BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

B.H. Levelton & Associates Ltd. - Inventory of Sources and Emissions in the Kamloops, Cache Creek, Clinton and Highland Valley Areas - August 1978.

ENVIRONMENTAL IMPACT STATEMENT REFERENCE NUMBER: 48

INVENTORY OF SOURCES AND EMISSIONS IN THE KAMLOOPS - CACHE CREEK, CLINTON AND HIGHLAND VALLEY AREAS

Prepared for

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We wish to acknowledge the assistance and co-operation offered by personnel of each company in providing information and data on their plant's operation.

SUMMARY

The inventory of atmospheric emissions has been prepared to provide reliable information regarding the nature, magnitude and extent of the emissions of particulate matter, sulfur oxides and nitrogen oxides in the Kamloops - Cache Creek - Clinton - Highland Valley area.

Total current emissions of sulfur dioxide (SO_x), oxides of nitrogen (NO_x) and particulate matter are estimated at 27,716; 7,736 and 35,864 pounds per day, respectively. Estimates of emissions were based on Pollution Control Permit conditions, emission factors and measurement data.

1. INTRODUCTION

1.1. Basis for the Project

British Columbia Hydro and Power Authority require an inventory of sources (existing and proposed) and emissions of oxides of sulfur (SO_x), oxides of nitrogen (NO_x) and total particulate matter in the Kamloops - Cache Creek - Clinton - Highland Valley area.

The inventory consists of emission parameters on a mass emission rate and will be used to evaluate the load on the air shed, and the potential for cumulative effects on ambient air quality for each area.

1.2. Statement of Work

The approach taken toward obtaining reliable data may best be described by the statement of work and may be summarized as follows:

1.2.1. To identify all emission sources of SO_x, NO_x and particulate matter.

1.2.1.1. Fuel combustion in stationary sources (excluding commercial and domestic buildings).

1.2.1.2. Industrial processes (existing and proposed).

1.2.1.3. Solid waste incineration (e.g. wood waste).

1.2.1.4. Miscellaneous.

1.2.2. To account for at least 90% of the total emission of each contaminant.

1.2.3. For each of the selected sources to identify and quantify the emissions of each contaminant studied.

1.2.4. Wherever possible indicate potential expansion of existing facilities.

2. EMISSIONS

2.1. General

This report summarizes the estimates of emissions of the three primary air contaminants in terms of point sources which are currently in operation or are proposed operations for the study area.

The accuracy of the estimates presented varies with the contaminant and the emission sources. In most cases information was obtained by interviewing individual companies. In others, information was obtained from Pollution Control Permits and by using emission-factor techniques.

A summary on each emission point source is given in Appendix A.

Figure 1 shows the location of emission sources in the study area. Figure 2 shows the proposed site for the 1000 TPD smelter/refinery complex near Clinton, B.C.

All companies that were contacted were reasonably certain that their operating facility would not be significantly expanded during the next ten to fifteen years.

2.2. Sulfur Oxides

The emission rates for oxides of sulfur (SO_x) were calculated on the basis of maximum permissible concentration at the stack (Permit conditions) where processes were identified as producing SO_x. For processes not identified by the permit as generating SO_x, e.g. combustion process, emission factors were used to estimate the amount of SO_x produced.

The maximum allowable emission rate of oxides of sulfur for presently operating point sources is 20,212 lb/day which includes Afton Mines Ltd. (NPL) as an operating source, Table I. The actual "operating emission rate" for all point sources in the study area is estimated to be 27,716 lb/day.

Should the two copper smelter complexes be built and operated their combined SO_x emission would be 310,080 lb/day, Table II. The proposed 2,000 M.W. Thermal Electric Generating Station would contribute 752,000 lb/day of SO_x.

The total emissions of SO_x from currently operating and proposed emission sources is estimated at 998,592 lb/day, Table III.

Data concerning emission of SO_x at Gulf Oil Canada (Appendix A) were prorated from a production rate of 10,000 barrels per day. The actual production rate is reported at approximately 8,500 bpd, thus, the SO_x emission rate would be reduced to 20,178 lb/day.

2.3. Nitrogen Oxides

In every combustion process the high temperatures at the burners result in the fixation of some oxides of nitrogen (NO_x) not only from the reaction of atmospheric nitrogen and oxygen, but from combustion of nitrogenous compounds contained in the fuel. Major factors that lead to NO_x production are: flame and furnace temperature, combustion gas residence time, rate of cooling, and amount of excess air present in the combustion zone.

The estimated daily average of NO_x emitted from all operating sources is 7,736 lb/day. The proposed 400 TPD and 1000 TPD copper smelter/refineries would contribute an estimated 43,200 lb/day NO_x based on emission factors for a pyrometallurgical copper smelting/refining process (1)[1]. The thermal electric generating station would produce an estimated 357,120 lb/day NO_x (2).

It should be noted that in "Pollution Control Objectives for Food-Processing, Agriculturally Oriented, and Other Miscellaneous Industries in British Columbia", Level A operation in general allows up to 660 ppm nitrogen oxides measures as NO_2. Specifically, objectives for stationary industrial combustion sources limit emissions to 50 lb/1000 imperial gallons of fuel oil, 200 lb/10^6 scf natural gas and 27 lb/ton of coal burned.

2.4. Particulates

An accurate evaluation of the emissions of particulate matter requires detailed information describing the extent, design and efficiency of a control system being used or actual measurements of particulate matter concentration. The type of information available was not sufficiently detailed to permit consistent accuracy.

Based on emission limit values prescribed by Pollution Control Permits issued to operating point sources, (and operating point sources not under permit), the calculated daily emission rate is estimated at 43,543 lb/day of particulate matter, Table I. The estimated particulate emission rate for the proposed 400 and 1000 TPD copper smelters is 18,900 lb/day. Particulate matter emitted by the proposed thermal electric generating station is estimated at 83,520 lb/day after passing through a gas cleaning system.

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[1]Numbers in brackets refers to References.

Six of the fifteen companies operating under Pollution Control Permit conditions are allowed a combined total emission rate of 35,412 lb/day. The actual measured rate of emission was found to be 29,158 lb/day, or 82% of the permissible total.

