification (new plant design involving latest technological development). It may be impractical in many instances for existing plants to incorporate this new technology without complete a overhaul.

Process changes may be instituted which would decrease sulfide emissions as well as add-on control system.

Data on existing plant control was not obtained however we make the assumption that the achievable control on existing plants will be near the average at an uncontrolled plant

$$E_{IIId} = \frac{E_u + E_N}{2} = \frac{18.79 + 1.29}{2} = 10.04$$

$$E_{IIId}^{(\text{sulfide})} \approx 10.0 \text{ lb/ton pulp}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-19-74

Source Wood Pulping - Kraft (Sulfate)

E_s :

Ref 148-084

Regulations specific to hydrocarbons and CO do not apply to this industry $\therefore E_s = E_u$

$$E_s (\text{CO}) = 70 \text{ lb/ton pulp}$$

$$E_s (\text{HC}) = 4.69 \text{ lb/ton pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 2-4-75
 Source Wood Pulping - Kraft (Sulfate)

A listing was not found of Kraft production by state nor a total listing of states having Kraft capacity. The only indication of Kraft location is by referring to Ref 084 § 148 which specify actual state regulations (Particulate, SO_x, Sulfides). If we assume that all the states identified represent the majority of Kraft producing states then we may synthesize E_s emission factors by treating each state equally and averaging ^{allowable} _{emission} levels.

The list of States identified is as follows:

	<u>Part</u>	<u>SO_x</u>	<u>Sulfide</u>
Alaska	✓	✓	
Florida	✓		✓
Idaho	✓		✓
Kentucky		✓	✓
Louisiana	✓	✓	
Maine	✓		
Mississippi	✓		✓
Montana			✓
New Hampshire	✓	✓	✓
New Mexico	✓		✓
Ohio		✓	
North Carolina	✓		
Oklahoma		✓	
Oregon	✓		
Pennsylvania	✓		
South Carolina	✓		
Virginia	✓		
Wash	✓		
Tenn	✓		

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 2-4-75

Source Wood Pulping - Kraft (Sulfate)

The following will be used in calculating E_S value

- (a) States with no particulate reg specific to Kraft will use process weight table to determine allowable
- (b) From Ref 148 391:0515 Louisiana Reg 3000 lb dry solid in spent liquor for 1 ton pulp and 550 lb lime in kiln for 1 ton pulp
- (c) States not having SO_x or Sulfides applicable will be assumed to have $E_{Sc} = E_u$
- (d) Some states have Total Sulfides limitations which we assume will regulate SO_x and Sulfides. From $E_u(SO_x)$ and $E_u(\text{Sulfide})$ we see;

	$E_u(\text{lb/ton pulp})$	lb S /ton pulp	% S of rate
SO_x	5.0 lb/ton	2.5	11.7
Sulfide	18.8 lb/ton	18.8	88.3
		21.3	

We will assume that if Total S regulation is started then it is applied so that 11.7% is for S (SO_x) and 88.3% as S (Sulfides)

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 2-4-75

Source Wood Pulping - Kraft (Sulfate)

E_{Si} : Allowable Emission Summary Table

<u>State</u>	<u>Particulate lb/ton pulp</u>	<u>SO_x lb/ton pulp</u>	<u>Sulfide lb/ton pp</u>
Alaska	2.0	5+	18.8
Florida	3.0	5	.5
Idaho	5.5	.12*	6.33*
Kentucky	1.5 ++	.12*	6.33*
Louisiana	5.5	5+	18.8
Maine	5.5	5	18.8
Mississippi	5.5	.5*	7.7*
Montana	1.5 ++	.03*	6.1*
New Hampshire	5.5	.12*	6.33*
New Mexico	5.5	.05*	6.07*
Ohio	1.5 ++	5+	18.8
North Carolina	3.5	5	18.8
Oklahoma	1.5 ++	2.1	7.9
Oregon	5.5	.12*	6.33*
Pennsylvania	— +++	5	18.8
South Carolina	4.75	5	18.8
Virginia	5.75	5	18.8
Tenn.	4.5	5	18.8
Wash.	5.5	5	18.8

* control for recovery furnace only

+ reg exceeds E_u : $E_{Si} = E_u$

++ Using PWR curve for state (Ref 084, 148) and lb/hr. $\leq 100,000$ weight rate. (see next page)

+++ assumed equal to average since regulation does not easily apply to overall Kraft.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 2-5-75

Source Wood Pulping - Kraft (Sulfate)

s: cont'd

Ref 243 pg 5 1969 date

Kraft mills 116

Production 29.6×10^6 TON pulp

Avg size = $255,170 \frac{\text{TON}}{\text{yr}}$ per plant
 with $8760 \frac{\text{hr}}{\text{yr}} \rightarrow \approx 29. \frac{\text{TON}}{\text{hr}}$

$3000 + 350$ lb solid weight / TON pulp

assuming $8760 \frac{\text{hr}}{\text{yr}}$ then we may estimate average
 process weight rate for average Kraft plant.

$$\begin{aligned} \text{Avg PWR} &= 3500 \frac{\text{lb PW}}{\text{TON pulp}} \times \frac{\text{yr}}{8760 \text{ hr}} \times 255,170 \frac{\text{TON}}{\text{yr}} \\ &= 101,951 \text{ lb/hr} \quad \text{or } \approx 51 \text{ TON/hr} \end{aligned}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 2-5-75

Source Wood Pulping - Kraft

E_s : cont'd

We may now calculate E_s for Pt, SO_x and Sulfide by taking the average value for each from the table on pg 14

Particulate

$$E_s = \frac{\sum E_{s,i}}{18} = \frac{73.5}{18} \approx 4.1 \text{ lb/TON pulp}$$

We see that $E_s < E_N$ which implies that this pollutant is stringently controlled in this industry

E_s is assumed in reality to be no less than E_N or in fact $E_s = E_N$

$$E_s (\text{PT}) = 5.63 \text{ lb/TON pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 2-5-75
 Source Wood Pulpmy - Kraft

E_s cont'd

SO_x :

$$E_s = \frac{\sum E_{si}}{19} = \frac{58.16}{19} \approx 3.06 \text{ lb/TON}$$

pulp

Sulfide:

$$E_s = \frac{\sum E_{si}}{19} = \frac{241.6}{19} \approx 12.7 \text{ lb/TON}$$

pulp

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Computation Sheet For Industrial Factors

