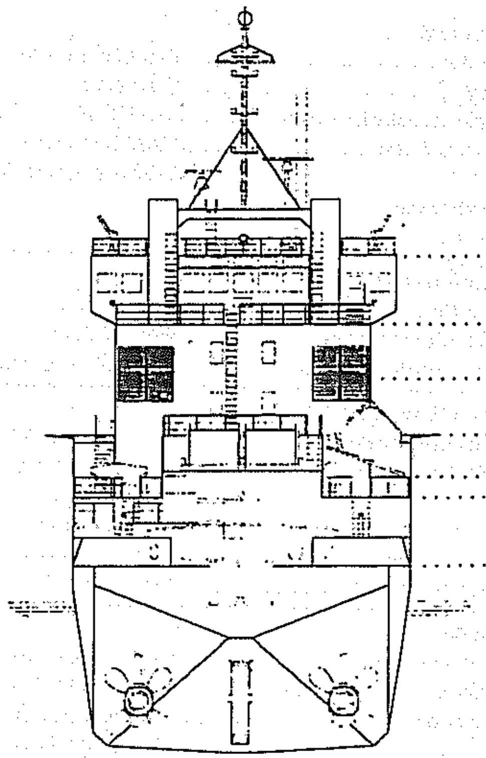
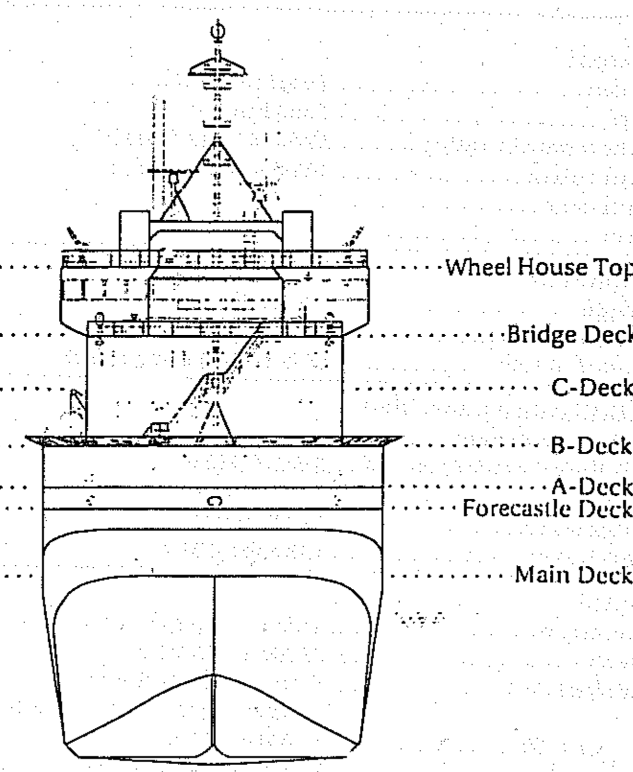
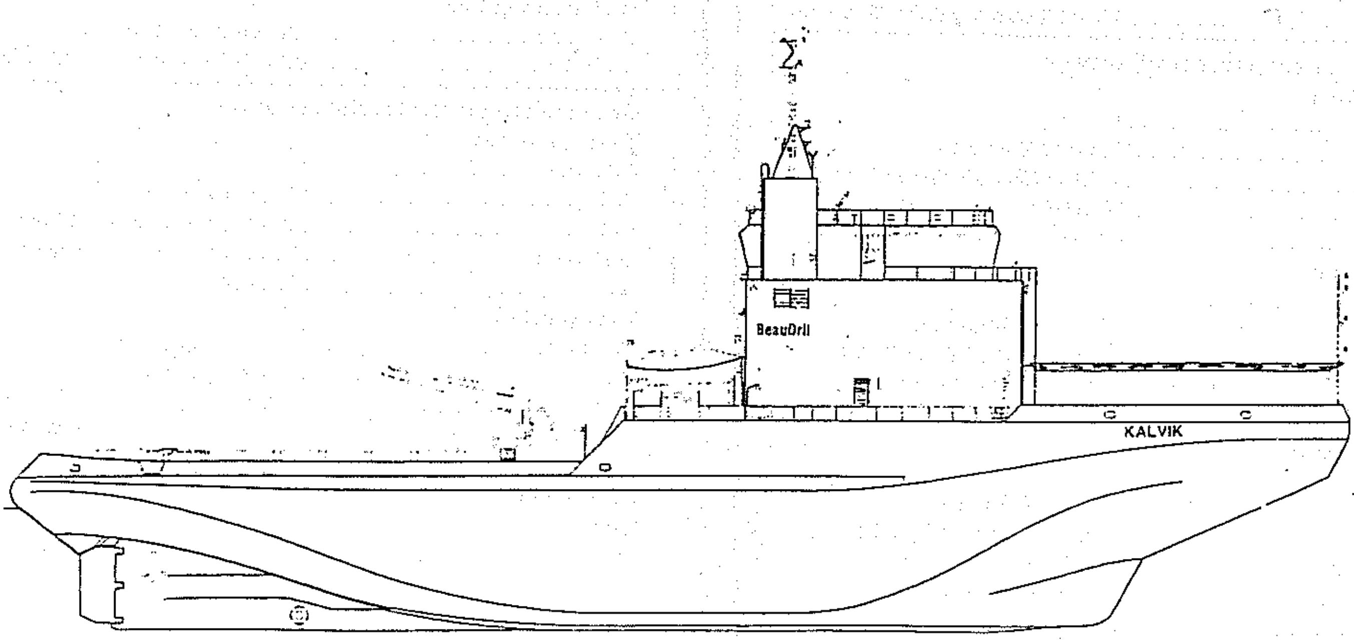
Terry Fox & Kalvik



Stern Elevation



Bow Elevation



General Arrangement

NOTE: Only Kalvik Equipped
With Helideck

Principal Schematic Drawings and Specifications

General
Owner: BeauDril Limited
Flag: Canadian
Arctic capability rating: CASPPR Arctic Class IV
Lloyd's class: 100AI Icebreaker, Tug
Berth total: 34
Crew: 19

Dimensions
Length: 289 ft (88.0 m)
Breadth extreme: 58 ft (17.8 m)
Depth molded: 33 ft (10.0 m) to main deck

Deck (Loading Capacities)
Deck measurements: 125 ft x 43 ft (38.1 m x 13.1 m)
Bulk barite/cement capacity: 3,602 cf (102 m^3)
Fuel oil: 12,070 bbls (1 919 m^3)
Ballast water: 10,240 bbls (1 628 m^3)
Fresh water: 1,491 bbls (237 m^3)

Engine
Main engine: 4 x Stork Werkspoor Diesel
Power: 23,200 hp (17 300 kW)
Thrusters Fwd: Twin Air Bubbler System
777,000 cf/hr (22 000 m^3/hr) each
Thrusters Aft: 1 x 500 hp (373 kW)
Water maker: 94 bbls/day (15 m^3/day)
Bollard pull: Over 220 tons (200 tonnes)
Service speed
Two engines: 13.4 knots
Four engines: 15.4 knots
Fuel consumption
Open water: 189 bbls/day (30 m^3/day)
Heavy ice: 314 to 472 bbls/day (50 to 75 m^3/day)

Deck machinery (electrically driven)
Towing winch
Quantity: 1
Pull: 88 tons (80 tonnes)
Line: 4,920 ft x $2^7/_8$ in (1 500 m x 73 mm)
Line speed: 10 to 99 ft/min (3 to 30 m/min)
Brake: 430 ton (390 tonne) SWL
Work winches
Quantity: 2
Pull: 276 tons (250 tonnes)
Line: 820 ft x $2^7/_8$ in (250 m x 73 mm)
Line speed: 7 to 43 ft/min (2 to 13 m/min)
Brake: 220 ton (200 tonne) SWL
Storage winches
Quantity: 2
Pull: 17 tons (15 tonnes)
Line: 4,920 ft x $2^7/_8$ in (1 500 m x 73 mm)
Deck cranes: 2 x 5.5 ton (5 tonne) SWL
Capstans: 2 x 27 ton (24.5 tonne) pull
Tuggers: 1 x 31 ton (28 tonne) SWL

General
Owner: BeauDril Limited
Flag: Canadian
Arctic capability rating: CASPPR Arctic Class IV
Lloyd's class: 100AI Icebreaker,
Offshore Supply Ship
Berth total: 34
Crew: 19

Dimensions
Length: 259 ft (78.8 m)
Breadth extreme: 56 ft (17.2 m)
Depth molded: 32 ft (9.7 m) to main deck

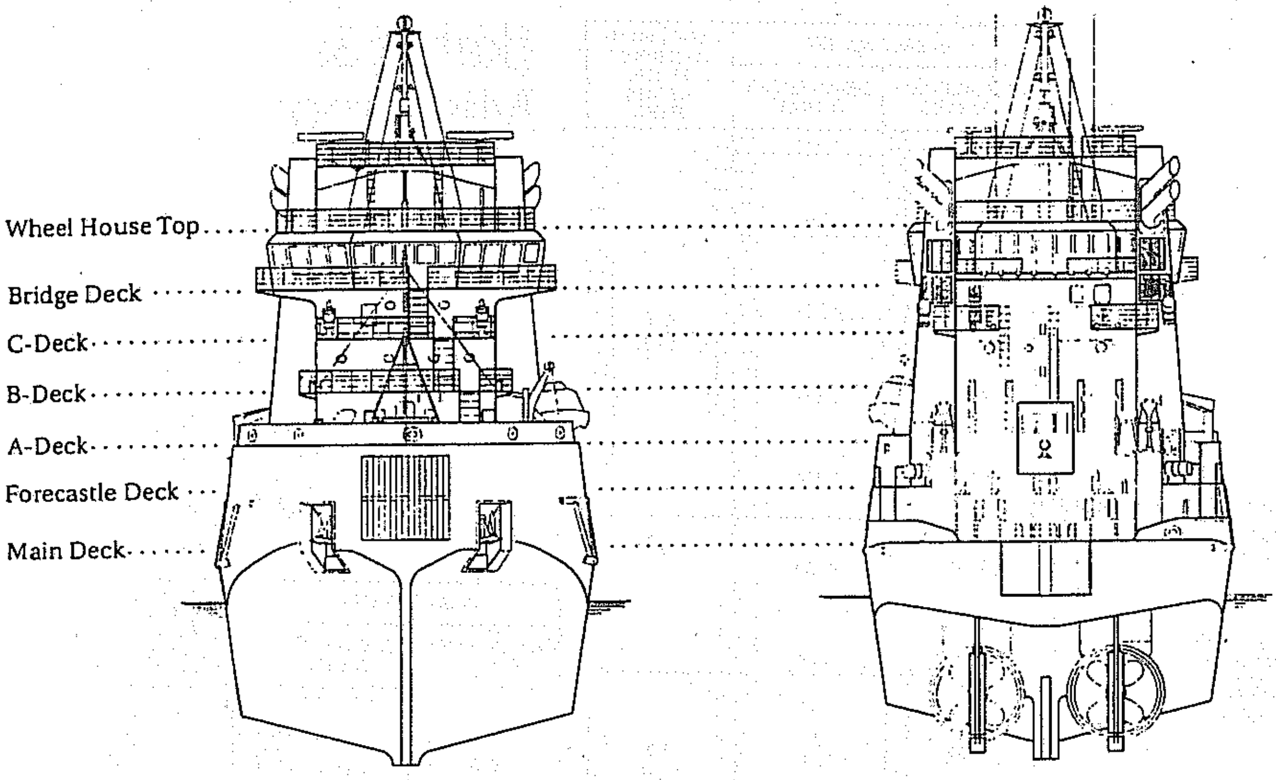
Deck (Loading Capacities)
Deck measurements: 115 ft x 41 ft (35.1 m x 12.6 m)
Bulk barite/cement capacity: 5,015 cf (142 m^3)