REFERENCES

(1) AP-42, Compilation of Air Pollutant Emission Factors, Second Edition, U.S. Environmental Protection Agency, March, 1975.

(2) Pollution Control Objectives for Food-Processing, Agriculturally Oriented and Other Miscellaneous Industries of British Columbia, January 1975.

OTHER REFERENCES

Pollution Control Objectives for the Mining, Mine-Milling, and Smelting Industries of British Columbia, December, 1973.

Pollution Control Objectives for the Chemical and Petroleum Industries of British Columbia, March 1974.

Pollution Control Objectives for the Forest Products Industry of British Columbia, September 1971.

TABLE I

EMISSIONS FROM OPERATING EMISSION SOURCES IN THE
KAMLOOPS-CACHE CREEK, CLINTON AND HIGHLAND VALLEY AREAS

EMISSION SOURCE	EMISSION RATE ALLOWED BY PERMIT[1] (lb/day)			OPERATING EMISSION RATES[2] (lb/day)		
	SO_x	NO_x	Particulate	SO_x	NO_x	Particulate
West Coast Transmission	1	480	Trace	1	480	Trace
Central Heating Plant	500	106	37	500	106	38
Tranquille Hospital	666	142	50	666	142	50
B. A. Blacktop	1	340	514	1	340	82
Weyerhaeuser	11,800 (3)	6,090	28,137	2,948 (3)	1,290	27,200
Ainsworth Lumber	22	644	367	22	644	367
Trans Mountain Pipe Line	9	460	10	9	460	10
Gulf Oil Canada	3,623	6,249	1,243	20,178	684	145
Canada Cement Lafarge	1	3,584	1,994	1	2,066	676
Evans Products Company	84	840	2,926	84	470	2,780
Balco Industries	1	486	2,930	1	486	2,190
Bethlehem Copper	202	15	1,266	4	1	943
Dawson Construction	1	332	491	1	332	120
Afton Mines[4]	3,300	322	1,320	3,300	156	1,151
Lornex Mining	Neg	181	2,258	Neg	79	112
Operating Total	20,212	20,271	43,543	27,716	7,736	35,864

(1) Based on Level A Objective operation or prescribed permit conditions and emission factors.

(2) Based on measured emission rates and/or emission factors.

(3) Figure represents only the recovery unit.

(4) All figures are based on design criteria, no measurements are available for this site.

TABLE II

EMISSIONS FROM PROPOSED EMISSION SOURCES IN THE
KAMLOOPS-CACHE CREEK, CLINTON AND HIGHLAND VALLEY AREAS

EMISSION SOURCE	EMISSION RATES ALLOWED BY PERMIT[1] (lb/day)			PROPOSED OPERATING EMISSION RATES[2] (lb/day)		
	SO_x	NO_x	Particulate	SO_x	NO_x	Particulate
Proposed 1000 TPD Copper Smelter/Refinery Complex (70 Mile House)	30,300	38,000	13,500	302,000	38,000	13,500
Proposed 400 TPD Copper Smelter (Highland Valley)	8,080	15,200	5,400	8,080	15,200	5,400
Proposed 2,000 MW Thermal Electric Generating Station (Hat Creek)	940,000	1,269,000	235,000	752,000	357,120	83,520
Total	978,380	1,322,200	253,900	1,062,080	410,320	102,420

1. Based on Level A Objective operation and/or emission factors for controlled sources.

2. Proposed emission rates based on control methods to be applied.

TABLE III

TOTAL EMISSIONS FROM EXISTING AND PROPOSED EMISSION SOURCES IN THE KAMLOOPS-CACHE CREEK, CLINTON AND HIGHLAND VALLEY AREAS

EMISSION SOURCES	EMISSION RATES ALLOWED BY PERMIT[1] (lb/day)			OPERATING EMISSION RATES[2] (lb/day)		
	SO_x	NO_x	Particulate	SO_x	NO_x	Particulate
Emissions from existing and operating plants	20,212	20,271	43,543	27,716	7,736	35,864
Emissions from proposed plants	978,380	1,322;200	253,900	1,062,080	410,320	102,420
Total (all sources)	998,592	1,342,471	297,443	1,089,796	418,056	138,284

1. Based on Level A Objectives operation and/or emission factors for controlled sources.

2. Based on measured rates and/or emission factors, and proposed control methods to be applied.

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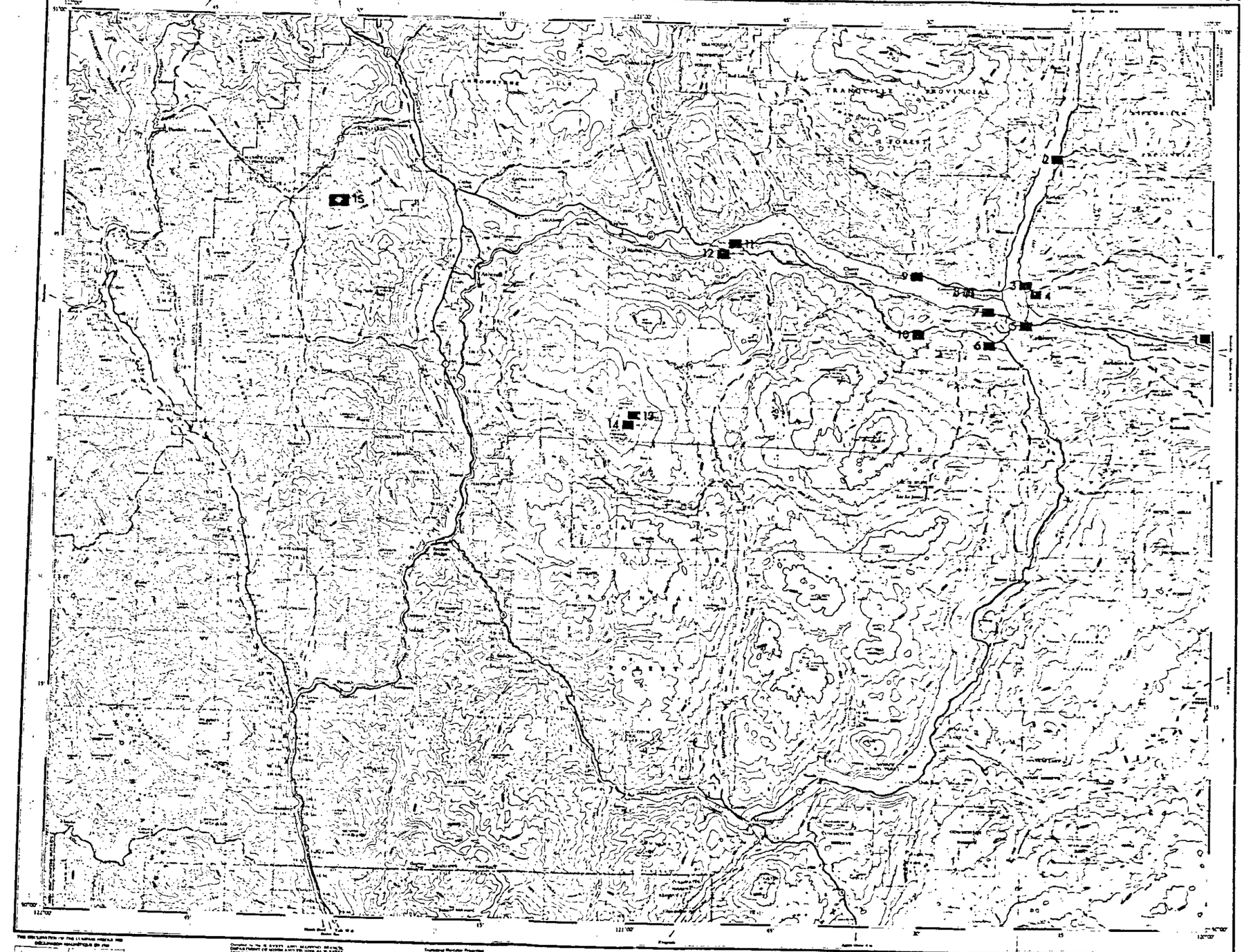
1:250,000

