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To Nahid Zoueshtiagh/R9/USEPA/US@EPA
cc Margaret Alkon/R9/USEPA/US@EPA, TRWOOD@stoel.com, TUmenhofer@entrix.com
bcc
Subject Cabrillo Port: Revised Emission Spreadsheets

Nahid:

Per our telephone conference today, I have revised the emissions spreadsheets and attached them for your review as follows:

Attachment 2: FSRU Equipment Emissions Summary

The tables at the bottom of Table FSRU 2, Equipment Controlled Emissions Summary (FSRU Page 2), have been removed

Attachment 3: Federal Waters Vessel Emissions Summary

The references to "Biodiesel" have been removed from all spreadsheets and replaced with "CA Diesel".

Attachment 4: District Waters Vessel Emissions Summary

The references to "Biodiesel" have been removed from all spreadsheets and replaced with "CA Diesel".

Should you have any questions concerning these revisions, please contact me.

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EPA Response Revised Emissions Attachment 2.xls
EPA Response Revised Emissions Attachment 3.xls
EPA Response Revised Emissions Attachment 4.xls

Index: FSRU Emission Summary Tables

Table No.	Table Name
Table FSRU 1	SCV and ICE Fuel Usage
Table FSRU 2	Equipment Controlled Emissions Summary
Table FSRU 3	Equipment Uncontrolled Emissions Summary
Table FSRU 4	Release Parameters
Table FSRU 5	Wartsila 9L50DF Controlled Emissions Summary
Table FSRU 6	Wartsila 9L50DF Uncontrolled Emissions Summary
Table FSRU 7	Wartsila 9L50DF Diesel Emissions Controlled Summary
Table FSRU 8	Wartsila 9L50DF Diesel Emissions Uncontrolled Summary
Table FSRU 9	SCV Controlled Emissions Summary
Table FSRU 10	SCV Uncontrolled Emissions Summary
Table FSRU 11	Firewater Pump Emissions Summary
Table FSRU 12	Emergency Generator Emissions Summary
Table FSRU 13	Freefall Lifeboat Emissions Summary
Table FSRU 14	Diesel Storage Tank Emissions Summary

Table FSRU 1: SCV and ICE Fuel Usage

Quantity	Description	Rating (each)	LNG Fuel Usage			
			mmBTU/hr	mcf/hr	hrs/yr	mmcf/yr
3	Wartsila 9L50DF Main Generators	8250 KW	90.43	89.75	8760	786
8	Sub-X Submerged Combustion Vaporizers	115 mmBTU/hr	460.00	456.53	8760	3,999
Total Usage			**550.43**	**546.28**		**4,785**
Total LNG Throughput (see notes)						**292,000**
Percent of Total Usage						**1.64%**

Device Notes:

FSRU throughput 800 mmcf/day, 365 days/yr, 292 mmmcf/yr total

Three 9L50DF main generators (8.25 MW each) operating at 100% load for hourly max, 110,903 MW-hr annual total, 99.2% gas fuel, 0.008% diesel pilot fuel (heat input)

Four SCVs operating at 100% capacity factor for 8,760 hrs/yr, low-NOx burners

Table FSRU 2: Equipment Controlled Emissions Summary

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year						
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2	NH_3
3	Wartsila 9L50DF Main Generators	8250 KW	Gas / CA Diesel	13.1	24.6	29.5	0.07	7.4	54,279	5.4
1	Wartsila 9L50DF Backup Generator	8250 KW	Gas / CA Diesel	4.0	0.2	0.2	0.00	0.2	473	-
8	Sub-X Submerged Combustion Vaporizers	115 mmBTU/hr	Natural Gas	48.9	3.5	148.9	0.33	3.8	215,271	-
2	Emergency Fire Pump / Generator	600 / 4200 KW	CA Diesel	3.0	0.4	1.9	0.00	0.1	370	-
1	Freefall Lifeboat	56 KW	CA Diesel	0.0	0.0	0.0	0.00	0.0	2	-
1	Diesel Fuel Storage Tank	145,000 gallons	CA Diesel	-	0.03	-	-	-	-	-
Total Emissions				**69.0**	**28.8**	**180.5**	**0.41**	**11.5**	**270,395**	**5.4**