Calculations Done By W. Martone Date 12-18-74

Source Wood Pulping - Sulfite

$K:$

All pulping processing will be assumed equally effected by predicted supply/demand trends so that the K developed for Kraft Plants is considered representative of all Pulp Plants

$$\therefore K = .98$$

$P_c:$

As discussed under "Wood Pulping - Kraft" pg 3 Ind Factors by W. Martone

$$P_c = .012 \text{ compound}$$

$P_B:$

Per "Wood Pulping - Kraft" pg 4 Ind Factor

$$P_B = .031 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Mannone Date 12-18-74

Source Wood Pulping - Sulfite

A:

Using the 1973 production of sulfite wood pulp shown on pg 2 IF of "Wood Pulping - Kraft" and K, P_c we may calculate the 1975 production capacity for sulfite wood pulp.

$$P_{75} = P_{73} (1 + P_c)^2 \\ = 2,293,000 \frac{\text{Ton}}{\text{Yr}} (1 + .012)^2$$

$$P_{75} = 2,348,000 \frac{\text{Ton}}{\text{Yr}}$$

$$A = \frac{P_{75}}{K} = \frac{2,348,000}{.98} \approx 2,396,000 \frac{\text{Ton}}{\text{Yr}}$$

$$A = 2.40 \times 10^6 \frac{\text{Ton}}{\text{Yr}} \text{ wood pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-20-74

Source Wood Pulping - Sulfite

Emissions from this industry are not well defined especially since there are a wide variety of plant designs and process types. There are four basic sulfite base systems (magnesium, calcium, ammonia, sodium) Recovery is not always attractive in this industry (nor practical) as it is in Kraft Pulp.

The emission both controlled and uncontrolled will be determined based on information in Ref 196 and 235.

Ref ~~243~~²⁴³ pg 71 a plant not practicing any recovery or liquid burning would have only blow tank and dump tank SO_x emissions

$$\begin{array}{rcl} \text{BT} & 100-150 \text{ lb/ton} & \approx 125 \\ \text{DT} & 10-25 \text{ lb/ton} & \approx \frac{18}{143} \text{ lb/TON} \end{array}$$

Ref ~~243~~²⁴³ pg 75 $7 + 8 + 6 = 21$ plants were surveyed

2 had a recovery furnace

1+2 disposed of liquid stream

We will assume that $\frac{5}{21} \approx 24\%$ operate recovery systems

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-20-74

Source Wood Pulping - Sulfite

Eu:

Ref 196 Table 1 pg 101

	<u>Part</u>	<u>lb/TON pulp</u>	<u>SO_x</u>
Recovery Furnace	2-4		<u>12</u>
Digester Blow	<u>—</u>		<u>10-15</u>
	<u>3</u>		<u>≈ 24</u>

pg 101 states that the SO_x emissions from the process is about an 80% reduction from calcium based process emissions which generally has no recovery.

$$E_u' (SO_x) = \frac{24}{.2} = 120 \text{ lb/TON pulp}$$

pg 100 recovery of dust from recovery furnace is 97% eff

$$E_u' (\text{part}) = \frac{3}{.03} = 100 \text{ lb/TON pulp}$$

Particulate

24% will emit 100 lb/ton (from recovery)
 76% will emit 0

$$E_u = .24(100) + .76(0) = 24 \text{ lb/TON}$$

$$E_u (\text{part}) = 24 \text{ lb/TON pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-20-74

Source Wood Pulping - Sulfite

E_u : cont'd

SO_x

24% Digester only 143 lb/tow

76% "controlled" by system 120 lb/tow

$$E_u = .24(143) + .76(120) = 34.32 + 91.20 = 125.5$$

$$E_u(\text{SO}_x) = 126 \text{ lb/ton}$$

pulp produced

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-20-74

Source Wood Pulping - Sulfite

E_N :

Particulate

Ref 196 p 101
 Based on results of tests on new magnetite pulping mill utilizing chemical recovery, and source controls

Emission from controlled recovery furnace = 3 lb/ton avg

$$E_N = 3 \text{ lb/ton pulp}$$

SO_x

Ref 196 p 101

state that this mill (designed to meet air pollution regulations) will attain total SO₂ emission from the mill of 20 lb/ton by 1975

$$E_N^{(SO_x)} = 20 \text{ lb/ton pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 2-3-75

Source Wood Pulping - Sulfite

Particulate

E_s :

From ref 243 pg 5 for 1969 there were reportedly
 38 mills and 3×10^6 TONS/yr production

$$\frac{3 \times 10^6 \text{ TON}}{38 \text{ mill}} = 78.95 \times 10^3 \frac{\text{TON}}{\text{yr}} \text{ per plant}$$

assuming $24 \text{ hr} \times 7 \text{ d} \times 50 \text{ wk} = 8400 \text{ hr/yr}$

$$\text{Avg Plant} = 78.95 \times 10^3 \frac{\text{TON}}{\text{yr}} \times \frac{\text{yr}}{8400 \text{ hr}} \times \frac{2000 \text{ lb}}{\text{TON}} = 18.8 \times 10^3$$

pulp
produce

using info Lamm Rsg (Ref 148) \leftarrow 391:0515 which was used
 for Kraft Pulping and give solid content of spent liquor
 per ton of pulp, we may estimate the process weight
 rate upon which allowable emissions are determined

$$\text{Avg PWR} = 18.8 \times 10^3 \frac{\text{lb/pulp}}{\text{hr}} \times \frac{\text{TON/pulp}}{2000 \text{ lb}} \times \frac{3000 \text{ lb solid}}{\text{TON pulp}}$$

$$\text{Avg PWR} = 28.2 \times 10^3 \frac{\text{lb}}{\text{hr}} \text{ solids}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 2-3-75
 Source Wood Pulping - Sulfite

Particulate

E_s :

With a lack of information on production of sulfite pulp by state we will estimate the allowable emissions from the Generalized Process Weight Rate Curve.

$$\text{Allowable Emission Rate} = 23.5 \text{ lb/hr}$$

For an average plant of $18.8 \times 10^3 \text{ lb pulp/hr}$ we determine:

$$E_s = \frac{23.5 \text{ lb/hr}}{18.8 \times 10^3 \frac{\text{lb pulp}}{\text{hr}} \times \frac{\text{TON}}{2000 \text{ lb}}} \approx 2.5 \text{ lb/TON pulp produced}$$