CANADA

EDITION 2

92-I



KEY

Locations by Number

1. Canada Cement Lafarge
2. Balco Industries
3. B.A. Blacktop
4. Dawson Construction
5. Central Heating Plant
6. Trans Mountain Pipeline
7. Weyerhauser Canada
8. Gulf Oil
9. Tranquille Hospital
10. Afton Mines
11. Savona Timber
12. Westcoast Transmission
13. Bethlehem Copper
14. Lornex Mining
15. Proposed Thermal Electric Station

TEN THOUSAND METRE
ZONE 10

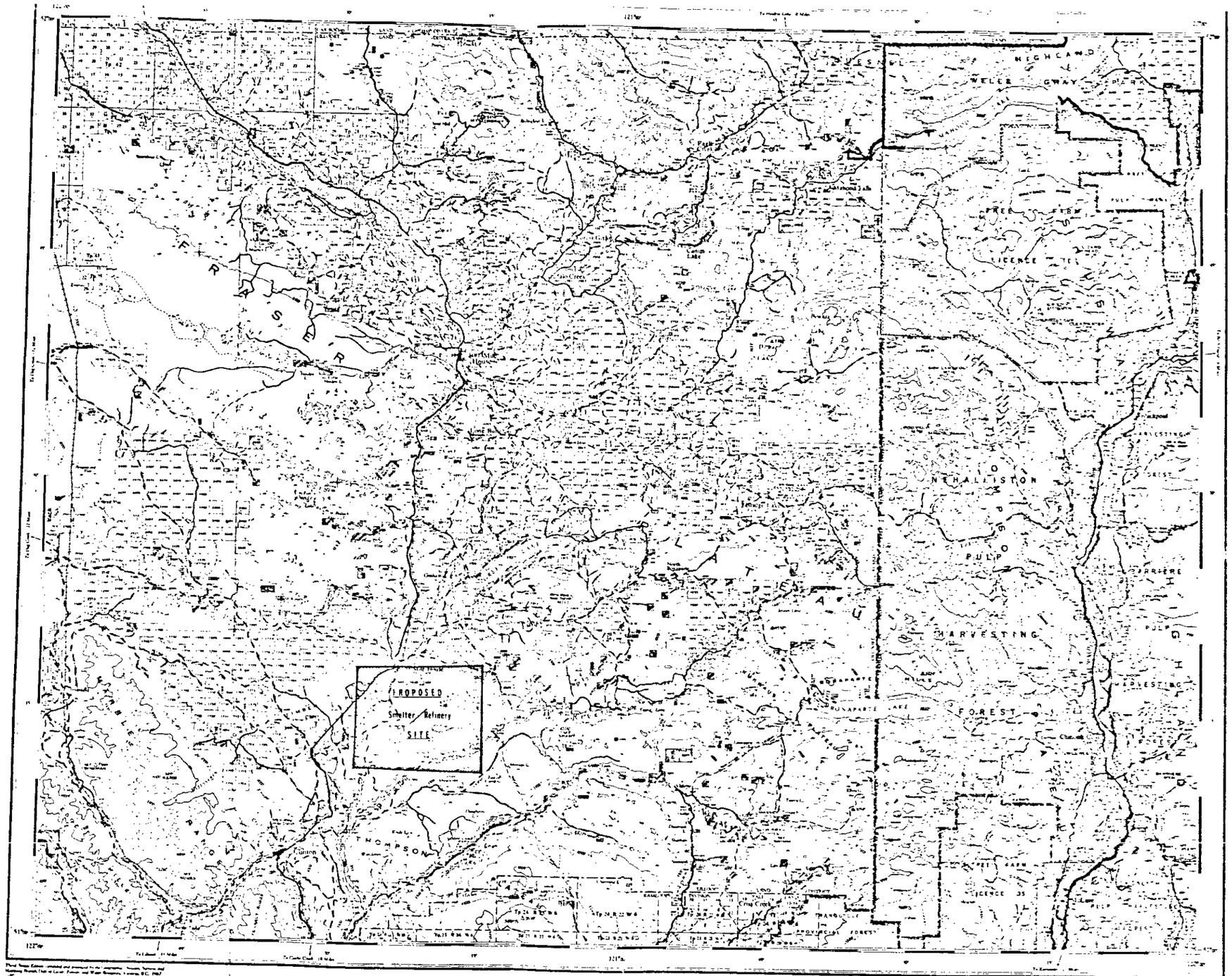
ASHCROFT

BRITISH COLUMBIA

WEST OF SIXTH MERIDIAN - OUEST DU SIXIÈME MÉRIDIEN

Scale 1:250,000 Echelle

ASHCROFT
92-I
EDITION 2



REFERENCE

BONAPARTE RIVER

BRITISH COLUMBIA

Scale 1:250,000 or approximately 1 Inch to 4 Miles

Scale of Kilometres

REFERENCE

BONAPARTE RIVER, B.C.
SHEET 92P
THIRD STATUS EDITION

APPENDIX A

INVENTORY OF POINT SOURCE EMISSIONS

WESTCOAST TRANSMISSION CO. LTD.