Device Notes:

FSRU throughput 800 mmcf/day, 365 days/yr, 292 mmmcf/yr total

Three 9L50DF main generators (8.25 MW each) operating at 100% load for hourly max, 110,903 MW-hr annual total, 99.2% gas fuel, 0.008% diesel pilot fuel (heat input)

Backup 9L50DF generator operating at 100% load for 100 machine hours per year, diesel fuel, 2006 Tier 2 standards

Four SCVs operating at 100% capacity factor for 8,760 hrs/yr, low-NOx burners

Emergency fire pump and generator operating at 100% load for 100 machine hours each per year, diesel fuel, 2006 Tier 2 standards

Three Life Boats exercising at 100% load for 50 machine hours per year total, diesel fuel, 2006 Tier 2 standards

Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

Table FSRU 3: Equipment Uncontrolled Emissions Summary

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year						
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2	NH_3
3	Wartsila 9L50DF Main Generators	8250 KW	Gas / CA Diesel	146.7	88.6	463.2	0.1	7.4	54,279	-
1	Wartsila 9L50DF Backup Generator	8250 KW	Gas / CA Diesel	5.1	0.7	3.2	0.0	0.2	473	-
8	Sub-X Submerged Combustion Vaporizers	115 mmBTU/hr	Natural Gas	97.9	3.5	119.1	0.3	3.8	215,271	-
2	Emergency Fire Pump / Generator	600 / 4200 KW	CA Diesel	3.0	0.4	1.9	0.0	0.1	370	-
1	Freefall Lifeboat	56 KW	CA Diesel	0.0	0.0	0.0	0.0	0.0	2	-
1	Diesel Fuel Storage Tank	145,000 gallons	CA Diesel	-	0.03	-	-	-	-	-
Total Emissions				**252.6**	**93.3**	**587.3**	**0.4**	**11.5**	**270,395**	**-**

Device Notes:

FSRU throughput 800 mmcf/day, 365 days/yr, 292 mmmcf/yr total

Three 9L50DF main generators (8.25 MW each) operating at 100% load for hourly max, 110,903 MW-hr annual total, 99.2% gas fuel, 0.008% diesel pilot fuel (heat input)

Backup 9L50DF generator operating at 100% load for 100 machine hours per year, diesel fuel, 2006 Tier 2 standards

Four SCVs operating at 100% capacity factor for 8,760 hrs/yr, low-NOx burners

Emergency fire pump and generator operating at 100% load for 100 machine hours each per year, diesel fuel, 2006 Tier 2 standards

Three Life Boats exercising at 100% load for 50 machine hours per year total, diesel fuel, 2006 Tier 2 standards

Diesel Storage Tank, 145,000 gallon capacity, throughput based on diesel fuel usage defined above for applicable devices

Table FSRU 4: Release Parameters

Release Parameter	Units	Main Gens	Backup Gen	Vaporizers	Emerg. Pump	Emerg. Gen	Life Boat
Fuel	Type	Dual Fuel	Diesel	Gas	Diesel	Diesel	Diesel
Heat Input	mmBTU/hr	178.2	59.4	460.0	5.9	35.8	0.64
Wet Fd Factor	wscf/mmBTU	10,608	10,320	10,610	10,320	10,320	10,320
Oxygen Content	percent	15%	15%	3%	15%	15%	15%
Exhaust Temperature	Deg F	800	800	70	800	800	800
Stack Diameter	inches	68.2	39.4	78.7	10.0	26.0	3.0
Stack Area	sq. ft.	25.36	8.45	33.82	0.55	3.69	0.05
Stack Flow	wscf/min	111,608	36,194	94,976	3,565	21,835	388
Stack Flow	wacf/min	266,338	86,372	95,336	8,507	52,106	926
Stack Velocity	ft/min	10,502	10,217	2,819	15,597	14,132	18,871
Release Height	meters	33	33	35	25	25	1
Release Diameter	meters	1.73	1.00	2.00	0.25	0.66	0.08
Release Velocity	meters/sec	53.3	51.9	14.3	79.2	71.8	95.9
Release Temperature	degrees K	700	700	294	700	700	700