	Miscaroo	Ikaluk
Fuel oil:	9,435 bbls (1 500 m^3)	10,038 bbls (1 596 m^3)
Ballast water:	6,403 bbls (1 018 m^3)	7,208 bbls (1 146 m^3)
Fresh water:	900 bbls (143 m^3)	956 bbls (152 m^3)

Engine
Main engine: 4 x Wartsila Diesel
Power: 14,900 hp (11 110 kW)
Thrusters Fwd: Omnithruster System
1200 hp (895 kW)
Thrusters Aft: 1 x 800 hp (596 kW)
Water maker: 63 bbls/day (10 m^3/day)
Bollard pull: 165 tons (150 tonnes)
Service speed
Two engines: 12.0 knots
Four engines: 14.7 knots
Fuel consumption
Open water: 126 bbls/day (20 m^3/day)
Heavy ice: 220 to 365 bbls/day (35 to 58 m^3/day)

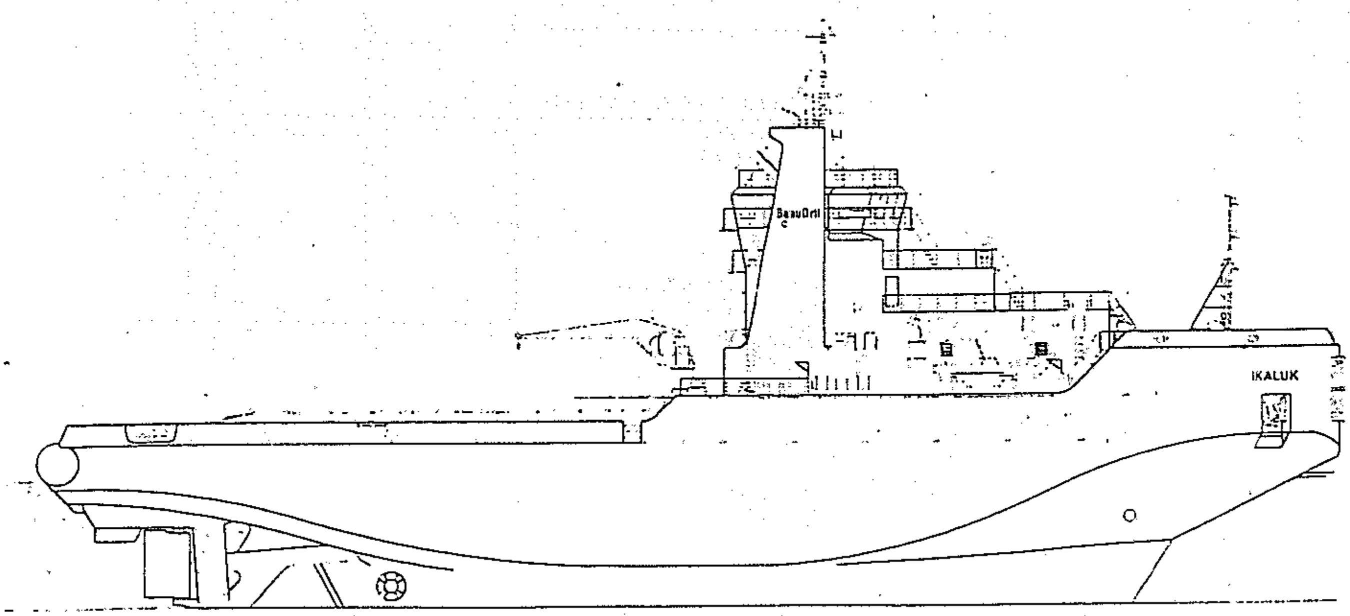
Deck machinery (hydraulically driven)
Towing winches
Quantity: 2
Pull: 154 tons (140 tonnes)
Line: 3,000 ft x $2^7/_8$ in (915 m x 73 mm)
Line speed: 23 to 164 ft/min (7 to 50 m/min)
Brake: 330 ton (300 tonne) SWL
Work winches
Quantity: 2
Pull: 165 tons (150 tonnes)
Line: 1,295 ft x $2^7/_8$ in (395 m x 73 mm)
Line speed: 20 to 151 ft/min (6 to 46 m/min)
Brake: 330 ton (300 tonne) SWL
Deck cranes: 2 x 5.0 ton (4.5 tonne) SWL
Capstans: 2 x 11 ton (10 tonne) pull
Tuggers: 2 x 13 ton (11.8 tonne) SWL

Ikaluk & Miscaroo



Bow Elevation

Stern Elevation



General Arrangement

Deadweight Scales

Ikaluk & Miscaroo

In Salt Water: Displacement Tonnes	In Salt Water: Deadweight Tonnes	Draft from Under Side of Keel Metres (Feet)
8 000	4 000	
7 500	3 500	
7 000	3 000	9.0 (29.5)
6 500	2 500	
6 000	2 000	
5 500	1 500	8.0 (26.2)
5 000	1 000	
4 500	500	7.0 (22.9)
4 000	0	
3 500		6.0 (19.7)

OPTIMUM DRAFT 8.1m (26.6 FT)
DEADWEIGHT
1 840 TONNES

MINIMUM OPERATIONAL
DRAFT 7.4 m (24.3 FT)
DEADWEIGHT
1 000 TONNES

LIGHT SHIP
DRAFT 6.5 m (21.3 FT)
DEADWEIGHT 0

Terry Fox & Kalvik

In Salt Water: Displacement Tonnes	In Salt Water: Deadweight Tonnes	Draft from Under Side of Keel Metres (Feet)
9 000	4 000	
8 500	3 500	
8 000	3 000	9.0 (29.5)
7 500	2 500	
7 000	2 000	
6 500	1 500	8.0 (26.2)
6 000	1 000	
5 500	500	7.0 (22.9)
5 000	0	
4 500		6.0 (19.7)

OPTIMUM DRAFT 8.3 m (27.2 FT)
DEADWEIGHT
2 120 TONNES

MINIMUM OPERATIONAL
DRAFT 7.38 m (24.2 FT)
DEADWEIGHT
1 000 TONNES

LIGHT SHIP
DRAFT 6.48 m (21.2 FT)
DEADWEIGHT 0

NOTE:
- DEADWEIGHT INCLUDES FUEL, BULK, POTABLE WATER AND DECK LOAD
- LIGHTSHIP DRAFT CAN NOT BE OBTAINED DURING OPERATION
- SHORT TONS = 1.1 x TONNES

The Fleet

Terry Fox, Kalvik, Ikaluk, and Miscaroo represent the latest generation of polar class rig support vessels. Built in 1983, these vessels are highly powered, heavily strengthened, well equipped and in all regards purpose designed for Arctic operations.

The vessels in this fleet have proven to meet or exceed all design and operational expectations.

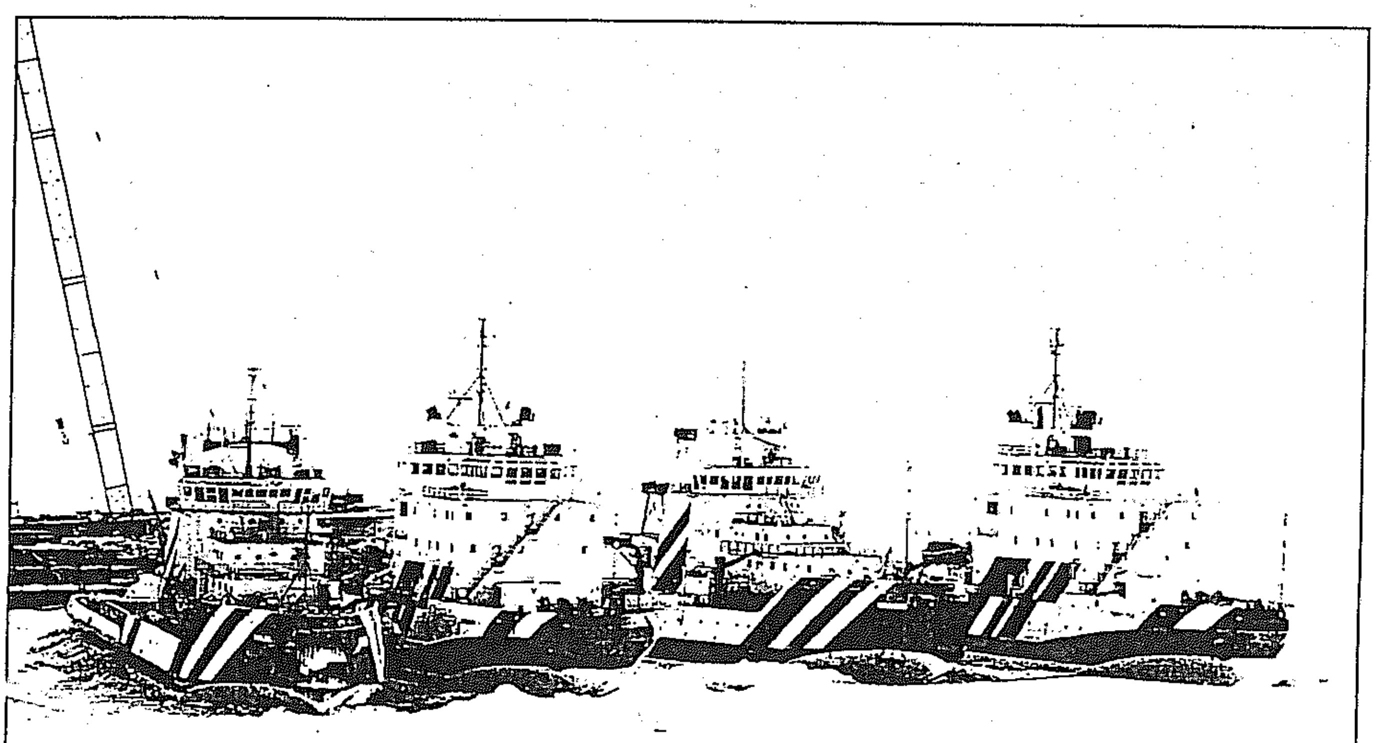
Terry Fox and Kalvik Icebreakers

- The two most powerful privately owned icebreakers in the world.
- Designed for ice management, long distance towing and secondary anchor handling.
- Designed to Arctic Class IV specifications enabling them to proceed continuously through 4 ft (1.2 m) of ice at three knots.
- Equipped with bulk storage and transfer facilities for barite, cement, fuel and water.
- Powered by four 5,800 horsepower (4 325 kW) diesel engines geared to twin controllable pitch propellers.
- Forward bubbler system for increased icebreaking efficiency.
- Kalvik is equipped with a helideck.