We see that E_s is slightly less than E_N which would imply an industry which is apparently fair tightly controlled on the basis of a PWR curve. We change the value of E_s so that it is equivalent to E_N since controls should not be set more stringent than existing technology. ($E_s = E_N$)

$$E_s = 3 \text{ lb/TON pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 2-3-75

Source Wood Pulping - Sulfite

$\cancel{SO_x}$
 $E_s :$

Ref 048 & 084

There are no state regulations applicable to SO_x emissions from sulfite pulping processes. In this case we assume $E_s = E_u$

$$E_s = 126 \text{ lb / TON}$$

pulp produced

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-18-74

Source Wood Pulping - Neutral Sulfite-Semichemical

The capacity utilization ratio for Neutral Sulfite-Semichemical is assumed to be the same as Kraft and Sulfite Plants

Ref "Wood Pulping - Kraft"
 "Wood Pulping - Sulfite"

$$K = .98$$

As discussed under "Wood Pulping - Kraft" pg 3 Ind Factor by W. Marrone

$$P_c = .012 \text{ compound}$$

Ref "Wood Pulping - Kraft" pg 4 Ind Factors

$$P_B = .031 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W.J. Marrone Date 12-18-74

Source Wood Pulping - Neutral Sulfite Semichemical

A:

Using the 1973 production of NSSC wood pulp shown on pg 2 Ind F of "Wood Pulping - Kraft" and K , P_c we may calculate the 1975 production capacity for NSSC wood pu

$$\begin{aligned} P_{75} &= P_{73} (1 + P_c)^2 \\ &= 4,003,000 \frac{\text{Ton}}{\text{yr}} (1 + .012)^2 \end{aligned}$$

$$P_{75} \approx 4,100,000 \text{ Ton/yr}$$

$$A = \frac{P_{75}}{K} = \frac{4,100,000}{.98} = 4,183,000 \text{ Ton/yr}$$

$$A = 4.18 \times 10^6 \frac{\text{Ton}}{\text{yr}} \text{ wood pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 12-20-74

Source Wood Pulping - NSSC

Very little info is available for emissions and controls from NSSC pulp plants.

Our best estimate is to consider NSSC plant emissions to be partially represented (SO_x) by Sulfite plants.

Ref 009 state that recovery is not practiced and that emissions are limited to absorbers, blow tanks, evaporators and fluid bed reactors.

Since recovery is not practiced (no recovery furnace) we believe that particulate emissions will be negligible and therefore eliminate the pollutant.

We will use emission factors from Pulping - Sulfite to provide best estimate of NSSC - SO_x emission until more definitive data becomes available.

~~SO_x~~ / E_u : from
 Sulfite - "Emission Factors" pg 3
 143 lb/Ton pulp SO_x from digester

$$E_u = 143 \text{ lb/Ton pulp}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 2-3-75
 Source Wood Pulping - NSSC

SO_x cont'd

E_N : Wood Pulping - Sulfite "Emission Factors" pg 4

assume same level of SO_x control for NSSC
 plant can be achieved as for sulfite

$$E_N = 20 \text{ lb/TON pulp}$$

E_S : Ref 084 & 148 SO_x regulations are not applicable
 so that $E_S = E_N$

$$E_S = 143 \text{ lb/TON pulp}$$

APPENDIX 4-I

DETERMINATION OF INPUT VARIABLES
FOR
ASSEMBLY PLANTS

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Computation Sheet For Industrial Factors

Calculations Done By William Marrone Date 8-8-74

Source Automobile Assembly Plants

K:

Ref 144 Vol 54 No 7
 pg 48 Table 1

Average Capacity Utilization Factor Dec 1965 to Dec 1973
 is reported to be 91% for motor vehicles
 It has peaked at 107% and lulled at 65%
 however this average for the ~~eight~~ year
 period (1965 - 1973) is a best estimate for
 this industry. We will use this value
 and assume it to be applicable to
 1975 to 1985

$$\therefore K = .91$$

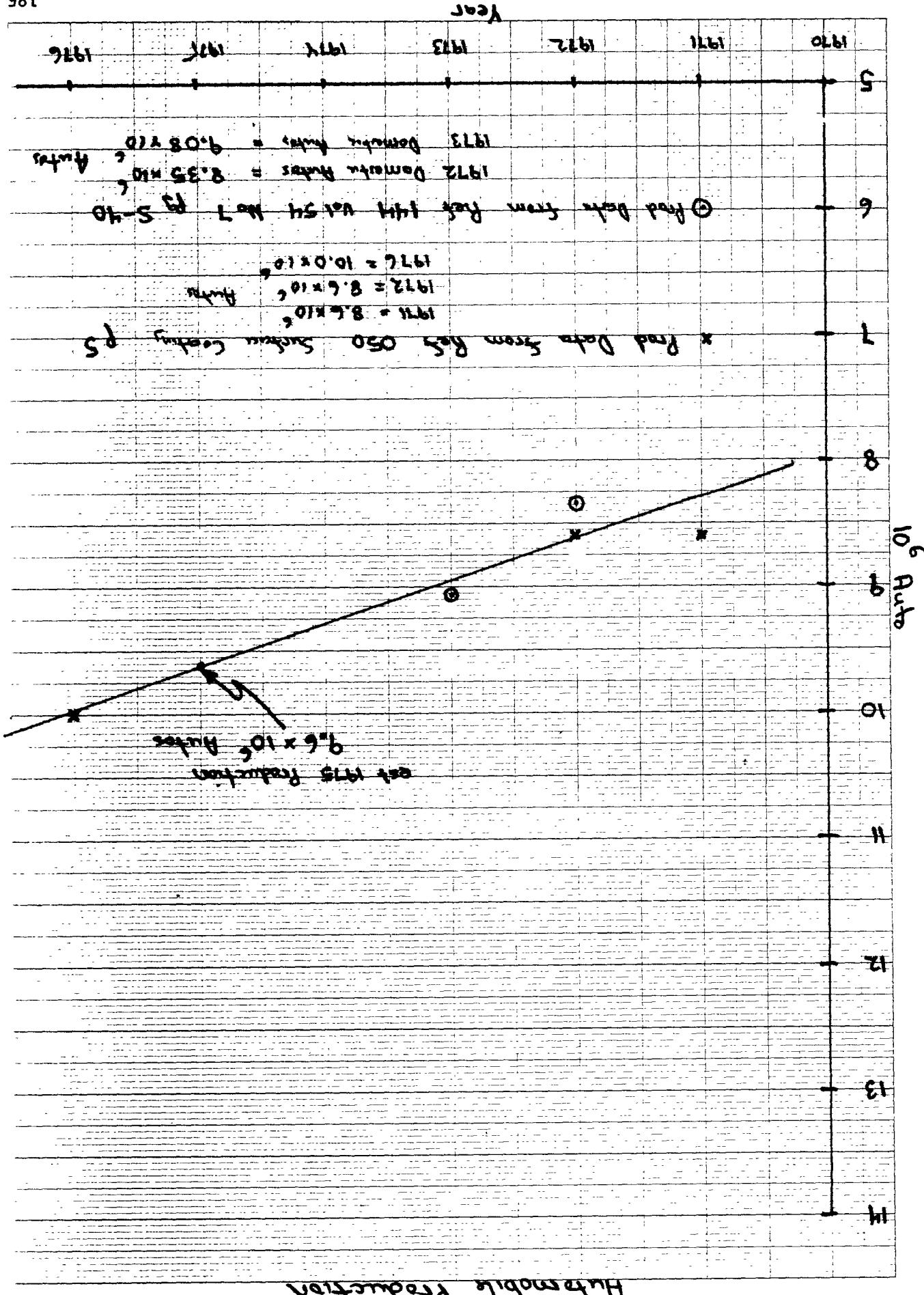
A: For the short period (1971 - 1986) we may interpolate
 by a straight line the estimated 1975 production
 of auto on the attached graph. This graph was
 developed from data in Ref 050 and Ref 144
 as indicated.