PLANT LOCATION: Savona, B. C.

PROCESS: Main Line Natural Gas Compressor Station

CONTROLS: None

Engines

Engines natural gas fueled. No alternate fuel.

Consumption Estimated: 1.83×10^6 ft^3 per day.

Emission Rate (daily average):*

CONTAMINANT	
SO_x (lb/day)	1.1
NO_x (lb/day)	480

*Compilation of Air Pollutant Emission Factors, 2nd Ed., U.S. E.P.A., March 1975, P3.3.2-1ff.

POINT SOURCES OPERATED BY

PROVINCE OF BRITISH COLUMBIA

A. CENTRAL HEATING PLANT

LOCATION: Kamloops, B. C.

Process: Hospital and government buildings heating

Controls: None

Fuel Consumption: 600,000 Imp. gal. per year of Bunker C (No. 6 oil) at 1.6% sulfur content.

Emission Rate[a] (daily average):

Contaminant[b]	
SO_x (lb/day)	500
NO_x (lb/day)	106
Particulate (lb/day)	38

(a) Assumes 365 days per year operation.

(b) Values based on emission factors.

B. TRANQUILLE HOSPITAL

LOCATION: Tranquille, B. C.

Process: Institutional heating

Controls: None

Fuel Consumption: 800,000 Imp. gal. per year of Bunker C (No. 6 oil) at 1.6% sulfur content.

Emission Rate[a] (daily average):

Contaminant[b]	
SO_x (lb/day)	666
NO_x (lb/day)	142
Particulate (lb/day)	50

(a) Assumes 365 days per year operation.

(b) Values based on emission factors.

B. A. BLACKTOP (KAMLOOPS) LTD.

PLANT LOCATION: Kamloops, B. C.

PROCESS: Asphalt Hot-mix Plant

CONTROL: Cyclonic wet scrubber

Normal Operating Period: April through October

Daily Plant Production: 835 tons/day Asphalt Hot-Mix

Kiln: Natural Gas Fired (average 2,300 CF/ton)

CONTAMINANT	SOURCE		
	SCRUBBER	GAS FIRED KILN	TOTAL
SO_x (lb/day)[a]	-	1.2	1.2
NO_x (lb/day)[a]	-	340	340
Measured particulate[b] (lb/day)	82.3	-	82.3[2]
Allowable particulate[c] (lb/day)	514.3	-	514.3

(a) Values based on emission factors.

(b) Values based on emission compliance test data.

(c) Based on values allowed by Pollution Control Permit.

WEYERHAEUSER CANADA LTD.

PLANT LOCATION: Kamloops, B. C.

PROCESS: Bleached Kraft Pulp Mill

CONTROLS: Venturi wet scrubber on main stack gases (power and recovery boiler)
Electrostatic precipitators on lime kiln and recovery boiler
Multiclone collectors on power boilers; venturi scrubber on lime kiln

Typical Daily Production: 1250 ADT/day
Bleached Kraft

Fuel Usage: (a) No. 6 oil
(b) Natural gas
(c) Hogged fuel
(d) Black liquor solids

Emission Rates (daily average):

CONTAMINANT	MAIN STACK (b)	LIME KILN, DIGESTION EVACUATOR, ETC.	OIL/N.G. FIRED BOILER (c)	TWO BOILERS N.G. FIRED (c)	RECOVERY BOILER (EST. 245,000 SDCFM)	MISC. (d)
Measured SO_x (lb/day)	N.A.	N.A.	N.A.	N.A.	2,948	
Allowable SO_x (a) (lb/day)	N.A.	-	12.4	No Limit	11,800	-
NO_x (e) (lb/day)	N.A.	N.A.	200	790	300	-
Measured Particulate (lb/day)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Allowable Particulate (a) (lb/day)	23,571	1,668	428	Neg.	-	2,470

(a) Based on values allowed by Pollution Control Permit.

(b) Includes power boilers, recovery boiler and dissolving tank.

(c) These units are considered standby and operate approximately 3-4 days per month.

(d) Does not include any fugitive dust occurring at this site.

(e) Based on emission factors (No permit limitations).

N/A = Not Available

AINSWORTH LUMBER CO. LTD.

PLANT LOCATION: Clinton, B. C.

PROCESS: Wood Products Plant

CONTROLS: Wood waste burner is equipped with damper doors and temperature control

Typical Daily Production: N.A.

Emission Rates (daily average):*

SOURCE	CONTAMINANT		
	SO_x (lb/day)	NO_x (lb/day)	PARTICULATE (lb/day)
Gasification Plant Flares	Neg.	300	1.0
Gas Fired Lumber Kilns	Neg.	120	4.0
Cyclones	-	-	137
Wood Waste Burner	22.4	224	225
Total	22.4	644	367

* Calculations based on emission factors.

TRANS MOUNTAIN PIPE LINE CO. LTD.

PLANT LOCATION: West Trans-Canada Highway

PROCESS: Crude Oil Pumping Station

CONTROL: None

Typical Daily Production: Pumping 146,000 barrels crude per day

Typical Fuel Consumption per month (30-day month):

(a) 14.0×10^6 CF Natural Gas
(b) 8,500 gal No. 2 oil

Emission Rates (daily average):*

Contaminant	Natural Gas	No. 2 Oil	Total
SO_x (lb/day)	0.28	8.83	9.11
NO_x (lb/day)	330	130	460
Particulate (lb/day)	-	9.5	9.5

*Calculations are based on emission factors.

CANADA CEMENT LAFARGE LTD.

PLANT LOCATION: Kamloops, B. C.