Ikaluk and Miscaroo Icebreaking Supply Vessels

- Designed for primary anchor handling, transport of drilling supplies and equipment, towing, and ice management.
- Designed to Arctic Class IV specifications enabling them to proceed continuously through 4 ft (1.2 m) of ice at three knots.
- Equipped with bulk storage and transfer facilities for barite, cement, fuel and water.
- Powered by four 3,725 horsepower (2 778 kW) diesel engines geared to twin shafts with controllable pitch propellers.
- Forward and aft thrusters for added manoeuverability.

FOR MORE INFORMATION ABOUT THE FLEET, CONTACT MANAGER, BEAUDRIL AT (403) 233-3030.



APPENDIX B
EMISSION RATE CALCULATION SUPPORT DOCUMENTATION

AP-42 EMISSION FACTORS

TABLE 1.3-1. UNCONTROLLED EMISSION FACTORS FOR FUEL OIL COMBUSTION

EMISSION FACTOR RATING: A

Boiler Type[a]	Particulate Matter[b]		Sulfur Dioxide[c]		Sulfur Trioxide		Carbon Monoxide[d]		Nitrogen Oxide[e]		Volatile Organics[f] Nonmethane		Methane	
	kg/10^3l	lb/10^3gal	kg/10^3l	lb/10^3gal	kg/10^3l	lb/10^3gal	kg/10^3l	lb/10^3gal	kg/10^3l	lb/10^3gal	kg/10^3l	lb/10^3gal	kg/10^3l	lb/10^3gal
Utility Boilers														
Residual Oil	g	g	19S	157S	0.34S[h]	2.9S[h]	0.6	5	8.0 (12.6)(5)[i]	67 (105)(42)[i]	0.09	0.76	0.03	0.28
Industrial Boilers														
Residual Oil	g	g	19S	157S	0.24S	2S	0.6	5	6.6[j]	55[j]	0.034	0.28	0.12	1.0
Distillate Oil	0.24	2	17S	142S	0.24S	2S	0.6	5	2.4	20	0.024	0.2	0.006	0.052
Commercial Boilers														
Residual Oil	g	g	19S	157S	0.24S	2S	0.6	5	6.6	55	0.14	1.13	0.057	0.475
Distillate Oil	0.24	2	17S	142S	0.24S	2S	0.6	5	2.4	20	0.04	0.34	0.026	0.216
Residential Furnaces														
Distillate Oil	0.3	2.5	17S	142S	0.24S	2S	0.6	5	2.2	18	0.085	0.713	0.214	1.78

[a]Boilers can be approximately classified according to their gross (higher) heat rate as shown below:
Utility (power plant) boilers: >106 x 10^9 J/hr (>100 x 10^6 Btu/hr)
Industrial boilers: 10.6 x 10^9 to 106 x 10^9 J/hr (10 x 10^6 to 100 x 10^6 Btu/hr)
Commercial boilers: 0.5 x 10^9 to 10.6 x 10^9 J/hr (0.5 x 10^6 to 10 x 10^6 Btu/hr)
Residential furnaces: <0.5 x 10^9 J/hr (<0.5 x 10^6 Btu/hr)

[b]References 3-7 and 24-25. Particulate matter is defined in this section as that material collected by EPA Method 5 (front half catch).

[c]References 1-5. S indicates that the weight % of sulfur in the oil should be multiplied by the value given.

[d]References 3-5 and 8-10. Carbon monoxide emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

[e]Expressed as NO_2. References 1-5, 8-11, 17 and 26. Test results indicate that at least 95% by weight of NO_x is NO for all boiler types except residential furnaces, where about 75% is NO.

[f]References 18-21. Volatile organic compound emissions are generally negligible unless boiler is improperly operated or not well maintained, in which case emissions may increase by several orders of magnitude.

[g]Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content:
Grade 6 oil: 1.25(S) + 0.38 kg/10^3 liter [10(S) + 3 lb/10^3 gal] where S is the weight % of sulfur in the oil. This relationship is based on 81 individual tests and has a correlation coefficient of 0.65.
Grade 5 oil: 1.25 kg/10^3 liter (10 lb/10^3 gal)
Grade 4 oil: 0.88 kg/10^3 liter (7 lb/10^3 gal)

[h]Reference 25.

[i]Use 5 kg/10^3 liters (42 lb/10^3 gal) for tangentially fired boilers, 12.6 kg/10^3 liters (105 lb/10^3gal) for vertical fired boilers, and 8.0 kg/10^3 liters (67 lb/10^3 gal) for all others, at full load and normal (>15%) excess air. Several combustion modifications can be employed for NO_x reduction: (1) limited excess air can reduce NO_x emissions 5-20%, (2) staged combustion 20-40%, (3) using low NO_x burners 20-50%, and (4) ammonia injection can reduce NO_x emissions 40-70% but may increase emissions of ammonia. Combinations of these modifications have been employed for further reductions in certain boilers. See Reference 23 for a discussion of these and other NO_x reducing techniques and their operational and environmental impacts.

[j]Nitrogen oxides emissions from residual oil combustion in industrial and commercial boilers are strongly related to fuel nitrogen content, estimated more accurately by the empirical relationship:
kg NO_2/10^3 liters = 2.75 + 50$(N)^2$ [lb NO_2/10^3gal = 22 + 400$(N)^2$] where N is the weight % of nitrogen in the oil. For residual oils having high (>0.5 weight %) nitrogen content, use 15 kg NO_2/10^3 liter (120 lb NO_2/10^3gal) as an emission factor.

TABLE 2.1-3. UNCONTROLLED EMISSION FACTORS FOR INDUSTRIAL/COMMERCIAL REFUSE COMBUSTORS[a]

EMISSION FACTOR RATING: A

Incinerator type	Particulate		Sulfur oxides[b]		Carbon monoxide		Volatile organics[c]		Nitrogen oxides[d]	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Multiple chambers[e]	3.5	7	1.25	2.5[f]	5	10	1.5	3	1.5	3
Single chamber[g]	7.5	15	1.25	2.5[f]	10	20	7.5	15	1	2
Trench[h]										
Wood	6.5	13	0.05	0.1[j]	NA	NA	NA	NA	2	4
Rubber tires	69	138	NA	NA	NA	NA	NA	NA	NA	NA
Municipal refuse	18.5	37	1.25	2.5[f]	NA	NA	NA	NA	NA	NA
Flue fed										
Single chamber[k]	15	30	0.25	0.5	10	20	7.5	15	1.5	3
Modified[m]	3	6	0.25	0.5	5	10	1.5	3	5	10
Domestic single chamber										
Without primary burner[n]	17.5	35	0.25	0.5	150	300	50	100	0.5	1
With primary burner[p]	3.5	7	0.25	0.5	Neg	Neg	1	2	1	2
Pathological[q]	4	8	Neg	Neg	Neg	Neg	Neg	Neg	1.5	3

[a] Factors are averages based on EPA procedures for incinerator stack testing. NA = not available. Neg = negligible.
[b] Expressed as SO_2.
[c] Expressed as methane.
[d] Expressed as NO_2.
[e] References 6,10-13.
[f] Based on municipal incinerator data.
[g] References 6,10-11,13.
[h] Reference 8.
[j] Based on data for wood combustion in conical burners.
[k] References 6,11-15.
[m] With afterburners and draft controls. References 6,13-14.
[n] References 10-11.

January 1975 version of Table 3.3-1

3.3 Gasoline and Diesel Industrial Engines

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 3.3-1. 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 3.3-1. 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	–

January 1975 version of Table 3.3-1

Table 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

1. Hare, C. T. and K. J. Springer. Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines. Final Report. Part 5: Heavy-Duty Farm, Construction, and Industrial Engines. Southwest Research Institute. San Antonio, Texas. Prepared for Environmental Protection Agency, Research 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 emission s for farm, construction, and industrial engines. San Antonio, Tex. January 14, 1974.

TABLE 3.3-1. (ENGLISH UNITS) EMISSION FACTORS FOR UNCONTROLLED GASOLINE AND DIESEL INDUSTRIAL ENGINES[a]

Pollutant [Rating][b]	Gasoline Fuel SCC 20200301, 20300301		Diesel Fuel SCC 20200102, 20300101	
	[grams/hp-hr] (power output)	[lb/MMBtu] (fuel input)	[grams/hp-hr] (power output)	[lb/MMBtu] (fuel input)
NO_x [D]	5.16	1.63	14.0	4.41
CO [D]	199	62.7	3.03	0.95
SO_x [D]	0.268	0.084	0.931	0.29
Particulate [D]	0.327	0.10	1.00	0.31
CO_2 [B][c]	493	155	525	165
Aldehydes [D]	0.22	0.07	0.21	0.07
Hydrocarbons				
Exhaust [D]	6.68	2.10	1.12	0.35
Evaporative [E]	0.30	0.09	0.00	0.00
Crankcase [E]	2.20	0.69	0.02	0.01
Refueling [E]	0.49	0.15	0.00	0.00

a. Data based on uncontrolled levels for each fuel from references 1, 3 and 6. When necessary, the average brake specific fuel consumption (BSFC) value was used to convert from g/hp-hr to lb/MMBtu was 7000 Btu/hp-hr.

b. "D" and "E" rated emission factors are most appropriate when applied to a population of industrial engines rather than to an individual power plant, due to the aggregate nature of the emissions data.

c. Based on assumed 100 percent conversion of carbon in fuel to CO_2 with 87 weight percent carbon in diesel, 86 weight percent carbon in gasoline, average brake specific fuel consumption of 7000 Btu/hp-hr, diesel heating value of 19300 Btu/lb, and gasoline heating value of 20300 Btu/lb.