$$P_{75} = 9.6 \times 10^6 \text{ autos}$$

Applying $K = .91$ we determine the 1975 Prod Cap

$$A = \frac{9.6 \times 10^6}{.91} = 10.6 \times 10^6 \text{ autos}$$

185



2 of 3

K-E 10 X 10 TO 1½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO MADE IN U.S.A.

46 1320

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Computation Sheet For Industrial Factors

Calculations Done By William Marvone Date 8-8-74

Source Automobile Assembly Plant

P_c : Ref 144 Vol 54 No 7 Table 1 pg 48

Implied growth in capacity from 1966 - 1973
 (8 year period) was 26%

We reason that 1973 Cap = $1.26 \times 1966 \text{ Cap}$

$$\frac{1.26 \times (1966)}{(1966)} = (1 + P_c)^8$$

$$\sqrt[8]{1.26} = 1 + P_c \Rightarrow P_c = .02 \text{ comp}$$

$P_c = .029 \text{ compound}$

P_B : Ref 037 37.1 (37.11)
 1974 Ed

12 year asset guideline

$2 \times \text{IRS} = 24 \text{ yrs}$ 100% dep in 24 yrs simple rate

$$P_B \text{ est } \frac{100\%}{24} \approx 4\% \text{ sim}$$

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

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Computation Sheet For Emission Factors

Calculations Done By A. Marrone Date 8-8-74

Source Automobile Assembly Plant

Hydrocarbons

E_u :

Approximately 3.5 gal of paint is required to paint the average automobile Ref 050 Surface Content pg 7-8

Assuming that all of the solvent from the paint, primer etc is emitted and knowing the quantity of solvent in the coating we may estimate the HC emission from this source.

Ref 075	{ Paint	12 lb/Gal	$\frac{1120}{2000} = .56$	56% solvent
p4.2-1	{ Lacquer *	7 lb/Gal	$\frac{1540}{2000} = .77$	77% solvent
	{ Primer *	8 lb/gal	$\frac{1320}{2000} = .66$	66% solvent
	{ Enamel *	13 lb/gal	$\frac{840}{2000} = .42$	42% solvent

* estimated values by author.

Rather than attempt to weight the solvent content by use we will make the following assumptions:

- (1) 10 lb/Gal coating density
- (2) 60% solvent content

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Computation Sheet For Emission Factors

Calculations Done By William Marrone Date 8-8-74

Source Automobile Assembly Plants

E_u cont'd :

Therefore using $3.5 \text{ Gal coat / Auto}$
 $10 \text{ lb coat / Gal coat}$
 $.6 \frac{\text{lb solvent (HC)}}{\text{lb coat}}$

$$E_u = .6 \times 10 \times 3.5 = 21 \text{ lb HC / Auto}$$

$$E_u = 21 \frac{\text{lb}}{\text{Auto}}$$

E_N :

Two emission points for these plants are identified as sources of solvent (HC) pollutants from surface coating operations ; ① Application Booths
 ② Oven

Control of oven emissions is readily achieved by conventional systems while spray booth emissions are not feasibly controlled with these systems. Spray booths generally have exhaust volume flow rates of excessive size. Current trends in this industry is to develop new coating operations which would eliminate solvent emissions.

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Computation Sheet For Emission Factors

Calculations Done By William Marrone Date 8-8-74

Source Automobile Assembly Plants

The following surface coating operations are thought to be in the developing stage as competing with current spray booth systems:

- a) electrostatic spraying
- b) powder electrostatic
- c) electro coating
- d) flow coating

Ref 050 Surface Coating pg 13 states that a 98% overall efficiency or better could be attained by some suitable combination of modified application method and conventional oven control system.

We will use the figure of 98% efficiency as a overall attainable control level by modifying the surface coating process in the automobile industry.

$$\begin{aligned} E_N &= .02 \times E_u = .02 \times 21 \frac{\text{lb}}{\text{Auto}} \\ &= .42 \frac{\text{lb HC}}{\text{Auto}} \end{aligned}$$

$\therefore E_N = .42 \frac{\text{lb}}{\text{Auto}} \text{ HC}$

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Computation Sheet For Emission Factors

Calculations Done By R. J. Londergan Date 10-22-74
 Source Auto Assembly Plants

Hydrocarbons :

As discussed in Vol # 1,

$$E_S = E_S^U + E_S^P + E_S^A.$$

To determine E_S , we must ~~estimate~~ ^{first} obtain a breakdown of auto assembly operations on a state-by-state basis. This information was not directly available to us.

Instead, we have used as an indicator of auto assembly plant distribution the state-by-state figures for value-added production of the motor vehicles industry in 1963, as obtained from reference 155. The eight states with the highest value-added production for motor-vehicles account for over 80% of the total national production, and we therefore only consider these (many of the smaller contributions are not available.) The table below lists the figures for value-added and the fractional capacity A_i calculated on this basis:

STATE	1963 *	10^9 M. V. production (dollars)	A_i (estimated)
	value-added		
MICHIGAN	4.9		.47
OHIO	1.9		.18

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Computation Sheet For Emission Factors

Calculations Done By R. J. Londergan Date 10-22-74
 Source Auto Assembly

HC (Cont.)