PROCESS: Portland Cement Manufacturing

CONTROLS: (a) Electrostatic precipitator on kiln

(b) Gravel bed filter preceded by multiclone collector on clinker cooler

(c) Baghouse type collectors at all other points

Daily Plant Production: 1,200 tons (average)

Daily Fuel Consumption: 2.5 MMCF Natural Gas

Emission Rates (daily average):

CONTAMINANT	ALLOWABLE DISCHARGE RATE[a]	MEASURED DISCHARGE RATE[b]
SO_x (lb/day)	N.A.	1.5
NO_x (lb/day)	N.A.	2,066
Particulate (lb/day)	1,994	676

(a) Based on values allowed by Pollution Control Permit.

(b) Based on Compliance Test data and emission factors.

N.A. = Not Applicable

GULF OIL CANADA LIMITED
REFINERY DIVISION

PLANT LOCATION: Kamloops, B. C.

PROCESS: Oil refinery

CONTROLS: Under negotiations

Daily Plant Production: 8,250 to 8,750 barrels per day

Fuels Used at Refinery:

(a) Bunker C (No. 6 Oil), 1.58% sulfur
(b) Sweet Refinery Gas, 3.4 v/v% sulfur
(c) Natural Gas

Daily Fuel Consumption (6×10^6 BTU equivalent barrels):

(a) Bunker C: 50 barrels
(b) Refinery Gas: 390 fuel oil equivalent barrels
(c) Natural Gas: 190 fuel oil equivalent barrels

Emission Rates (daily average, prorated to 10,000 barrels per day for gaseous fuels):

SOURCE	CONTAMINANT SO_x[a] (lb/day)	NO_x[a] (lb/day)	PARTICULATE[b] (lb/day)
#1 Boiler	2,688	198	-
#2 Boiler	2,800	165	-
#3 Boiler	2,218	105	-
#4 Boiler	2,400	110	-
#1 Crude Heater	1,411	46	-
#2 Crude Heater	1,411	22	-
Vacuum Heater	470	11	-
#1 Reformer Heater	1,142	27	-
#2 Reformer Heater	1,342	53	-
#1 Unifin. Chge. Heater	1,612	21	-
#1 Unifin. Reb. Heater	1,612	18	-
#2 Unifin. Chge. Heater	627	12	-
#2 Unifin. Reb. Heater	627	15	-
Asphalt Heater	246	2	-
FCCU Regenerator	2,143 (1,430)[b]	Trace	171
Flare	990		
TOTAL	23,739	805	171

NOTE: Actual process rate = 8,500 bpd.

(a) Based on test data obtained from the plant and representing maximum discharge rate resulting from winter processing of high sulfur crude oil. Summer operation results in approximately 40% SO_x reduction due to low sulfur crude oil.

(b) Based on values allowed by Pollution Control Permit.

(c) New installation - estimated value.

EVANS PRODUCTS COMPANY LTD.

PLANT LOCATION: Savona, B. C.

PROCESS: Wood Products Plant

CONTROLS: Wood waste burner is equipped with damper doors and temperature control

Daily Production: Sawmill - 210,000 fbm
Plywood - 150,000 sq ft 3/8"
Veneer -

Wood Waste Burner Feed Rate: 35 TPH

Emission Rates (daily average):

SOURCE	CONTAMINANT SO_x (lb/day)	NO_x (lb/day)	Particulate (lb/day)
Natural Gas Combustion[(a)]	-	-	-
Wood Waste Burner[(b)]	84	840	840
Chip Handling Cyclones[(c)]	-	-	1,716
Veneer Dryer[(d)]	-	-	370
Total	84	840	2,926

(a) Based on emission factors. Includes natural gas fired boilers and veneer dryer.

(b) Based on emission factors; at satisfactory operating conditions, i.e. 700°F and approximately 500% excess air.

(c) Based on values allowed by Pollution Control Permit.

(d) Based on maximum assumed emission rate of 0.05 gr/sdcf.

BALCO INDUSTRIES LIMITED

PLANT LOCATION: Heffley Creek, B. C.

PROCESS: Wood Products Plant

CONTROLS: Cyclones

Average Daily Production: 380,000 BFM lumber and plywood

Daily Fuel Usage: 40,000 CF natural gas

Emission Rates (daily operating average):

CONTAMINANT	
SO_x (lb/day) [a]	1.0
NO_x (lb/day) [a]	486
Particulate (lb/day) [b]	2190

(a) Based on emission factors.

(b) Based on values allowed by Pollution Control Permit.

BETHLEHEM COPPER CORPORATION

PLANT LOCATION: Highland Valley

PROCESS: Open pit copper mine and copper ore concentrator

CONTROLS: Elbair System at crusher, gas washer at concentrate dryer

Daily Output through Dryer: 200 tons

Daily Fuel Use in Dryer: 50 gal No. 2 oil

(Above based on 30 days work per month)

Emission Rates (daily average):

CONTAMINANT	ORE CRUSHER	CU CONC. DRYER	TOTAL
SO_x [a] (measured-lb/day)	-	4.5	4.5
SO_x [b] (allowable-lb/day)	-	201.5	201.5
NO_x [c] (lb/day)	-	0.6	0.6
Particulate [a] (measured-lb/day)	867	76	943
Particulate [b] (allowable-lb/day)	1,107	159.1	1,266

(a) Based on compliance test data

(b) Based on values allowed by Pollution Control Permit

(c) Based on emission factors.
(Fugitive dust occurs at open pit mine site.)

DAWSON CONSTRUCTION LTD.

PLANT LOCATION: Kamloops, B. C.

PROCESS: Asphalt Hot-Mix Plant

CONTROL: Cyclonic Wet Scrubber

Daily Production: 830 tons asphalt hot-mix
(normal operating period - April through October)

Kiln natural gas fired: (Average 2,300 cf/ton)

Emission Rate[(a)] (daily average):

Contaminant	
SO_x (lb/day)	1.1
NO_x (lb/day)	332
Particulate (lb/day)	120.7
Allowable particulate (lb/day)	491

(a) Based on emission factors and Pollution Control Branch Objectives for Asphalt Hot-Mix Plants.

AFTON MINES (NPL) LTD.

PLANT LOCATION: Kamloops, B. C.