TABLE 3.3-2. (METRIC UNITS) EMISSION FACTORS FOR UNCONTROLLED GASOLINE AND DIESEL INDUSTRIAL ENGINES[a]

Pollutant [Rating][b]	Gasoline Fuel SCC 20200301, 20300301		Diesel Fuel SCC 20200102, 20300101	
	[grams/kW-hr] (power output)	[n/J] (fuel input)	[grams/kW-hr] (power output)	[n/J] (fuel input)
NO_x [D]	6.92	699	18.8	1,896
CO [D]	267	26,947	4.06	410
SO_x [D]	0.359	36	1.25	126
Particulate [D]	0.439	44	1.34	135
CO_2 [B][c]	661	66,787	704	71,065
Aldehydes [D]	0.30	29	0.28	28
Hydrocarbons				
Exhaust [D]	8.96	905	1.50	152
Evaporative [E]	0.40	41	0.00	0.00
Crankcase [E]	2.95	298	0.03	2.71
Refueling [E]	0.66	66	0.00	0.00

a. Data based on uncontrolled levels for each fuel from references 1, 3 and 6.

b. "D" and "E" rated emission factors are most appropriate when applied to a population of industrial engines rather than to an individual power plant, due to the aggregate nature of the emissions data.

c. Based on assumed 100 percent conversion of carbon in fuel to CO_2 with 87 weight percent carbon in diesel, 86 weight percent carbon in gasoline, average brake specific fuel consumption of 7000 Btu/hp-hr, diesel heating value of 19300 Btu/lb, and gasoline heating value of 20300 Btu/lb.

TABLE 3.4-1. (ENGLISH UNITS) GASEOUS EMISSION FACTORS FOR LARGE STATIONARY DIESEL AND ALL STATIONARY DUAL FUEL ENGINES[a]

Pollutant	Diesel Fuel SCC 20200401			Dual Fuel SCC 20200402		
	[grams/hp-hr] (power output)	[lb/MMBtu] (fuel input)	Emission Factor Rating[b]	[grams/hp-hr] (power output)	[lb/MMBtu] (fuel input)	Emission Factor Rating[b]
NO_x	11	3.1	C	9.2	3.1	D
CO	2.4	0.81	C	2.3	0.79	D
SO_x	[e]	[e]	B	[e]	[e]	B
CO_2[g]	524	165	B	350	110	B
TOC,[c] (as CH_4)	0.32	0.09	C	2.4	0.8	D
Methane	0.03	0.01	E[d]	1.8	0.6	E[f]
Nonmethane	0.33	0.10	E[d]	0.6	0.2	E[f]

a. Data are based on uncontrolled levels for each fuel from references 4, 5, and 6. When necessary, the average heating value of diesel was assumed to be 19300 Btu/lb with a density of 7.1 lb/gal. The power output and fuel input values were averaged independently from each other due to the use of actual Brake Specific Fuel Consumption values for each data point and the use of data that may have enough information to calculate only one of the two emission factors (e.g., if there was enough information to calculate lb/MMBtu, but not enough to calculate the g/hp-hr). The emission factors are based on averages across all manufacturers and duty cycles. The actual emissions from a particular engine or manufacturer could vary considerably from these levels.

b. "D" and "E" rating for emission factors are due to limited data sets, inherent variability in the population and/or a lack of documentation of test results. "D" and "E" rated emission factors may not be suitable for specific facilities or populations and should be used with care.

c. Total Organic Compounds.

d. Based on emissions data from one engine.

e. Emissions should be estimated based on the assumption that all sulfur in the fuel is converted to SO_2.

f. Based on the assumption that nonmethane organic compounds are 25 percent of TOC emissions from dual fuel engines. Molecular weight of nonmethane gas stream is assumed to be that of methane.

g. Based on assumed 100 percent conversion of carbon in fuel to CO_2 with 87 weight percent carbon in diesel, 70 weight percent carbon in natural gas, dual fuel mixture of 5 percent diesel with 95 percent natural gas, average brake specific fuel consumption of 7000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and natural gas heating value of 23,900 Btu/lb.

TABLE 3.4-2. (METRIC UNITS) GASEOUS EMISSION FACTORS FOR LARGE STATIONARY DIESEL AND ALL STATIONARY DUAL FUEL ENGINES[a]

Pollutant	Diesel Fuel SCC 20200401			Dual Fuel SCC 20200402		
	[g/kW-hr] (power output)	[ng/J] (fuel input)	Emission Factor Rating[b]	[g/kW-hr] (power output)	[ng/J] (fuel input)	Emission Factor Rating[b]
NO_x	14	1,322	C	12.3	1,331	D
CO	3.2	349	C	3.1	340	D
SO_x	[e]	[e]	B	[e]	[e]	B
CO_2[g]	703	70,942	B	469	47,424	B
TOC,[c] (as CH_4)	0.43	38	C	3.2	352	D
Methane	0.04	4	E[d]	2.4	240	E[f]
Nonmethane	0.44	45	E[d]	0.8	80	E[f]

a. Data are based on uncontrolled levels for each fuel from references 4, 5, and 6. When necessary, the average heating value of diesel was assumed to be 19300 Btu/lb with a density of 7.1 lb/gal. The power output and fuel input values were averaged independently from each other due to the use of actual Brake Specific Fuel Consumption values for each data point and the use of data that may have enough information to calculate only one of the two emission factors (e.g., if there was enough information to calculate lb/MMBtu, but not enough to calculate the g/hp-hr). The emission factors are based on averages across all manufacturers and duty cycles. the actual emissions from a particular engine or manufacturer could vary considerably from these levels.

b. "D" and "E" rating for emission factors are due to limited data sets, inherent variability in the population and/or a lack of documentation of test results. "D" and "E" rated emission factors may not be suitable for specific facilities or populations and should be used with care.

c. Total Organic Compounds.

d. Based on emissions data from one engine.

e. Emissions should be estimated based on the assumption that all sulfur in the fuel is converted to SO_2.

f. Based on the assumption that nonmethane organic compounds are 25 percent of TOC emissions from dual fuel engines. Molecular weight of nonmethane gas stream is assumed to be that of methane.

g. Based on assumed 100 percent conversion of carbon in fuel to CO_2 with 87 weight percent carbon in diesel, 70 weight percent carbon in natural gas, dual fuel mixture of 5 percent diesel with 95 percent natural gas, average brake specific fuel consumption of 7000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and natural gas heating value of 23,900 Btu/lb.

TABLE 3.4-5. (ENGLISH AND METRIC UNITS) PARTICULATE AND PARTICLE SIZING EMISSION FACTORS FOR LARGE STATIONARY DIESEL ENGINES[a]
(Emission Factor Rating: E)[b]

Pollutant	Power Output		Fuel Input	
	[grams/hp-hr]	[grams/kW-hr]	[lb/MMBtu]	[ng/J]
Particulate Size Distribution				
< 1 μm	0.1520	0.2038	0.0478	20.56
1-3 μm	0.0004	0.0005	0.0001	0.05
3-10 μm	0.0054	0.0072	0.0017	0.73
> 10 μm	0.0394	0.0528	0.0124	5.33
Total PM-10 (≤ 10 μm)	0.1578	0.2116	0.0496	21.34
TOTAL	0.1972	0.2644	0.0620	26.67
Particulate Emissions				
Solids	0.2181	0.2925	0.0686	29.49
Condensables	0.0245	0.0329	0.0077	3.31
TOTAL	0.2426	0.3253	0.0763	32.81

a. Data are based on the uncontrolled levels of one diesel engine from reference 6. The data for the particulate emissions were collected using Method 5 and the particle size distributions were collected using a Source Assessment Sampling System (SASS).

b. "E" rating for emission factors is due to limited data sets, inherent variability in the population and/or a lack of documentation of test results. "E" rated emission factors may not be suitable for specific facilities or populations and should be used with care.

TABLE 3.4-6. NO_x REDUCTION AND FUEL CONSUMPTION PENALTIES FOR LARGE STATIONARY DIESEL AND DUAL FUEL ENGINES[a]

Control Approach		Diesel		Dual Fuel	
		Percent NO_x Reduction	ΔBSFC,[b] Percent	Percent NO_x Reduction	ΔBSFC,[b] Percent
Derate	10%			<20	4
	20%	<20	4		
	25%	5-23	1-5	1-33	1-7
Retard	2°	<20	4	<20	3
	4°	<40	4	<40	1
	8°	28-45	2-8	50-73	3-5
Air-to-Fuel	3%			<20	0
	±10%	7-8	3	25-40	1-3
Water Injection (H_2O/fuel ratio)	50%	25-35	2-4		
Selective Catalytic Reduction (SCR)		80-95	0	80-95	0

a. Data are based on references 1, 2, and 3. The reductions shown are typical and will vary depending on the engine and duty cycle.

b. BSFC = Brake Specific Fuel Consumption.

more readily than corresponding normal isomers. The more highly branched the paraffin, the greater the tendency to smoke. Unsaturated hydrocarbons tend more toward soot formation than do saturated ones. Soot is eliminated by adding steam or air, hence most industrial flares are steam assisted and some are air assisted. Flare gas composition is a critical factor in determining the amount of steam necessary.

Since flares do not lend themselves to conventional emission testing techniques, only a few attempts have been made to characterize flare emissions. Recent EPA tests using propylene as flare gas indicated that efficiencies of 98 percent can be achieved when burning an offgas with at least 11,200 kJ/m^3 (300 Btu/ft^3). The tests conducted on steam-assisted flares at velocities as low as 39.6 meters per minute (130 feet per minute) to 1140 m/min (3750 ft/min), and on air-assisted flares at velocities of 180 m/min (617 ft/min) to 3960 m/min (13,087 ft/min) indicated that variations in incoming gas flow rates have no effect on the combustion efficiency. Flare gases with less than 16,770 kJ/m^3 (450 Btu/ft^3) do not smoke.

Table 11.5-1 presents flare emission factors, and Table 11.5-2 presents emission composition data obtained from the EPA tests.[1] Crude propylene was used as flare gas during the tests. Methane was a major fraction of hydrocarbons in the flare emissions, and acetylene was the dominant intermediate hydrocarbon species. Many other reports on flares indicate that acetylene is always formed as a stable intermediate product. The acetylene formed in the combustion reactions may react further with hydrocarbon radicals to form polyacetylenes followed by polycyclic hydrocarbons.[2]

In flaring waste gases containing no nitrogen compounds, NO is formed either by the fixation of atmospheric nitrogen with oxygen or by the reaction between the hydrocarbon radicals present in the combustion products and atmospheric nitrogen, by way of the intermediate stages, HCN, CN, and OCN.[2] Sulfur compounds contained in a flare gas stream are converted to SO_2 when burned. The amount of SO_2 emitted depends directly on the quantity of sulfur in the flared gases.