TABLE (cont.)	STATE	10^9 dollars) 1963 value-added M.V. production	A_i (est.)
	IND.		
	WIS. ILL.	0.8	.07
	CAL	0.7	.07
	N.Y.	0.6	.06
	MO.	0.6	.06
	ILL.	0.4	.04

* Ref 155

Using this estimate for A_i , we can proceed to calculate the various contributions to E_S .

$$(i) E_S^u = E_u \sum_{i=1}^k A_i$$

Of the states listed above, Michigan & Missouri, have no applicable HC regulation. Thus

$$E_S^u = (21)(.53) = 11.1 \text{ LB/Auto}$$

where $E_u = 21 \text{ LB/Auto}$ from an earlier

** Emission factor calculation.
 ** Ref 84 & 148.

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Computation Sheet For Emission Factors

Calculations Done By R. J. Londergan Date 10-22-74

Source A Auto Assembly

HYDROCARBON (Cont.)

(ii) All of the remaining states listed have regulations which require 85% emissions control at ~~the~~ emissions levels appropriate to this ~~industry~~ process.* Therefore we obtain

$$E_S^P = E_u \sum_{j=1}^M A_j (1 - P_{cj}) \\ = (21)(0.15)(0.48) = 1.5 \text{ LB/AUTO}$$

For the total E_S we then obtain

$$E_S = E_S^u + E_S^P = 12.6 \text{ LB/AUTO}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 6/5/75

Source Cask Cover Production

Ref (276) p 4b

1967 Pb Consumption = 63,037 tons

1971 Pb ESTIMATE = 52,920 tons

$$P_c = \sqrt[4]{\frac{52.92}{63.04}} - 1.0 = -0.043$$

$$P_c = -0.043 \quad \text{comp'd}$$

$$1975 \text{ Cons.} = 52920 (1 - 0.043)^4 = 44388$$

$$A = 0.0444 \times 10^6 \text{ tons Pb}$$

Ref (276) p 42 Due to lead recycling during the coating process, K must be modified to reflect the situation.

Ref (276) estimates a factor of @ least 10
 p 42

$$K = 10.0$$

Due to the lack of economic incentive, we will assume

$$P_B = 0.0$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 6/5/75

Source CABLE COVER PRODUCTION

From Ref (281) p12

$$E_U = 0.0439 \text{ LB/TON LEAD}$$

From Ref (275) p48

$$E_{ind} = (1 - .75)(0.0439) = .0109$$

$$E_{ind Pb} = 0.0109 \text{ LB/TON LEAD}$$

Ref (276) p43 indicates ~ 20 plants in the U.S. & 2/3 presses per plant. The Avg melt kettle size is 3,000 \rightarrow 15,000 lbs
 Assuming the Avg of 9,000

Ref (276) p46 indicates that most plants are located in Conn, NY & NJ

Using the PWR curves from Ref (84) & (48)

Allowable =

$$\text{Conn} \approx 9.7$$

$$NY = 10.8$$

$$NJ = 30$$

$$\overline{\text{AVG}} = 16.8 \text{ LB/HR particulate}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 6/5/75
 Source Cable Cover Production

Ref (281) p 12

$$\text{Avg \% Pb of part.} = \frac{(4.99 + 17.2 + 25.6)}{3} = 15.93\%$$

$$(.1593)(16.8) = 2.676 \text{ lb/hr}$$

Assuming "defacto"
Pb content resulting
from particulate eggs.

$$\frac{2.676 \text{ lb/hr (2000)}}{(9000)} = 0.595 \text{ lb/ton}$$

Since $E_S \gg E_U$ $E_S \approx E_U$

$$E_{S_{Pb}} = 0.0439 \text{ lb/ton LEAD}$$

PARTICULATE

Neg P.
Zero Pb Not applicable for NSPS.

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 6/5/75

Source CAN Mfg (Soldering Ops)

Ref (276) p 73

CANS SOLDERED IN 1973 = 65×10^9

$$\text{ESTIMATED # of cans soldered in 1980} = \frac{(30+40) \times 10^9}{2} = 35 \times 10^9$$

$$P_C = \sqrt[7]{\frac{35}{65}} - 1 = \sqrt[7]{.5385} - 1 = -.085$$

$$P_C = -0.085$$

cmfd

THERE WOULD BE NO ECONOMIC INCENTIVE TO REPLACE OBSOLETE CAPACITY,
 WE WILL ASSUME

$$P_B = 0.0$$

Ref (276) p 73 IN 1975, 50×10^9 CANS

Ref (277) APPB $1.8 \times 10^{-3} \text{ Pb}/1000 \text{ cans}$

$$\frac{(50 \times 10^9)(1.8 \times 10^{-3})}{2000} = 45,000 \text{ tons of Pb}$$

Ref (144) Using the avg 1965-1973 K for the food & BEVERAGE industry as representative
 p 48

$$K = 0.81$$

$$A = \frac{45,000}{.81} = 0.0555 \times 10^6 \text{ tons Pb} = A$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hoyer Date 6/5/75

Source CAN MFG (Soldering Ops)

Ref (276) p 75 gives Wiping Station Emissions of
 412 lb/yr of LEAD @ 50% control for $1.44 \times 10^8 \text{ cans/yr}$

+

96.4 lb/yr of LEAD @ 0% control for $1.44 \times 10^8 \text{ cans/yr}$
 @ the solder bath

$$\frac{\left[\left(\frac{412}{.5} \right) + (96.4) \right] 2000}{(1.44 \times 10^8)(1.8 \times 10^{-3})} = 7.1 \text{ lb/ton Pb}$$

$$E_{N_{Pb}} = 7.1 \text{ lb/ton Pb}$$

Ref (276) p 78 If we assume an overall control of 75%
 using low energy wet scrubbers, then . . .

$$E_{N_{Pb}} = 7.1 (1 - .75) = 1.78$$

$$E_{N_{Pb}} = 1.78 \text{ lb/ton Pb}$$

$$@ 1.44 \times 10^8 \text{ cans/yr} \quad 1.8 \times 10^{-3} \text{ lb Pb/1000 cans}$$

$$(1.44 \times 10^8)(1.8 \times 10^{-3}) = 259,200 \text{ lbs Pb/yr plant}$$

From Ref (276) p 75 Model can line operates 4800 hrs/yr

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 6/5/75

Source Can Mfg (Soldering Op'n)

$$\text{PWR} = \frac{259,200}{4800} = 54 \text{ lb/hr}$$

From the gen'l PWR curve (Ref 54 & 148)

Allowable = 0.044 lb/hr. (Assuming 'defacto' control
 of Pb thru part. reg's)

$$E_{SPb} = \frac{0.044(2000)}{(54)} = 1.63$$

It would appear that the States are not enforcing particulate
 reg's within this industry probably because of the low PWR.