PROCESS: Open pit copper mine, concentrator and smelter

CONTROLS: (a) A dual-alkali scrubbing system is used on gases from the top-blown rotary converter.

(b) Fabric dust collectors are used at other emission points.

Daily Production (proposed): (a) Combined metallic and copper concentrate - 146 tons

(b) Blister copper production - 95 tons

Daily Natural Gas Consumption: 450,000 CF

Emission Rates (daily average) from Mill:

CONTAMINANT	CRUSHER	ORE-PILE RECLAIM	METALLIC CONC. DRYER	FLOAT CONC. DRYER	TOTAL
SO_x (a) (lb/day)	-	-	0.0 (Not Operating)	59.8	59.8
NO_x (b) (lb/day)	-	-	0.0	3.9	3.9
Particulate (a) (lb/day)	411.4	205.7	0.0	102.8	719.9

(a) Based on values allowed by Pollution Control Permit

(b) Based on emission factors

Emission Rates (daily average) from Smelter:

CONTAMINANT	LADLE PREHEAT	LIME TRANSFER	MATERIALS HANDLING BAGHOUSE	POWER GENERATOR	T.B.R.C.	T.B.R.C. VENT
SO_x (lb/day)	Trace	-	-	Trace	*	*
NO_x (lb/day) (a)	1.8	-	-	Trace	150	-
Particulate (b) (lb/day)	Trace	0.2	360.0	Trace	70.5	Trace

(a) Based on emission factors

(b) Based on values allowed by Pollution Control Permit.

Note:* Proposed maximum emission will be 3300 lb/day for whole mine-mill complex.

LORNEX MINING CORPORATION

PLANT LOCATION: Highland Valley

PROCESS: Open pit copper mine and copper ore concentrator

CONTROLS: Ducon wet scrubbers are used on copper concentrate dryer and molybdenum concentrate dryer

Daily Output through Dryers: (a) 620 tons copper concentrate
(b) 10 tons molybdenite concentrate

Natural Gas Consumption:

(a) Cu Conc. Dryer - 5.0 MMCF per month
(b) Mo Conc. Dryer - 0.25 MMCF per month

Emission Rates (daily average):

CONTAMINANT	CU CONC. DRYER	MO CONC. DRYER	ORE RECLAIM	LIME BIN	CONVEYOR TRANSFER	ORE CRUSHER	TOTAL
SO_x (a) (lb/day)	0.15	0.01	-	-	-	-	0.16
NO_x (a) (lb/day)	75.0	3.8	-	-	-	-	78.8
Particulate (b) (measured - lb/day)	94.4	15.4	1.4	0.02	0.5	N.A.	111.7
Particulate (c) (allowable - lb/day)	633.7	63.5	742.9	50.8	69.7	697.7	2258.3

(a) Based on emission factors

(b) Based on Compliance Test data

(c) Based on values allowed by Pollution Control Permit

(Fugitive dust occurs at the open pit mine site.)

PROPOSED COPPER 1000 TPD SMELTER/REFINERY COMPLEX*

PROPOSED LOCATION: 70-MILE HOUSE, B. C.

1. PROPOSED PROCESS: Pyrometallurgical (unspecified)
2. PROPOSED CONTROLS: (a) Particulate collection equipment
   (b) Tall stack dispersion of SO_2
3. PROPOSED SMELTING RATE: 1,000 TPD of copper concentrate
4. FUEL: Natural gas (assumed)
5. EMISSION RATES (estimated daily average):

CONTAMINANT	BASED ON EMISSION FACTORS (a)	BASED ON PROCESS CONTROL (b)
SO_x (lb/day)	302,000	302,000
NO_x (lb/day)	N.A.	38,000
Particulates (lb/day)	33,750	13,500 (c)

(a) Emission factor rating for uncontrolled smelter/refinery.

(b) Based on process description and control method.

(c) Based on Level A Objective operation, i.e. not greater than 0.100 gr/scf particulate.

*Ref: Review of Report of the British Columbia Copper Task Force, British Columbia Institute for Economic Policy Analysis.

PROPOSED 400 TPD SMELTER/REFINERY COMPLEX

PROPOSED LOCATION: HIGHLAND VALLEY, B. C.

1. PROPOSED PROCESS: Not specified. Assumed pyrometallurgical
2. PROPOSED CONTROLS: (a) Particulate collection equipment
   (b) SO_2 recovery through acid plant, possibly followed by lime slurry scrubbing, estimated 90% SO_2 reduction.
3. PROPOSED SMELTING RATE: 400 TPD of copper concentrate
4. FUEL: Natural gas (assumed)
5. EMISSION RATES (estimated daily average):

CONTAMINANT	
SO_x (lb/day)	8,080
NO_x (lb/day)	15,200
Particulate (lb/day)[a]	5,400

(a) Assumes Level A Objective operation, i.e. not greater than 0.100 gr/scf particulate.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

PLANT LOCATION: Hat Creek, B. C. (proposed)

PROCESS: 2,000 MW thermal-electric generating station

CONTROLS: (a) Particulate controlled by electrostatic precipitator or by a baghouse type collector.

(b) Sulfur oxides uncontrolled

Fuel Used: Sub-bitunimous coal containing 0.4% sulfur (wet basis)

Fuel Rate: 47,000 tons per day (wet basis)

Emission Rates (daily average):

CONTAMINANT	ALLOWABLE DISCHARGE RATE[a]	PROPOSED DISCHARGE RATE[b]
SO_x (lb/day)	940,000	752,000
NO_x (lb day)	1,269,000	357,120
Particulate (lb/day)	235,000	83,520

(a) Based on Level A Objective operation

(b) Proposed emission rates based on control methods to be applied.