Table 11.5-1. EMISSION FACTORS FOR FLARE OPERATIONS[a]

EMISSION FACTOR RATING: B

Component	Emission Factor (lb/10^6 Btu)
Total hydrocarbons[b]	0.14
Carbon monoxide	0.37
Nitrogen oxides	0.068
Soot[c]	0 to 274

[a]Reference 1. Based on tests using crude propylene containing 80 % propylene and 20 % propane.
[b]Measured as methane equivalent.
[c]Soot in concentration values: nonsmoking flares, 0 μg/liter; lightly smoking flares, 40 μg/l; average smoking flares, 177 μg/l; and heavily smoking flares, 274 μg/l.

Table 11.5-2. HYDROCARBON COMPOSITION OF FLARE EMISSION[a]

Composition	Average (range), Volume %	
Methane	55	(14 - 83)
Ethane/Ethylene	8	(1 - 14)
Acetylene	5	(0.3 - 23)
Propane	7	(0 - 16)
Propylene	25	(1 - 65)

[a]Reference 1. Ranges in parentheses. The composition presented is an average of a number of test results obtained under the following sets of test conditions: steam-assisted flare using high Btu content feed; steam-assisted using low Btu content feed; air-assisted flare using high Btu content feed; and air-assisted flare using low Btu content feed. In all tests, "waste" gas was a synthetic gas consisting of a mixture of propylene and propane.

The VOC emission rate for flares is assumed to be 45% of the total HC. Methane (at 55%) is not a VOC.

References for Section 11.5

1. Flare Efficiency Study, EPA-600/2-83-052, U. S. Environmental Protection Agency, Cincinnati, OH, July 1983.

2. K. D. Siegel, Degree Of Conversion Of Flare Gas In Refinery High Flares, Dissertation, University of Karlsruhe, Karlsruhe, Germany, February 1980.

3. Manual On Disposal Of Refinery Wastes, Volume On Atmospheric Emissions, API Publication 931, American Petroleum Institute, Washington, DC, June 1977.

For Marine Propulsion Engines

Table II-3-2. EMISSION FACTORS FOR COMMERCIAL STEAMSHIPS—ALL GEOGRAPHIC AREAS
EMISSION FACTOR RATING: D

Pollutant	Residual oil[b] Hoteling kg/10^3 liter	Residual oil[b] Hoteling lb/10^3 gal	Residual oil[b] Cruise kg/10^3 liter	Residual oil[b] Cruise lb/10^3 gal	Residual oil[b] Full kg/10^3 liter	Residual oil[b] Full lb/10^3 gal	Distillate oil[b] Hoteling kg/10^3 liter	Distillate oil[b] Hoteling lb/10^3 gal	Distillate oil[b] Cruise kg/10^3 liter	Distillate oil[b] Cruise lb/10^3 gal	Distillate oil[b] Full kg/10^3 liter	Distillate oil[b] Full lb/10^3 gal
Particulates[c]	1.20[d]	10.0[d]	2.40	20.0	6.78	56.5	1.8	15	1.78	15	1.78	15
Sulfur oxides (SO_x as SO_2)[e]	19.1S	159S	19.1S	159S	19.1S	159S	17.0S	142S	17.0S	142S	17.0S	142S
Carbon monoxide[c]	Neg[d]	Neg[d]	0.414	3.45	0.872	7.27	0.6	4	0.5	4	0.5	4
Hydrocarbons[c]	0.38[d]	3.2[d]	0.082	0.682	0.206	1.72	0.4	3	0.4	3	0.4	3
Nitrogen oxides (NO_x as NO_2)	4.37	36.4	6.70	55.8	7.63	63.6	2.66	22.2	2.83	23.6	5.34	44.5

[a] The operating modes are based on the percentage of maximum available power. "Hoteling" is 10 to 11 percent of available power, "full" is 100 percent of available power, and "cruise" is an intermediate power (35 to 75 percent, depending on the test organization and vessel tested).

[b] Test organizations used "Navy Special" fuel oil, which is not a true residual oil. No vessel test data were available for residual oil combustion. "Residual" oil results are from References 2, 3, and 5. "Distillate" oil results are from References 3 and 5 only. Exceptions are noted. "Navy Distillate" was used as distillate test fuel.

[c] Particulate, carbon monoxide, and hydrocarbon emission factors for distillate oil combustion are based on stationary boilers (see Section 1.3 of this document).

[d] Reference 18 indicates that carbon monoxide emitted during hoteling is small enough to be considered negligible. This reference also places hydrocarbons at 0.38 kg/10^3 liter (3.2 lb/10^3 gal) and particulate at 1.20 kg/10^3 liter (10.0 lb/10^3 gal). These data are included for completeness only and are not necessarily compatible with other tabulated data.

[e] Emission factors listed are theoretical in that they are based on all the sulfur in the fuel converting to sulfur dioxide. Actual test data from References 3 and 5 confirm the validity of these theoretical factors. "S" is fuel sulfur content in percent.

For Marine Propulsion Engines

Table II-3-3. DIESEL VESSEL EMISSION FACTORS BY OPERATING MODE[a]

EMISSION FACTOR RATING: C

		Emissions[b]					
		Carbon monoxide		Hydrocarbons		Nitrogen oxides (NO_x as NO_2)	
Horsepower	Mode	lb/10³ gal	kg/10³ liter	lb/10³ gal	kg/10³ liter	lb/10³ gal	kg/10³ liter
200	Idle	210.3	25.2	391.2	46.9	6.4	0.8
	Slow	145.4	17.4	103.2	12.4	207.8	25.0
	Cruise	126.3	15.1	170.2	20.4	422.9	50.7
	Full	142.1	17.0	60.0	7.2	255.0	30.8
300	Slow	59.0	7.1	56.7	6.8	337.5	40.4
	Cruise	47.3	5.7	51.1	6.1	389.3	46.7
	Full	68.5	7.0	21.0	2.5	275.1	33.0
500	Idle	282.5	33.8	118.1	14.1	99.4	11.9
	Cruise	99.7	11.9	44.5	5.3	338.6	40.6
	Full	84.2	10.1	22.8	2.7	269.2	32.3
600	Idle	171.7	20.6	68.0	8.2	307.1	36.8
	Slow	50.8	6.1	16.6	2.0	251.5	30.1
	Cruise	77.6	9.3	24.1	2.9	349.2	41.8
700	Idle	293.2	35.1	95.8	11.5	246.0	29.5
	Cruise	38.0	4.3	8.8	1.1	452.8	54.2
900	Idle	223.7	26.8	249.1	29.8	107.5	12.9
	2/3	62.2	7.5	16.8	2.0	167.2	20.0
	Cruise	80.9	9.7	17.1	2.1	360.0	43.1
1580	Slow	122.4	14.7	–	–	371.3	44.5
	Cruise	44.6	5.3	–	–	623.1	74.6
	Full	237.7	28.5	16.8	2.0	472.0	5.7
2500	Slow	59.8	7.2	22.8	2.7	419.6	50.3
	2/3	126.5	15.2	14.7	1.8	326.2	39.1
	Cruise	78.3	9.4	16.8	2.0	391.7	46.9
	Full	95.9	11.5	21.3	2.6	399.6	47.9
3600	Slow	148.5	17.8	60.0	7.2	367.0	44.0
	2/3	28.1	3.4	25.4	3.0	358.6	43.0
	→ Cruise	41.4	5.0 ←	32.8	4.0	339.6	40.7 ←
	Full	62.4	7.5	29.5	3.5	307.0	36.8

[a] Reference 7.

[b] Particulate and sulfur oxides data are not available.

SO_2 MASS BALANCE

FLARE

Sulfur Dioxide Emission Factor
(Natural Gas Combustion)

$$\frac{1.69 \times 10^{-4} \text{ lb } SO_2}{\text{mscf - ppm}}$$ where ppm = ppmv of H_2S in Fuel

at 100 ppmv of H_2S;
and 1000 BTU/SCF for natural gas

$$\frac{1.69 \times 10^{-4} \text{ lb } SO_2}{\text{mscf - ppm}} \times 100 \text{ ppm} \times \frac{\text{SCF}}{1000 \text{ BTU}} = 0.0169 \frac{\text{lb } SO_2}{\text{mmBTU}}$$

Subject SUPPORT VESSEL MAIN ENGINES

Project No. 23036

By R. Potert

Checked By MR Myers

Task No. 004

File No.

Date 1/25/93

Date 2/4/93

Sheet 1 of 1

Sulfur Dioxide Emission Factor – Mass Balance
(Diesel Fuel Combustion)

Sulfur Content 0.05% by weight

#2 Diesel Density = 6.83 lb/gal ✓

$$\left(6.83 \frac{lb}{gal}\right)\left(264 \frac{gal}{m^3}\right) = 1803 \frac{lb}{m^3 \text{ fuel}}$$

$$\left(1803 \frac{lb \text{ diesel}}{m^3 \text{ fuel}}\right)\left(\frac{Kg}{2.2 lb}\right) = 820 \frac{Kg \text{ diesel}}{m^3}$$

For Sulfur Content = 0.05% by wt:

$$\left(820 \frac{Kg}{m^3} \text{ diesel}\right)\left(\frac{0.05}{100}\right) = 0.41 \frac{Kg\ S}{m^3 \text{ of fuel}}$$

For 1 mole S ⟶ 1 mole SO_2

then 32 g S ⟶ 64 g SO_2

So $0.41 \frac{Kg\ S}{m^3 \text{ fuel}} \longrightarrow 0.82 \frac{Kg}{m^3} \frac{SO_2}{\text{fuel}}$ ✓

CIDS SO_2 Mass Balance

Emergency Generator and Deck Cranes (Pedestal & Crawler)

✓ @ 100% eff

$$507 \text{ kW } (= 680 \text{ HP}) \times 3.413 \times 10^3 \frac{\text{Btu/hr}}{\text{kW}} = 1.73 \frac{\text{mm Btu}}{\text{hr}} ✓$$

$$1.73 \frac{\text{mm Btu}}{\text{hr}} \times \frac{\text{gal of diesel}}{136{,}000 \text{ Btu}} \times \frac{6.83 \text{ lb diesel}}{\text{gal of diesel}} \times \frac{.0005 \text{ lb S}}{\text{lb diesel}} = \frac{.043 \text{ lb S}}{\text{hr}}$$

19940 BTU/lb

$$0.043 \frac{\text{lb S}}{\text{hr}} \rightarrow 0.087 \frac{\text{lb } SO_2}{\text{hr}}$$

$$0.087 \frac{\text{lb } SO_2}{\text{hr}} \times \frac{453.6 \text{ g}}{\text{lb}} \times \frac{1}{680 \text{ hp}} = 0.06 \frac{\text{g}}{\text{hp-h}}$$

or

$$0.087 \frac{\text{lb } SO_2}{\text{hr}} \times \frac{453.6 \text{ g}}{\text{lb}} \times \frac{1}{507 \text{ kW}} = 0.08 \frac{\text{g}}{\text{kW-h}}$$

Doesn't appear that Thermal eff of I.C. engine was accounted for

$$\frac{1.73 \times 10^6 \text{ BTU/hr}}{680 \text{ HP}} = 2544$$

This is a straight units conversion @ 100% eff

VENDOR EMISSIONS DATA

FLOATING VESSEL

KULLUK

AIR EMISSION SOURCES FROM COMBUSTION

This information was gathered by telephoning various product suppliers.
These standards apply provided that the equipment is being operated and maintained in the factory approved manner.
Fuel used is Diesel 0.