Ref 276 p 75 indicates that dry cyclones @ ~50% efficiency
 are generally used on the wiping station emissions.

Since this is present industry practice, we will def'n Es
 as follows

$$\frac{[(412 + 46.4)]2000}{(1.44 \times 10^8)(1.8 \times 10^{-5})} = 3.92$$

$$E_{SPb} = 3.92 \text{ lb/Ton Pb}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marone Date 8-7-74

Source Lead Acid Battery

The major production of storage batteries is for lead-acid storage batteries as indicated by it representing 93% of the value of shipment Ref 039 pg 1

Lead and Lead oxide are consumed in battery manufg Ref 039 p 8 Table 1.6 lists the 1965-1971 lead consumption data which when combined with auto battery production figures (assumed to be total lead-acid product) on pg 3 Table 1.3 of the above source, may be used to calculate Lead and Lead oxide requirements per battery:

<u>YR</u>	<u>Batteries (MM)</u>	<u>Tons</u>		<u>Tons</u>	
		<u>Pb</u>	<u>lb Pb/Batt</u>	<u>PbO</u>	<u>lb PbO/Batt</u>
1967	40.0	229,287	11.5	231,378	11.9
1968	44.5	250,129	11.2	263,576	11.8
1969	45.4	280,386	12.3	302,160	13.3
1970	45.6	283,451	12.4	310,002	13.6
1971	49.7	283,110	11.4	342,149	13.7
		<hr/>		<hr/>	
		Avg 11.8 lb/Batt		Avg 12.9 lb/Batt	

We will use 12 lb Pb/Batt and 13 lb PbO/Batt which are the material consumptions in the battery manufacturing process.

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Computation Sheet For Industrial Factors

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

Source Lead Acid Battery

P_c :

Pg 1 and Table 1.2 pg 2 of Ref 039 indicate that the annual growth for lead-acid batteries is estimated to be 5%. This growth is assumed to continue for the period 1975 to 1985. Development in electric car technology would result in a higher growth rate, however feasible system are not in abundance nor do we expect a significant cut into the internal combustion market by 1985.

$$P_c = .05 \text{ compound}$$

Ref 044 pg 41 indicates a 5.1% growth (compound) for the present period

Ref 039

K: A fractional utilization factor is obtained by referring to Table 3-1 which gives the materials processed through various operations and the capacity of 5000 Batt/day. The Process flow chart Fig 2.1 pg 10 indicates the steps at which Pb and PbO are inputted

Lead (Pb) is inputted in the Lead Melt Pots and Oxide Paste Mixing.

Lead Oxide is inputted in the Oxide-Paste Mixing

From Table 3-1 pg 16 $Pb \text{ input} = 20,000 + 25,000 = 45,000$

$$PbO \text{ input} = 50,000 \text{ lb/day}$$

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Computation Sheet For Industrial Factors

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

Source Lead Acid Battery

↳ cont'd

With this data and our estimate of the Pb and PbO input/ per battery we may calculate the estimated production of the plant depicted on Table 3-1

$$\text{Pb: } \frac{45,000 \text{ lb Pb/day}}{12 \frac{\text{lb Pb}}{\text{Batt}}} = 3750 \text{ Batt/day}$$

$$\text{PbO: } \frac{50,000 \text{ lb PbO/day}}{13 \frac{\text{lb PbO}}{\text{Batt}}} = 3846 \text{ Batt/day}$$

K factors are obtained by reducing production to capacity where capacity was reported as 5000 Batt/day.

$$K_1 = \frac{3750}{5000} = .75$$

$$\text{Avg } K = .76$$

$$K_2 = \frac{3846}{5000} \approx .77$$

We will use the avg value of K obtained above

$$K = .76$$

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Computation Sheet For Industrial Factors

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

Source Lead-Acid Battery

A:

Taking the 1969 Battery shipments (original + replacement) from Table 1.3 pg 3 of Ref 039 and applying the $P_C = .05$ for the period 1969 - 1975 we may calculate the 1975 estimated production of lead-acid batteries

$$P_{75} = 45.4 (1 + .05)^6 \times 10^6$$

$$P_{75} = 60.8 \times 10^6 \text{ Batt/yr}$$

Applying $K = .76$ we calculate the 1975 Production capacity (A)

$$A = \frac{P_{75}}{K} = \frac{60.8 \times 10^6}{.76}$$

$$A = 80 \times 10^6 \text{ Batt/yr}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-27-74

Source Lead Acid Battery Plants

P_B :

Ref 037 pg 34-35. Section 36.1

We assume that this industry is covered under the above table which does refer to storage batteries.

Asset guideline period 12 yrs

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

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

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

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marzzone Date 8-8-74

Source Lead Acid Battery

Particulates

E_u : Table 3.2 pg 17 of Ret 039 tabulates the results of emission data from 9 lead-acid battery manufacturers. Lead oxide (PbO) emitted from oxide paste mixing, assembly, lead melting pots is in the particulate matter. Uncontrolled PbO particulate emissions are obtained from Plants #1, #6, #7, #8 which had no control device or just a simple filter pad as in Plant #7. The emission factor is $E = 20 \frac{lb\ PbO}{Ton}$

Using the weight contribution of PbO to the manuf of batt (13 lb PbO /Batt) we calculate the emission factor in terms of lb/PbO per battery

$$E_u = \frac{20 \frac{lb\ PbO}{Ton\ PbO}}{\frac{13 \frac{lb\ PbO}{Batt}}{2000 \frac{lb\ PbO}{Ton}}} = \frac{20}{13} \frac{Ton}{Batt} = \frac{20}{13} \frac{Ton}{Ton} = \frac{20}{13} lb/Batt$$

$$E_u = .13 \frac{lb}{Batt}$$

PbO (particulate)
emission factor
uncontrolled

E_N :