Downwash Dimensions	Units	FSRU Hull
Height	meters	21
Width (min horizontal)	meters	65
Length (max horizontal)	meters	286

Table FSRU 6: Wartsila 9L50DF Uncontrolled Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, Wartsila 50DF		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S (with 1% diesel pilot charge, 15 ppm S)		
TOTAL YEARLY PROCESS RATE	110903	MW-hrs	from BHP estimates
HOURLY PROCESS RATE	24.75	MW	from BHP estimates
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/cf	
OPERATING SCHEDULE	8760	hrs/yr	
HEAT RATE	7200	BTU/KW-hr	
CONVERSION EFFICIENCY	47.4%	percent	from Wartsila Report
HEAT INPUT	178.21	mmBTU/hr	
DRY Fd	8714	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	5.50	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	99.7	1.0000	2.6456	293,401	146.70	65.48	1.200	0.895
Reactive Hydrocarbons (ROC) as CH_4	173	1.0000	1.5984	177,263	88.63	39.56	0.725	0.541
Carbon Monoxide (CO)	517	1.0000	8.3525	926,316	463.16	206.72	3.789	2.825
Sulfur Dioxide (SO_2)	0.034	1.0654	0.0013	140	0.07	0.03	0.0006	0.0004
Particulates (as PM_{10}) (grains/dscf)	0.0042	1.0744	0.1330	14,754	7.38	3.29	0.060	0.045
Carbon Dioxide (CO_2)	3.86%	1.0000	978.8576	108,558,240	54,279	24,227	444	331
Ammonia Slip (NH_3)								

Wartsila Emission Factors

NO_X = 1.2 g/kw-hr (Wartsila Report 4 July 2003)

ROC = 0.725 g/kw-hr (25% of 2.9 g/kw-hr THC, AP-42 Table 3.4-1 , Wartsila Report 4 July 2003)

CO = 1.16 lb/mmBTU (AP-42 Table 3.4-1)

PM_{10} = 0.06 g/kw-hr (BACT)

CO_2 = 444 g/kw-hr (Wartsila Report 4 July 2003)

Average generation	110,903	MW-hrs/yr
Maximum generation	216,810	MW-hrs/yr
Average Capacity Factor	51.2%	percent

Table FSRU 7: Wartsila 9L50DF Diesel Emissions Controlled Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, Wartsila 50DF		
FUEL TYPE/PROCESS INFO	California diesel, 15 ppm S		
TOTAL YEARLY PROCESS RATE	825	MW-hrs	
HOURLY PROCESS RATE	8.25	MW	from BHP estimates
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	137030	BTU/gal	USEPA AP-42
OPERATING SCHEDULE	100	hrs/yr	
HEAT RATE	7200	BTU/KW-hr	
CONVERSION EFFICIENCY	47.4%	percent	from Wartsila Report
HEAT INPUT	59.40	mmBTU/hr	
DRY Fd	9190	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	1.93	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	349	0.7900	9.7533	8,046	4.02	80.46	4.424	3.299
Reactive Hydrocarbons (ROC) as CH_4	56	0.3100	0.5467	451	0.23	4.51	0.248	0.185
Carbon Monoxide (CO)	27	0.0600	0.4630	382	0.19	3.82	0.210	0.157
Sulfur Dioxide (SO_2)	0.3	1.0000	0.011	9	0.00	0.09	0.005	0.004
Particulates (as PM_{10}) (grains/dscf)	0.0132	1.0000	0.4409	364	0.18	3.64	0.200	0.149
Carbon Dioxide (CO_2)	4.28%	1.0000	1146.4098	945,788	473	9,458	520	388
Ammonia Slip (NH_3)								

* USEPA Tier 2 Standards (>560 kw)

NO_X + ROC = 6.4 g/kw-hr

CO = 3.5 g/kw-hr

PM_{10} = 0.2 g/kw-hr

CO_2 = 520 g/kw-hr (Wartsila)

Backup Diesel Fuel Usage 43,351 gal/yr

SCR Control Ratios for Diesel

NO_X = (99.7 - 8.9) / 441 = 21% (molar basis)

ROC = (173 - 48) / 181 = 69% (molar basis)

CO = 94% (molar basis, same as gas because uncontrolled concentration is less)