MAIN GENERATOR ENGINES, 3 units.
Manufactured by: Electromotive Division of General Motors
Type 16 cylinder E.M.D.
Model # 16-645-MD16ESB,

CO		30% red.
NOx	.37 grams per H.P./Hr.	
SO2	13.52 grams per H.P./Hr.	(.7) = 9.46 g/hphr
Hydro Carbons	1.30 grams per H.P./Hr.	
AMOUNT USED.	.32 grams per H.P./Hr.	

Always one unit running at about 25 to 35% power. During drilling one unit operating at 100% for 70% to 80% of the time, and two units operating at 60% to 75% for the rest of the time.

EMERGENCY GENERATOR ENGINE, 1 unit.
Manufactured by: Detroit Diesel Division of General Motors
Type: 16V-92T
Model # 8163-7305
The following information is taken at 2100 RPM

CO	
NOx	2120 grams/hr.
SO2	9.15 grams/hr.
Hydro Carbons	1900 grams/hr.
Bosh Smoke Number:	257 grams/hr.
	1.8 at rated value, 1.2 at peak

AMOUNT USED:
Only used during cold start up of rig. Tun approximate .5 hr. per week to verify operation in case of emergency.

COLD START AIR COMPRESSOR ENGINE, 1 unit
Manufactured by: Lister Diesel
Model # TS 3

NOx		
CO	12	Grams/Kw. Hr.
Hydro Carbons	5.5	Grams/Kw. Hr.
AMOUNT USED	3.0	Grams/Kw. Hr.

This unit is only used if the battery start of the emergency generator fails. It would only be used in an emergency were we could not run one of the electric compressors from the emergency generator.

FLOATING DRILLING VESSEL

DECK CRANE ENGINE, 3 units
Manufactured by: Mercedes - Benz.
Type OM404, 259 kw at 2300 RPM

These engines are no longer manufactured, information is not available.

AMOUNT USED
These cranes are used to onload and offload all material used on the drilling unit. They are also used to handle all the anchoring equipment, and loading hoses. Frequently they are used for personnel transfer. Once the unit is operational I would estimate that we operate about 10 crane hrs. per day. This is an average over the entire operating season, for example 100 days X 10 hrs.= 1000 total crane hrs. for that period.

SURVIVAL ANCHOR WINCH ENGINE, 1 unit
Manufactured by: Deutz
M# BFGL913
The following information is provided at an exhaust gas flow rate of 1800 l/min. This unit will seldom see a load great enough to give gas flow rates this high.

NOx	
CO	1800 ppm
Hydro Carbons:	350 ppm
	250 ppm

AMOUNT USED:
This is used infrequently, only to retrieve the survival anchor, if used. It is used for going on location and then retrieved, and they for winter harbor. Estimated use of 6 times per year for 1 hr. each.

WELL LOG EQUIPMENT, 2 engines (Slumberger)
Diesel Generator, 1 unit
Manufactured by: Onan
Model # 120DJC-18
No information is available, since this unit has been out of production for some time.

Wire Line Winch, 1 unit
Manufactured by: General Motors Detroit Diesel Division
Type 4-71
Model 1043-7000

NOx	
CO	1460 grams/hr.
SO2	740 grams/hr.
Hydro Carbons	200 grams/hr.
	56 grams/hr.

FLOATING DRILLING VESSEL

AMOUNT USED
Dependent entirely on the well drilling program and how it progresses. Difficult to estimate. An average would be available from past well history.

HEATING BOILER, 2 units
Manufactured by: Kewane
Model: KE15-1562-02

No tests were required when these were manufactured.

AMOUNT USED
Entirely dependent on the weather and load on the main engines. The waste heat form the main engines is used to provide heat in the heating system and the boilers supplement it when the engines can not provide enough heat.

HOT WATER HEATER, 2 units
Manufactured by: P.V.I. Industries
Identifying # 3.8-N-250-A-O and 36-N-150-A-E

No tests were required when these were manufactured.

AMOUNT USED
Dependent upon numbers of people onboard. Generally one operates for 8 to 10 hrs. in a 24 hr. period. This is an estimate.

FLASH STEAM GENERATOR, 1 unit
Manufactured by: Clayton Manufacturing
Model. # EO-200-2, S# 21605
The following information is at a fuel usage of 55.3 U.S. gal/Hr. and assumes 24 hr. operation. There is no variance in flue gas flow since this unit uses a pressure fed open flame burner. Neither fuel or air are modulated.

NOx	200 ppm or 54 lb/day
CO	20 ppm or 3.1 lb/day
SO2	38 lb/day

AMOUNT USED
This unit is seldom used, and when used the steam is used for cleaning.

INCINERATOR, 1 unit
Manufactured by: Hamworthy Engineering
Type T2809Z2T7460V
Almost impossible to estimate exhaust gas content. The fuel oil burner is used primarily to ignite the content of the incinerator and then the main flame shuts off and a pilot light is kept running. Emissions are entirely dependent on what is put in the unit to be burnt up.

FLOATING DRILLING VESSEL

BURN BASKET, 1 unit
Used as required to burn paper trash while hanging overboard from the crane hook. It is ignited by pouring fuel on contents of basket and then lighting with a match. Use is difficult to estimate, and depends entirely on the amount of trash. Emissions are impossible to estimate.

FLARE BOOM, 2 units
Used during testing to burn off produced formation fluid. Emissions are impossible to estimate without knowing the properties of the fluid, temperature of fluid, water content, flow rates, etc.

PLEASE NOTE:
Information is available on exhaust emission of newer models of the same style equipment. If necessary, with the proper equipment, it is possible to do an analysis of flue emissions while the rig is operational.

SUPPORT VESSEL # F
GENERATORS
Mr Dennis Schwab Ph 604-872-4444
Fx 604-691-6269.

(M/V Kalvik)

EXHAUST CHEMISTRY

REQUEST NO: 90-029 DATE: 21SEP90

REQUESTED BY: M. REGENHARDT APPLICATION: MAR GEN SET

IDENTIFICATION: D399 PCTA E198 100% LOAD WET
HP: 1315
RPM: 1200

Exhaust Constituent	Pounds per Hour	Grams per Hour	Parts per Million (Wet)	Percent by Volume	Percent by Weight
CO_2	1573.0	713493	87718	8.77	13.44
N_2	8588.7	3895761	756608	75.66	73.41
O_2	898.0	407343	69303	6.93	7.68
H_2O	622.4	282327	84983	8.50	5.32
CO	2.2	1000	195	0.02	0.02
NO (NOTE 1)	13.2	6000		0.11	0.11
NOX	20.2	9173	1092	0.00	0.00
HC	0.1	60	23	0.00	0.00
SO_2	2.0	906	77	0.01	0.02
DPM (NOTE 2)	0.4	196			

				g/Hr	g/n cu.M (NOTE 3)
SMOKE (Cat Units)	0.06				
FUEL RATE	499.70	Lb/Hr			
INLET AIR FLOW	11200	Lb/Hr			
EXHAUST FLOW RATE	11700	Lb/Hr			
EXH. FLOW (60 deg F. and 760mm Hg)	2567	SCFM	NOX	9173	2.530
EXH. FLOW (1080 deg F. stack temp)	7604	CFM	CO	1000	0.276
			HC	60	0.017

NOTES: 1. The NOX shown is not present in the exhaust but rather is formed in the atmosphere from the NO present in the exhaust.

2. Dry particulate matter is an approximation based on smoke density and therefore is not included in the total exhaust flow rate.

3. Grams per normal cubic meter values corrected to 5% Oxygen.

Both the NO and NOX are corrected to 75 grains humidity.

The SO2 is based on a SULFUR content of 0.2 pct. (by wt.) in the fuel.

This data is based on steady-state engine operating conditions of 77 deg. F, 29.61 In. Hg., and No.2 diesel fuel. This data is also subject to instrumentation, measurement, and engine-to-engine variations.

Stack Emissions Cats

SUPPORT VESSELS # 2 and # 3

MAIN ENGINES

2 of 2

Oy Wärtsilä Diesel International Ltd
Diesel Technology
Pitkäkatu 2-12, P.O. Box 244
65101 Vaasa, Finland
Telephone +358-61-3242111
Telex 74250 wva sf
Telecopier +358-61-120 387

TELECOPIER WORK ORDER 4323

Attn: Randy Poteet.

Attn: Bob Rushton

To:	Wartsila Diesel Canada Inc. Imperial Square, Lake City Burnaby, British Columbia	Operator:	
		Date: 4 September 1992	
Attn:	Hans Lundquister	Our ref:	
Telecopier No.:	990-1-604-420-6003	No. of pages including cover sheet: 1	
From:	Göran Hellen		

Subject: NOx emissions for Beaudril

Dear Mr Lundquister

Estimated present NO_x emissions for the 8R32 engines are:

100% load (3725 BHP): 37 kg/hour (NO_x as NO_2) – 9.93 g/hp/hr ✓
 90% load (3350 BHP): 34 kg/hour "
 75% load (2790 BHP): 29 kg/hour "

For reducing the NO_x emissions we suggest fuel injection retard by 3 degree. In this special case no exchange of camshaft is needed.

Estimated NO_x reduction: 20-25%
" Fuel consumption increase: 5%

I regret the late answer, but it was necessary to check up this installation more in detail with the Vasa 32 product group.

Best Regards

Göran Hellén
Göran Hellen
Section Manager
Emission Control and Engine Fluids
Diesel Laboratory

Copy to: O Pellas

CIDS DRILLING UNIT

DRILLING MAIN ENGINES

GET SO_2 mB by dividing by four.