Plants #2, #3, #4 and #9 control the PbO emissions by baghouse filters. #4 also has controlled temperature

#2 .20 lb/T

#3 .20 lb/T

#4 .02 lb/T

#9 .05 lb/T

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Computation Sheet For Emission Factors

Calculations Done By R.W. Mannone Date 8-8-74

Source Lead Acid Battery

Σ_N : cont'd Plants #4 and #9 are more efficiently controlled

$$\text{#4} = \frac{20-.02}{20} = 99.9\%$$

$$\text{#9} = \frac{20-.05}{20} = 99.2\%$$

Baghouses or air scrubbers are generally used in Lead-acid plants and the practical efficiency is 98.2-99.8% off. We will use 99.9% efficiency as obtainable in 1985-1985

$$E_N = .001 \times E_u = .001 \times .13$$

$$E_N = .00013 \text{ lb/Batt}$$

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Computation Sheet For Emission Factors

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

Source Lead Acid Battery

Lead Fumes

$E_u :$

Referring to Ref 039 pg 17 Table 3.2 we obtain emission factors for lead from 9 lead battery plants.

Plant #	Control	E lb/TON
#1	NONE	.92
#2	Baghouse	.80
#3	Baghouse	.80
#4	Baghouse & Temp Cont	.55
#5	Lead Traps	.86
#6	None	1.00
#7	Filter Pads	.80
#8	None	.83
#9	Baghouse	.81

$$E_{Avg} = \frac{.82}{9}$$

These values are statistically the same and we will develop an average lead emission factor. The fact that the emission factors for controlled plants are nearly the same for uncontrolled plants concludes either of the following:

- ① Sources of lead emissions are not generally points of emission control.
- ② the fume nature of the lead effluent would preclude poor collection efficiency

In any case the uncontrolled emission factor is derived from the avg of the above values.

$$E_{Avg} = .82 \frac{\text{lb Pb}}{\text{TON Pb}}$$

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Computation Sheet For Emission Factors

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

Source Lead Acid Battery
Lead Fumes cont'd

E_u

Taking the avg emission factor and the lb Pb input / Batt we may estimate the uncontrolled emission factor for Lead

$$E_u = .82 \frac{\text{lb Pb}}{\text{Ton Pb}} \times \frac{12 \text{ lb Pb}}{\text{Batt}} \times \frac{\text{Ton Pb}}{2000 \text{ lb Pb}}$$

$$E_u = .005 \frac{\text{lb Pb}}{\text{Batt}}$$

E_N :

Control technology for controlling the lead fumes does not appear to be presently available.

We assume $E_N = 0$ for maximum impact determination

E_{IIIc} is also considered equal to zero

$$E_{IIIc} = 0$$

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Computation Sheet For Emission Factors

Calculations Done By 2) Morrone Date 8-8-74
 Source Lead Acid Battery

Acid Mist

E_u : From Table 3.1 pg 16 Ref 039 we obtain:

Typical Plant {
 150 lb/day H_2SO_4 Fume
 No control
 5,000 Batt day cap

We will apply our $K = .76$ and the above data to determine an estimate of the uncontrolled emission factor for acid mist.

$$E_u = \frac{150 \text{ lb acid}}{\text{day}} \times \frac{\text{day}}{.76 \times 5000 \text{ Batt}}$$

$$E_u = .04 \text{ lb/Batt Acid mist}$$

E_N : pg 20 Ref 039

control of H_2SO_4 fume from forming operation is achieved by ~~water~~ water scrubbing of room air. The water is neutralized by NH_3 and $NaOH$. The air is recycled to the plant. H_2SO_4 is high sol.

This system is assumed, especially in light of recycle, to be 99.98% eff. $E_N = .0001 \times E_u$

$$E_{11d} = E_N = .000004 \text{ lb/Batt}$$

$$E_N = .000004 \text{ lb/Batt}$$

Negligible

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Computation Sheet For Emission Factors

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

Source Lead Acid Battery

E_u :

Hydrocarbons

HC emissions may be emitted by spray booths, dryers, and heat seal machines.

Ref 039 Table 3.1

<u>Operation</u>	<u>HC Emission Rate</u> (uncontrolled)
Spray Booths	4 Gal/day
Dryer	.5 Gal/day
Heat Sealing	.1 lb/day

Using 7.5 lb/gal as the density of average paints solvents. we obtain

Spray Booth	30 lb/day
Dryer	3.8 lb/day
Heat Seal	1
	34.8 \approx 35 lb/day

Capacity = 5000 Batt/day

Production = $.76 \times 5000 = 3800$ Batt/day

$$E_u = \frac{35 \text{ lb HC/day}}{3800 \text{ Batt/day}}$$

$$E_u = .009 \cdot \text{lb/Batt}$$

negligible?

Hydrocarbons

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 8-8-74
 Source Lead Acid Battery

Hydrocarbons

E_N :

We assume that incineration or carbon adsorption may be applied to these sources.

Efficiencies to be expected by these systems would be on the order of 95-99%. We will assume 99%.

$$E_N = .01 \times E_u = .01 \times .009 \text{ lb/Batt}$$

$$E_N = .00009 \text{ lb/Batt}$$

(negligible)

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-23-74

Source Lead Acid Battery

Ref 148 § 084

Regulations do not apply to emissions of lead fume and acid mist from acid battery plants so that the allowable emission are assumed equal to the uncontrolled level.