APPENDIX B

EXCERPTS FROM "COMPILATION OF AIR POLLUTION EMISSION FACTORS"

Table 1.3-1. EMISSION FACTORS FOR FUEL OIL COMBUSTION
EMISSION FACTOR RATING: A

Pollutant	Type of unit: Industrial and commercial — Power plant		Residual		Distillate		Domestic	
	lb/10^3 gal	kg/10^3 liters	lb/10^3 gal	kg/10^3 liters	lb/10^3 gal	kg/10^3 liters	lb/10^3 gal	kg/10^3 liters
Particulate[a]	8	1	23	2.75	15	1.8	10	1.2
Sulfur dioxide[b,c]	157S	19S	157S	19S	142S	17S	142S	17S
Sulfur trioxide[b,c]	2S	0.25S	2S	0.25S	2S	0.25S	2S	0.25S
Carbon monoxide[d]	3	0.4	4	0.5	4	0.5	5	0.6
Hydrocarbons[e]	2	0.25	3	0.35	3	0.35	3	0.35
Nitrogen oxides (NO_2)[f]	105[g]	12.6[g]	(40 to 80)[h]	(4.8 to 9.6)[h]	(40 to 80)[h]	(4.8 to 9.6)[h]	12	1.5
Aldehydes (HCHO)[i]	1	0.12	1	0.12	2	0.25	2	0.25

[a]References 2 through 6.
[b]Reference 2.
[c]S equals percent by weight of sulfur in the oil.
[d]References 2, 7 through 10, 12, and 15.
[e]References 2, 6, and 9 through 12.
[f]References 2 through 6, 9, 10, 12, 13, 15, and 16.
[g]Use 50(6) for tangentially fired units.
[h]Use 40 (4.8) for tangentially fired units and 80 (9.6) for horizontally fired units.
[i]References 2, 9, 11, and 14.

Table 1.4-1. EMISSION FACTORS FOR NATURAL-GAS COMBUSTION
EMISSION FACTOR RATING: A

Pollutant	Type of unit: Power plant		Industrial process boiler		Domestic and commercial heating	
	lb/10^6 ft^3	kg/10^6 m^3	lb/10^6 ft^3	kg/10^6 m^3	lb/10^6 ft^3	kg/10^6 m^3
Particulates[a]	5-15	80-240	5-15	80-240	5-15	80-240
Sulfur oxides (SO_2)[b]	0.6	9.6	0.6	9.6	0.6	9.6
Carbon monoxide[c]	17	272	17	272	20	320
Hydrocarbons (as CH_4)[d]	1	16	3	48	8	128
Nitrogen oxides (NO_2)[e]	700[f-h]	11,200[f-h]	(120-230)[i]	(1920-3680)[i]	(80-120)[i]	(1280-1920)[i]

[a] References 4,7,8,12.
[b] Reference 4 (based on an average sulfur content of natural gas of 2000 gr/10^6 $stdft^3$ (4600 g/10^6 Nm^3).
[c] References 5, 8-12.
[d] References 8, 9, 12.
[e] References 3-9, 12-16.
[f] Use 300 lb/10^6 $stdft^3$ (4800 kg/10^6 Nm^3) for tangentially fired units.
[g] At reduced loads, multiply this factor by the load reduction coefficient given in Figure 1.4-1.
[h] See text for potential NO_x reductions due to combustion modifications. Note that the NO_x reduction from these modifications will also occur at reduced load conditions.
[i] This represents a typical range for many industrial boilers. For large industrial units (> 100 MMBtu/hr) use the NO_x factors presented for power plants.
[j] Use 80 (1280) for domestic heating units and 120 (1920) for commercial units.

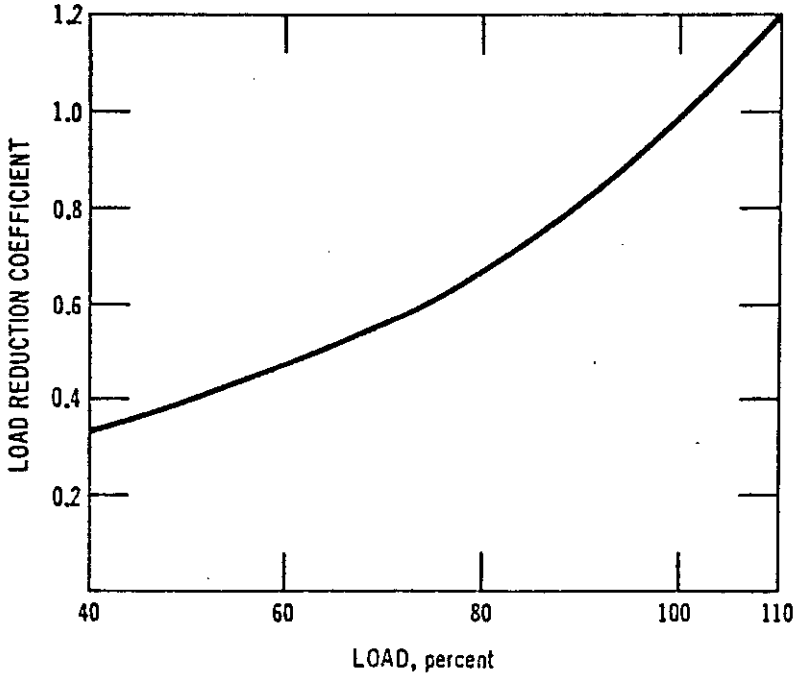


Figure 1.4-1. Load reduction coefficient as function of boiler load. (Used to determine NO_x reductions at reduced loads in large boilers.)

Table 2.3-1. EMISSION FACTORS FOR WASTE INCINERATION IN CONICAL BURNERS WITHOUT CONTROLS[a]
EMISSION FACTOR RATING: B

Type of waste	Particulates		Sulfur oxides		Carbon monoxide		Hydrocarbons		Nitrogen oxides	
	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT
Municipal refuse[b]	20(10 to 60)[c,d]	10	2	1	60	30	20	10	5	2.5
Wood refuse[e]	1[f]	0.5	0.1	0.05	130	65	11	5.5	1	0.5
	7[g]	3.5	/							
	20[h]	10								

[a]Moisture content as fired is approximately 50 percent for wood waste.
[b]Except for particulates, factors are based on comparison with other waste disposal practices.
[c]Use high side of range for intermittent operations charged with a bulldozer.
[d]Based on Reference 3.
[e]References 4 through 9.
[f]Satisfactory operation: properly maintained burner with adjustable underfire air supply and adjustable, tangential overfire air inlets, approximately 500 percent excess air and 700°F (370°C) exit gas temperature.
[g]Unsatisfactory operation: properly maintained burner with radial overfire air supply near bottom of shell, approximately 1200 percent excess air and 400°F (204°C) exit gas temperature.
[h]Very unsatisfactory operation: improperly maintained burner with radial overfire air supply near bottom of shell and many gaping holes in shell, approximately 1500 percent excess air and 400°F (204°C) exit gas temperature.