EXHAUST CHEMISTRY

REQUEST NO: 93-009

DATE: 02/01/93

REQUESTED BY: L.BROOKS

APPLICATION: GEN SET

IDENTIFICATION: D399 PCTA 100% LOAD DRY
HP: 1529
RPM: 1200

Exhaust Constituent	Pounds per Hour	Grams per Hour	Parts per Million (Wet)	Percent by Volume	Percent by Weight
CO2	1925.9	873574	91126	9.11	13.94
N2	10126.0	4593038	755511	75.55	73.31
O2	981.8	445332	64145	6.41	7.11
H2O	762.1	345670	86181	8.82	5.52
CO	1.3	574	95	0.01	0.01
NO (NOTE 1)	12.0	5466		0.08	0.09
NOX	18.4	8360	842	0.00	0.00
HC	0.1	59	20	0.00	0.00
SO2	2.4	1109/4	80	0.01	0.02
DPM (NOTE 2)	0.8	342			

SMOKE (Cat Units)	0.09
FUEL RATE	611.60 Lb/Hr
INLET AIR FLOW	13200 Lb/Hr
EXHAUST FLOW RATE	13812 Lb/Hr
EXH. FLOW (60 deg F. and 760mm Hg)	3030 SCFM
EXH. FLOW (1025 deg F. stack temp)	8656 CFM

	g/Hr	g/n cu.M (NOTE 3)
NOX	8360	1.884
CO	574	0.129
HC	59	0.013

NOTES: 1. The NOX shown is not present in the exhaust but rather is formed in the atmosphere from the NO present in the exhaust.

2. Dry particulate matter is an approximation based on smoke density and therefore is not included in the total exhaust flow rate.

3. Grams per normal cubic meter values corrected to 5% Oxygen.

Both the NO and NOX are corrected to 75 grains humidity.

The SO2 is based on a SULFUR content of 0.2 pct. (by wt.) in the fuel.

This data is based on steady-state engine operating conditions of 77 deg. F, 29.61 In. Hg., and No.2 diesel fuel. This data is also subject to instrumentation, measurement, and engine-to-engine variations.

LR BROOKS
Engine Div. Engrg
EXT. 86196

CIDS DRILLING UNIT
BARGE MAIN ENGINES

EXHAUST CHEMISTRY

REQUEST NO: 93-004 DATE: 20JAN93

GET SO_2 mB by dividing by four.

REQUESTED BY: T.ALLEMAN APPLICATION: GEN SET

IDENTIFICATION: D379 PCTA 100% LOAD DRY
HP: 550
RPM: 1200

Exhaust Constituent	Pounds per Hour	Grams per Hour	Parts per Million (Wet)	Percent by Volume	Percent by Weight
CO2	710.0	322048	72909	7.29	11.22
N2	4678.8	2122258	762344	76.23	73.97
O2	647.7	293770	92850	9.28	10.24
H2O	280.9	127433	70697	7.07	4.44
CO	1.4	625	225	0.02	0.02
NO (NOTE 1)	5.7	2600		0.09	0.09
NOX	8.8	3976	875	0.00	0.00
HC	0.1	50	36	0.00	0.00
SO2	0.9	409	64	0.01	0.01
DPM (NOTE 2)	0.1	36			

SMOKE (Cat Units).................... 0.02
FUEL RATE.......................... 225.50 Lb/Hr
INLET AIR FLOW..................... 6100 Lb/Hr
EXHAUST FLOW RATE.................. 6326 Lb/Hr
EXH. FLOW (60 deg F. and 760mm Hg). 1388 SCFM
EXH. FLOW (900 deg F. stack temp). 3631 CFM

	g/Hr	g/n cu.M (NOTE 3)
NOX	3976	2.440
CO	625	0.383
HC	50	0.031

NOTES: 1. The NOX shown is not present in the exhaust but rather is formed in the atmosphere from the NO present in the exhaust.

2. Dry particulate matter is an approximation based on smoke density and therefore is not included in the total exhaust flow rate.

3. Grams per normal cubic meter values corrected to 5% oxygen.

Both the NO and NOX are corrected to 75 grains humidity.

The SO2 is based on a SULFUR content of 0.2 pct. (by wt.) in the fuel.

This data is based on steady-state engine operating conditions of 77 deg. F, 29.61 In. Hg., and No.2 diesel fuel. This data is also subject to instrumentation, measurement, and engine-to-engine variations.

LRBROOKS
Engine Div. Engrg
EXT. 86196

[illegible] DRILLING UNIT
WATER SPRAY ENGINES

Engine Model: 3399 PCTA running at 100% load, 1215 Hp at 1200 RPM, with dry manifolds.
Arr#: none PL#: none
Application: An electric drive pumping/drilling oil field engine rating.

	Lb/Hr	g/Hr	g/Hp-Hr	PPM (Wet)	% BY Vol.	%BY Wt.
CO2	1492.3	676886	557.11	79368	7.94	12.16
N2	9052.9	4106299	3379.67	760030	76.00	73.76
O2	1125.3	510424	420.10	82792	8.28	9.17
H2O	590.5	267842	220.45	76854	7.69	4.81
*CO	1.6	730	0.60	135	0.01	0.01
NO~	9.3	4220	3.47		0.07	0.08
*NOx~	14.2	6455	5.31	732	0.00	0.00
*HC	0.1	50	0.04	19	0.00	0.00
*SO2^	1.9	859	0.71	70	0.01	0.02
*DPM+	0.2	104	0.09			

	g/Hr	g/Hp-Hr	g/n cu.M'
NOx	6455	5.31	1.878
CO	730	0.60	0.212
HC	50	0.04	0.015

SMOKE (Cat Number)..... 0.030
FUEL RATE................ 473.85 Lb/Hr
INLET AIR FLOW........... 11800 Lb/Hr
EXHAUST FLOW:
Rate..................... 12274 Lb/Hr
at 60 deg F and 760mm Hg. 2693 SCFM
at 900 deg F stack temp. 7048 CFM

Notes: * This data is based on steady-state engine operating conditions of 85 deg. F and 29.38 in. Hg. and No. 2 diesel fuel. This data is also subject to instrumentation, measurement and engine-to-engine variations.

~ The NOx shown is not actually present in the exhaust. It is based on the assumption that the NO present in the exhaust is converted to NOx in the atmosphere. NO and NOx are corrected to 75 grains humidity.

^ SO2 is proportional to a sulfur content of 0.20 % by weight of the fuel.

+ DPM (Dry Particulate Matter) is an approximation based on a correlation to smoke density, and is not included in the total exhaust flow rate.

' Grams per normal cubic meter values are corrected to 5% oxygen.

This report provides the best information available at this time. It should not be used at a future date without verification as to its validity for the current engine.

GET SO_2 MB by dividing by four.

6455

APPENDIX C
SOURCE CHARACTERISTICS

Subject: Stack Characteristics for Flares ARCO Model Project No. 23096 E

By MRB Checked By Task No. 004

File No.

Date 2/4/93 Date Sheet of

The EPA SCREEN MODEL was used to calculate the Effective Release height (meters) of the flare assumed for the ARCO Alaska Inc. Beaufort Sea Project.

Flaring was assumed to be 10,000,000 cubic feet per day

Assume 1000 BTU/CF = 10×10^9 Btu/day or 4.16×10^8 Btu/hr

Input height of flare was 15.24 m.

Calculated effective height = 37.3 m

SCREEN assumes

$V_s = 20$ m/sec

$t_s = 1273$ °K

$d_s = (9.88 \times 10^{-4})(Q_H)$

$Q_H = \sqrt{(0.45)(H \text{ in cal/sec})}$

$H = 10 \times 10^9$ Btu/day $= 4.16 \times 10^8$ Btu/hr

$(4.16 \times 10^8)\left(0.07 \frac{\text{Cal/sec}}{\text{Btu/hr}}\right) = 2.912 \times 10^7$ cal/sec

$Q_H = \sqrt{(0.45)(2.912 \times 10^7)} = 3619.4$

$d_s = (9.88 \times 10^{-4})(Q_H) = 3.58$ m

*** SCREEN-1.1 MODEL RUN ***
*** VERSION DATED 88300 ***

KUVLUM FLARE

SIMPLE TERRAIN INPUTS:

```
   SOURCE TYPE               =    FLARE
   EMISSION RATE (G/S)       =    1.000
   FLARE STACK HEIGHT (M)    =    20.44
   TOT HEAT RLS (CAL/S)      =    .2912E+08
   RECEPTOR HEIGHT (M)       =      .00
   IOPT (1=URB,2=RUR)        =     2
   EFF RELEASE HEIGHT (M)    =    37.30
   BUILDING HEIGHT (M)       =      .00
   MIN HORIZ BLDG DIM (M)    =      .00
   MAX HORIZ BLDG DIM (M)    =      .00
```

BUOY. FLUX = 482.81 M**4/S**3; MOM. FLUX = 294.41 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
150.	.1161E-01	5	1.0	1.6	5000.0	237.3	57.8	57.3	NO
200.	.1193E-01	5	1.0	1.6	5000.0	237.3	58.3	57.5	NO
300.	.1275E-01	5	1.0	1.6	5000.0	237.3	59.6	57.8	NO
400.	.1367E-01	5	1.0	1.6	5000.0	237.3	61.2	58.2	NO
500.	.1474E-01	5	1.0	1.6	5000.0	237.3	63.2	58.6	NO
600.	.4063E-01	1	3.0	3.3	960.0	517.0	153.9	172.4	NO
700.	.1923	1	3.0	3.3	960.0	517.0	174.9	230.0	NO
800.	.3694	1	3.0	3.3	960.0	517.0	195.5	298.2	NO
900.	.4749	1	2.0	2.2	757.8	756.8	243.7	393.8	NO
1000.	.6609	1	2.0	2.2	757.8	756.8	265.1	482.4	NO
1100.	.7475	1	2.0	2.2	757.8	756.8	286.2	582.0	NO
1200.	.7570	1	2.0	2.2	757.8	756.8	306.8	692.7	NO
1300.	.7287	1	2.0	2.2	757.8	756.8	327.2	814.5	NO
1400.	.6905	1	2.0	2.2	757.8	756.8	347.3	947.5	NO
1500.	.6628	1	2.0	2.2	757.8	756.8	362.2	1090.2	NO
1600.	.6374	1	2.0	2.2	757.8	756.8	376.6	1244.4	NO
1700.	.6137	1	2.0	2.2	757.8	756.8	391.1	1410.4	NO
1800.	.5916	1	2.0	2.2	757.8	756.8	405.8	1588.1	NO
1900.	.5709	1	2.0	2.2	757.8	756.8	420.5	1777.6	NO
2000.	.5516	1	2.0	2.2	757.8	756.8	435.2	1978.9	NO
2100.	.5334	1	2.0	2.2	757.8	756.8	450.0	2192.0	NO
2200.	.5164	1	2.0	2.2	757.8	756.8	464.9	2416.9	NO
2300.	.5004	1	2.0	2.2	757.8	756.8	479.7	2653.7	NO
2400.	.4853	1	2.0	2.2	757.8	756.8	494.6	2902.4	NO
2500.	.4712	1	2.0	2.2	757.8	756.8	509.5	3163.1	NO
2600.	.4578	1	2.0	2.2	757.8	756.8	524.3	3435.8	NO
2700.	.4452	1	2.0	2.2	757.8	756.8	539.2	3720.5	NO
[illegible]00.	.4332	1	2.0	2.2	757.8	756.8	554.1	4017.3	NO
[illegible]00.	.4219	1	2.0	2.2	757.8	756.8	568.9	4326.3	NO
3000.	.4112	1	2.0	2.2	757.8	756.8	583.8	4647.4	NO
3500.	.3650	1	2.0	2.2	757.8	756.8	657.6	5000.0	NO
4000.	.3554	2	2.0	2.2	757.8	756.8	566.0	540.8	NO
4500.	.3540	2	2.0	2.2	757.8	756.8	619.9	605.2	NO