(Lead Fume)

$$E_s = .005 \frac{lb \text{ Pb Fume}}{\text{Battery}}$$

(Acid Mist)

$$E_s = .04 \frac{lb \text{ Acid Mist}}{\text{Battery}}$$

(Particulate)

The process weight for lead acid battery manuf. is considered to be the sum of the lead and lead oxide inputs calculated previously.

$$12 \frac{lb \text{ Pb}}{\text{Batt}} + 13 \frac{lb \text{ PbO}}{\text{Batt}} = 25 \frac{lb \text{ process input}}{\text{Batt}}$$

Using a typical plant size of 5000 battery/day and $16 \frac{hr}{day}$
 operation

$$\frac{25 \text{ lb input}}{\text{Battery}} \times \frac{5000 \text{ Battery}}{\text{day}} \times \frac{\text{day}}{16 \text{ hr}} \approx 7813 \frac{\text{lb}}{\text{hr}}$$

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 11-23-74
Source Lead Acid Battery

E_s :
(particulate)

From the generalized process weight rate curve the allowable hourly emission rate is about 10.1 lb/hr for the process weight rate of 7813 lb/hr.

$$\frac{10.1 \frac{\text{lb}}{\text{hr}} \times \frac{16 \text{ hr}}{\text{day}}}{5000 \frac{\text{Batt}}{\text{day}}} = .032 \frac{\text{lb particulate}}{\text{Battery}}$$

$$E_s = .032 \text{ lb Particulate/Battery}$$

E_s :
Hydrocarbon

$$\frac{30}{35} = 86\% \text{ of solvent emission from spray booth}$$

We assume solvent emissions are in the reactive category. (non-heat process) for E_s determination.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-23-74

Source Lead Acid Battery

S : cont'd

Hydrocarbons

Ref 039 Appendix Table 1.1

Ref 148 & 084

<u>State</u>	<u>No of Battery Plants</u>	<u>Allowable Emission</u>
Alabama	1	40 lb/day
Alaska	2	No Reg
Arizona	1	No Reg
Arkansas	1	No Reg
California	54	40 lb/day
Colorado	4	No Reg
Connecticut	5	40 lb/day
Delaware	1	No Reg
Florida	13	No Reg
Georgia	6	No Reg
Illinois	15	8 lb/hr (128 lb/day)
Indiana	9	15 lb/day
Iowa	2	No Reg
Kansas	2	No Reg
Kentucky	5	40 lb/day
Louisiana	2	15 lb/day
Mass.	6	No Reg
Michigan	8	No Reg
Minnesota	3	No Reg
Mississippi	2	No Reg

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Computation Sheet For Emission Factors

Calculations Done By W. Marone Date 11-23-74

Source Lead Acid Battery

E_s

Hydrocarbon
cont'd

<u>State</u>	<u>No of Battery Plants</u>	<u>Allowable Emiss</u>
Missouri	5	No Reg
Nebraska	1	No Reg
New Jersey	5	No Reg
New Mexico	1	No Reg
New York	9	No Reg
N. Carolina	3	40 lb/day
Ohio	5.	40 lb/day
Oklahoma	1	40 lb/day
Oregon	8	No Reg
Pennsylvania	14	40 lb/day
Rhode Island	2	No Reg
S. Carolina	2	No Reg
Tennessee	6	No Reg
Texas	20	100 lb/day
Vermont	1	No Reg
Virginia	3	40 lb/day
Washington	5	No Reg
W. Virginia	1	No Reg
Wisconsin	6	30 lb/day
Total	240	

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-23-74

Source Lead Acid Battery

; : cont'd

hydrocarbon

① For those plants (states) with No Regs E_s assumed equal to E_u'

$$97 \text{ plants} = E_s = E_u' = 35 \text{ lb/day}$$

$$A_c = \frac{97}{240} = .404$$

② For those plants (states) with $E_{sc} \geq 35 \text{ lb/day}$, $E_{sc} = E_u' = 35 \text{ lb/day}$

$$126 \text{ plants} = E_s = E_u' = 35 \text{ lb/day}$$

$$A_i = \frac{126}{240} = .525$$

③ plants with $E_{sc} < E_u' (35 \text{ lb/day})$

$$11 \text{ plants} \quad 15 \text{ lb/day}$$

$$A_i = \frac{11}{240} = .046$$

$$6 \text{ plants} \quad 30 \text{ lb/day}$$

$$A_i = \frac{6}{240} = .025$$

$$E_s = .404(35) + .525(35) + .046(15) + .025(30)$$

$$E_s = 14.14 + 18.38 + .69 + .75$$

$$E_s = 33.96 \frac{\text{lb}}{\text{day}} \text{ or } E_s = \frac{33.96 \text{ lb/day}}{5000 \frac{\text{Battery}}{\text{day}}} = .0068$$

$$\therefore E_s = .0068 \text{ lb/Batt}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 5/27/75

Source Type METAL Production

Ref(277) Section IX-B gives the following info as taken from the Minerals Yearbook

$$P_C = -0.06$$

simple

$$K = 1.0$$

$$A = 0.016 \times 10^6 \text{ tons}$$

From Ref(277) doubling the IRS depreciation life gives a replacement rate of 4.5%. However, since the industry is declining @ 1.6% rate, they would not in all probability replace obsolete capacity for economic reasons.

$$P_B = 0.0$$

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Computation Sheet For Emission Factors

Calculations Done By Horne Date 5/27/75
 Source Type METAL Production

Ref (278) p 88

For a single plant, emissions were 1425 lbs Pb per year from a plant that purchased 104 tons of metal. The controlled E.F. is $\eta^* / \text{ton Pb in the Alloy}$

$$\frac{1425}{104 (\% \text{ lead})} = 17 \quad \% \text{ lead} = 80\%$$

$$\eta_{\text{collection}} = 78\%$$

$$E_{\text{upb}} = \frac{17}{.22} = 77.3$$

$$E_{\text{upb}} = 77.3 \text{ lb/ton Pb in Alloy}$$

If we assume that all plants (existing) can achieve 80% η then

$$E_{\text{ind}} = 77.3 (1-.8) = 15.5$$

$$E_{\text{ind}} = 15.5 \text{ lb/ton Pb in Alloy}$$

Ref (277) Section IX-3 gives E_S as 38.8

$$E_{S_{\text{pb}}} = 38.8 \text{ lb/ton Pb in Alloy}$$

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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16. ABSTRACT The purpose of this document is to present the results of a study to determine the impact of new source performance standards on nationwide emissions. The work presented covers 14 potential pollutants from approximately 200 source categories for the year 1985. The results are being used by EPA as input to the development of an overall standard setting strategy. The report contains information regarding controlled and uncontrolled emission factors, State emission limitations, industrial capacity, utilization, growth and retirement rates. The results of this study have been published as three volumes which encompass ten separate documents. This document contains Appendices 4F through 4I of Volume II - Calculation Sheets for Evaporation Loss Sources, Petroleum Industry, Wood Products Industry, and Assembly Plants.		
17. KEY WORDS AND DOCUMENT ANALYSIS		
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Air Pollution Air Pollution Control Industrial Processes Combustion Regulations Economic Factors	Priorities Chemical Industry Paper Industry Petroleum Industry	Metal Industry Agricultural Mineral Flyash Exhaust Gases
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