3.3.2 Heavy-Duty, General Utility, Gaseous-Fueled Engines

3.3.2.1 General – Engines in this category are used in the oil and gas industry for driving compressors in pipeline pressure boosting systems, in gas distribution systems, and in vapor recovery systems (at petroleum refineries). The engines burn either natural gas or refinery gas.

3.3.2.2 Emissions – Emissions from heavy-duty, gaseous-fueled internal combustion engines are reported in Table 3.3.2-1. Test data were available for nitrogen oxides and hydrocarbons only; sulfur oxides are calculated from fuel sulfur content. Nitrogen oxides have been found to be extremely dependent on an engine's work output; hence, Figure 3.3.2-1 presents the relationship between nitrogen oxide emissions and horsepower.

Table 3.3.2-1. EMISSION FACTORS FOR HEAVY-DUTY, GENERAL-UTILITY, STATIONARY ENGINES USING GASEOUS FUELS

EMISSION FACTOR RATING: C

Pollutant	Emissions[a]			
	lb/10^6 ft^3	kg/10^6 m^3	lb/hr	kg/hr
Sulfur oxides[b]	0.6	9.6	–	–
Nitrogen oxides[c]	–	–	–	–
Hydrocarbons[d]	1.2	19	4.2	1.9

[a] Reference 1. Values for lb/10^6 ft^3 (kg/10^6 m^3) based on 3.37 10^6 ft^3/hr heat input.
[b] Based on an average natural gas sulfur content of 2000 gr/10^6 ft^3 (4600 g/10^6 m^3).
[c] See Figure 3.3.2-1.
[d] Values in Reference 1 were given as tons/day. In converting to lb/hr, 24-hour operation was assumed.

3.3 Gasoline and Diesel Industrial Engines

by David S. Kircher

3.3.1 General – This engine category covers a wide variety of industrial applications of both gasoline and diesel internal combustion power plants, such as fork lift trucks, mobile refrigeration units, generators, pumps, and portable well-drilling equipment. The rated power of these engines covers a rather substantial range–from less than 15 kW to 186 kW (20 to 250 hp) for gasoline engines and from 34 kW to 447 kW (45 to 600 hp) for diesel engines. Understandably, substantial differences in both annual usage (hours per year) and engine duty cycles also exist. It was necessary, therefore, to make reasonable assumptions concerning usage in order to formulate emission factors.[1]

3.3.2 Emissions – Once reasonable usage and duty cycles for this category were ascertained, emission values from each of the test engines [1] were aggregated (on the basis of nationwide engine population statistics) to arrive at the factors presented in Table 3.3.3-1. Because of their aggregate nature, data contained in this table must be applied to a population of industrial engines rather than to an individual power plant.

The best method for calculating emissions is on the basis of "brake specific" emission factors (g/kWh or lb/hphr). Emissions are calculated by taking the product of the brake specific emission factor, the usage in hours (that is, hours per year or hours per day), the power available (rated power), and the load factor (the power actually used divided by the power available).

Table 3.3.3-1. EMISSION FACTORS FOR GASOLINE- AND DIESEL-POWERED INDUSTRIAL EQUIPMENT
EMISSION FACTOR RATING: C

Pollutant[a]	Engine category[b]	
	Gasoline	Diesel
Carbon monoxide		
g/hr	5700.	197.
lb/hr	12.6	0.434
g/kWh	267.	4.06
g/hphr	199.	3.03
kg/10^3 liter	472.	12.2
lb/10^3 gal	3940.	102.
Exhaust hydrocarbons		
g/hr	191.	72.8
lb/hr	0.421	0.160
g/kWh	8.95	1.50
g/hphr	6.68	1.12
kg/10^3 liter	15.8	4.49
lb/10^3 gal	132.	37.5
Evaporative hydrocarbons		
g/hr	62.0	–
lb/hr	0.137	–
Crankcase hydrocarbons		
g/hr	38.3	–
lb/hr	0.084	–

Table 3.3.3-1. (continued). EMISSION FACTORS FOR GASOLINE AND DIESEL-POWERED INDUSTRIAL EQUIPMENT
EMISSION FACTOR RATING: C

Pollutant[a]	Engine category[b]	
	Gasoline	Diesel
Nitrogen oxides		
g/hr	148.	910.
lb/hr	0.326	2.01
g/kWh	6.92	18.8
g/hphr	5.16	14.0
kg/10^3 liter	12.2	56.2
lb/10^3 gal	102.	469.
Aldehydes		
g/hr	6.33	13.7
lb/hr	0.014	0.030
g/kWh	0.30	0.28
g/hphr	0.22	0.21
kg/10^3 liter	0.522	0.84
lb/10^3 gal	4.36	7.04
Sulfur oxides		
g/hr	7.67	60.5
lb/hr	0.017	0.133
g/kWh	0.359	1.25
g/hphr	0.268	0.931
kg/10^3 liter	0.636	3.74
lb/10^3 gal	5.31	31.2
Particulate		
g/hr	9.33	65.0
lb/hr	0.021	0.143
g/kWh	0.439	1.34
g/hphr	0.327	1.00
kg/10^3 liter	0.775	4.01
lb/10^3 gal	6.47	33.5

[a] References 1 and 2.

[b] As discussed in the text, the engines used to determine the results in this table cover a wide range of uses and power. The listed values do not, however, necessarily apply to some very large stationary diesel engines.

References for Section 3.3.3

1. Hare, C. T. and K. J. Springer. Exhaust Emissions from Uncontrolled Vehicles and Related Equipment U Internal Combustion Engines. Final Report. Part 5: Heavy-Duty Farm, Construction, and Industrial Eng Southwest Research Institute. San Antonio, Texas. Prepared for Environmental Protection Agency, Rese Triangle Park, N.C., under Contract No. EHS 70-108. October 1973. 105 p.

2. Hare, C. T. Letter to C. C. Masser of the Environmental Protection Agency concerning fuel-based emi rates for farm, construction, and industrial engines. San Antonio, Tex. January 14, 1974.