5000.	.3415	2	2.0	2.2	757.8	756.8	673.6	671.2	NO
5500.	.3241	2	2.0	2.2	757.8	756.8	727.0	738.6	NO
6000.	.3054	2	2.0	2.2	757.8	756.8	780.1	807.0	NO
6500.	.2875	2	2.0	2.2	757.8	756.8	832.8	876.5	NO
7000.	.2710	2	2.0	2.2	757.8	756.8	885.1	946.8	NO
7500.	.2561	2	2.0	2.2	757.8	756.8	937.1	1017.9	NO
8000.	.2428	2	2.0	2.2	757.8	756.8	988.8	1089.6	NO
8500.	.2455	3	2.0	2.3	730.0	729.0	736.7	475.9	NO
9000.	.2514	5	2.0	3.2	5000.0	196.0	373.2	87.6	NO
9500.	.2594	5	2.0	3.2	5000.0	196.0	391.4	89.4	NO
10000.	.2664	5	2.0	3.2	5000.0	196.0	409.4	91.2	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 150. M:

1164.	.7599	1	2.0	2.2	757.8	756.8	299.2	650.4	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****
*** SUMMARY OF SCREEN MODEL RESULTS ***
****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	.7599	1164.	0.

****
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
****

GEP Table

Woodward-Clyde

Input Data
File Name: CID50.TAB
Date: 1-23-1993

Model: ISCST

Wake Area Section Option: Maximum of all directions within sector.

Wake Area Shape Option: Building edge moved 2L upwind
& 5L downwind.

Combine Structures: Combine buildings within one "L"
crosswind and 5.00 "L" upwind
-downwind of each other.

Number of Buildings: 3

Number of Tanks: 0

Number of Stacks: 2

Plant Rotation Angle: .000½

Input Data (cont.)

Building No. 1
Name: PLATFORM
Height: 15.24 (M)

Corner	East (M)	North (M)
1	-44.30	-41.80
2	-44.30	41.80
3	44.30	41.80
4	44.30	-41.80
5	-44.30	-41.80

Input Data (cont.)

Building No. 2
Name: PIPEHOUSE
Height: 27.31 (M)

Corner	East (M)	North (M)
1	-23.30	-6.70
2	-23.30	27.80
3	-13.50	27.80
4	-13.50	11.00
5	3.40	11.00
6	3.40	-6.70
7	-23.30	-6.70

Input Data (cont.)

Building No. 3
Name: QUARTER
Height: 32.04 (M)

Corner	East (M)	North (M)
1	-23.30	-39.70
2	-23.30	-24.30
3	35.20	-24.30
4	35.20	-39.70
5	-23.30	-39.70

Input Data (cont.)

Stack Parameters

Stack No.	Height (M)	------ Location ------- East (M)	North (M)
1	30.48	.00	.00
2	37.30	63.60	7.00

GEP Table

Woodward-Clyde

STACK ID 1

Sector No.	Critical Flow Vector (deg)	GEP Stack Height (M)	Controlling Structures Name-1	Name-2	Height (M)	Projected Width (M)
1	14.75	80.100	QUARTER		32.040	60.493
2	15.00	80.100	QUARTER		32.040	60.492
3	25.00	80.100	QUARTER		32.040	59.527
4	35.00	80.100	QUARTER		32.040	56.753
5	45.00	80.100	QUARTER		32.040	52.255
6	55.00	80.100	QUARTER		32.040	46.169
7	65.00	80.100	QUARTER		32.040	38.680
8	75.00	68.275	PIPEHOUSE	QUARTER	27.310	80.341
9	85.00	68.275	PIPEHOUSE	QUARTER	27.310	72.342
10	105.00	77.064	QUARTER		32.040	30.016
11	115.00	80.100	QUARTER		32.040	38.680
12	125.00	80.100	QUARTER		32.040	46.169
13	135.00	80.100	QUARTER		32.040	52.255
14	145.00	80.100	QUARTER		32.040	56.753
15	155.00	80.100	QUARTER		32.040	59.527
16	165.00	80.100	QUARTER		32.040	60.492
17	165.25	80.100	QUARTER		32.040	60.493
18	185.00	80.100	QUARTER		32.040	59.619
19	194.75	80.100	QUARTER		32.040	60.493
20	195.00	80.100	QUARTER		32.040	60.492
21	205.00	80.100	QUARTER		32.040	59.527
22	215.00	80.100	QUARTER		32.040	56.753
23	225.00	80.100	QUARTER		32.040	52.255
24	235.00	80.100	QUARTER		32.040	46.169
25	245.00	80.100	QUARTER		32.040	38.680
26	255.00	68.275	PIPEHOUSE	QUARTER	27.310	80.341
27	265.00	68.275	PIPEHOUSE	QUARTER	27.310	72.342
28	285.00	77.064	QUARTER		32.040	30.016
29	295.00	80.100	QUARTER		32.040	38.680
30	305.00	80.100	QUARTER		32.040	46.169
31	315.00	80.100	QUARTER		32.040	52.255
32	325.00	80.100	QUARTER		32.040	56.753
33	335.00	80.100	QUARTER		32.040	59.527
34	345.00	80.100	QUARTER		32.040	60.492
35	345.25	80.100	QUARTER		32.040	60.493
36	365.00	80.100	QUARTER		32.040	59.619

GEP Table

Woodward-Clyde

STACK ID 2

Sector No.	Critical Flow Vector (deg)	GEP Stack Height (M)	Controlling Structures: Name-1	Name-2	Height (M)	Projected Width (M)
1	14.75	80.100	QUARTER		32.040	60.493
2	15.00	80.100	QUARTER		32.040	60.492
3	25.00	80.100	QUARTER		32.040	59.527
4	35.00	80.100	QUARTER		32.040	56.753
5	45.00	80.100	QUARTER		32.040	52.255
6	55.00	80.100	QUARTER		32.040	46.169
7	65.00	80.100	QUARTER		32.040	38.680
8	75.00	77.064	QUARTER		32.040	30.016
9	85.00	68.275	PIPEHOUSE	QUARTER	27.310	72.342
10	98.25	68.275	PIPEHOUSE	QUARTER	27.310	68.208
11	105.00	68.275	PIPEHOUSE	QUARTER	27.310	67.736
12	125.00	38.100	PLATFORM	QUARTER	15.240	119.300
13	135.00	38.100	PLATFORM		15.240	121.764
14	136.75	38.100	PLATFORM		15.240	121.815
15	145.00	38.100	PLATFORM		15.240	120.528
16	155.00	38.100	PLATFORM		15.240	115.630
17	170.00		No structure within 5L			
18	180.00		No structure within 5L			
19	194.75	80.100	QUARTER		32.040	60.493
20	195.00	80.100	QUARTER		32.040	60.492
21	205.00	80.100	QUARTER		32.040	59.527
22	215.00	80.100	QUARTER		32.040	56.753
23	225.00	80.100	QUARTER		32.040	52.255
24	235.00	80.100	QUARTER		32.040	46.169
25	245.00	38.100	PLATFORM		15.240	113.211
26	255.00	38.100	PLATFORM		15.240	103.683
27	275.00	38.100	PLATFORM	QUARTER	15.240	91.004
28	285.00	38.100	PLATFORM	QUARTER	15.240	103.683
29	295.00	38.100	PLATFORM		15.240	113.211
30	305.00	38.100	PLATFORM		15.240	119.300
31	315.00	38.100	PLATFORM	QUARTER	15.240	121.764
32	316.75	38.100	PLATFORM		15.240	121.815
33	330.00		No structure within 5L			
34	340.00		No structure within 5L			
35	350.00		No structure within 5L			
36	360.00		No structure within 5L			

APPENDIX D
OCD LISTINGS

(on disk)

APPENDIX E
ISC LISTINGS

(on disk)

Woodward-Clyde Consultants

APPENDIX F
ISC TOXIC LISTINGS

(on disk)

APPENDIX G
PREDETERMINED POTENTIAL DRILLING LOCATIONS

APPENDIX G
PREDETERMINED POTENTIAL DRILLING LOCATIONS

Location #	OCS Block	Location Description	
2	672	7000' FWL	3000' FSL
2a	672	7800' FWL	4900' FSL
3	673	5100' FWL	5400' FNL
5	672	6000' FWL	8900" FSL
6	718	3700' FSL	5800' FEL

Woodward-Clyde Consultants

APPENDIX H

FINAL PERMIT SPECIAL CONDITIONS

APPENDIX H

FINAL PERMIT SPECIAL CONDITIONS

---

1. Predetermined Potential Drilling Locations - This February 12, 1993 Final Permit Application provides five (see Appendix G) of these locations. Doing so should allow relocation of drilling vessel(s)/unit(s) among predetermined locations at will with no notice provided to EPA. However, it should be noted that no more than two drilling vessels/units would simultaneously operate. Similar notice exemptions should be provided during the initial five year permit term.

2. Exploratory Drilling Outside Modeling Domain - These operations should be authorized by the Final Permit subject to the following conditions: a.) BACT re-determination, b.) new location significance modeling and, c.) minimum notice period to EPA.

3. Drilling Vessel/Unit and Support Vessel Substitutes - Substitutes should be allowed provided that total potential Project emissions do not increase above those inventoried in the February 12, 1993 Final Permit Application.

Bottom-founded unit options | SIDS SSDC Molik PAQ

Same or max. emissions may not result in equivalent AA impact