Table FSRU 8: Wartsila 9L50DF Diesel Emissions Uncontrolled Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Dual Fuel ICE generator, Wartsila 50DF		
FUEL TYPE/PROCESS INFO	California diesel, 15 ppm S		
TOTAL YEARLY PROCESS RATE	825	MW-hrs	
HOURLY PROCESS RATE	8.25	MW	from BHP estimates
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	137030	BTU/gal	USEPA AP-42
OPERATING SCHEDULE	100	hrs/yr	
HEAT RATE	7200	BTU/KW-hr	
CONVERSION EFFICIENCY	47.4%	percent	from Wartsila Report
HEAT INPUT	59.40	mmBTU/hr	
DRY Fd	9190	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	1.93	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	441	1.0000	12.3460	10,185	5.09	101.85	5.600	4.176
Reactive Hydrocarbons (ROC) as CH_4	181	1.0000	1.7637	1,455	0.73	14.55	0.800	0.597
Carbon Monoxide (CO)	453	1.0000	7.7162	6,366	3.18	63.66	3.500	2.610
Sulfur Dioxide (SO_2)	0.3	1.0000	0.011	9	0.00	0.09	0.005	0.004
Particulates (as PM_{10}) (grains/dscf)	0.0132	1.0000	0.4409	364	0.18	3.64	0.200	0.149
Carbon Dioxide (CO_2)	4.28%	1.0000	1146.4098	945,788	473	9,458	520	388
Ammonia Slip (NH_3)								

* USEPA Tier 2 Standards (>560 kw)

NO_X + ROC = 6.4 g/kw-hr

CO = 3.5 g/kw-hr

PM_{10} = 0.2 g/kw-hr

CO_2 = 520 g/kw-hr (Wartsila)

Table FSRU 9: SCV Controlled Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Submerged Combustion Vaporizer, Selas Sub-X, 120-180 ton LNG/hr, Low NO_X Burner		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S		
TOTAL YEARLY PROCESS RATE	3999.206		
HOURLY PROCESS RATE	0.456530		
PROCESS UNITS	PT074	Million Cubic Feet Burned	
HIGHER HEATING VALUE	1007.6	mmBTU/mmcf	
OPERATING SCHEDULE	8760	hrs/yr	
NUMBER OF DEVICES	4.00	Average	
UNIT RATING	115.000	mmBTU/hr	
HEAT INPUT	460.00	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	4.68	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE lb/mmBTU
Nitrogen Oxides (as NO_2)	20.0	1.0000	24.467	97,850	48.93	11.17	0.0243
Reactive Hydrocarbons (ROC) as CH_4	4.1	1.0000	1.745	6,977	3.49	0.80	0.0017
Carbon Monoxide (CO)	100.0	1.0000	74.466	297,805	148.90	34.00	0.0739
Sulfur Dioxide (SO_2)	0.10	1.0000	0.166	664	0.33	0.08	0.0002
Particulates (as PM_{10}) (grains/dscf)	0.0013	1.0000	1.900	7,598	3.80	0.87	0.0019
Carbon Dioxide (CO_2)	9.2%	1.0000	107656.700	430,541,325	215270.66	49148.55	106.8447
Ammonia Slip (NH_3)							

Emission Factors @ 3% oxygen

NO_X = 20 ppmv (Selas Specification) 106.8446806

ROC = 4.1 ppmv (Costain Report)

CO = 100 ppmv (Selas Specification)

PM_{10} = 1.9 lb/mmcf (AP-42 Table 1.4-2, non-condensible filterable fraction, condensibles remain in 70 F water solution)

CO_2 = 9.2% (Selas Specification, 6.6% @ 8% oxygen)

Device Notes:

FSRU throughput 800 mmcf/day, 365 days/yr, 292 mmmcf/yr total

SCV sendout rate =200 mmscf/day (guarantee)

Throughput, mmcf/day	800	design
SCV Sendout, mmcf/day each	200	guarantee
Equivalent SCVs Operating	4.00	average

Table FSRU 10: SCV Uncontrolled Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Submerged Combustion Vaporizer, Selas Sub-X, 120-180 ton LNG/hr, Standard Burner		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S		
TOTAL YEARLY PROCESS RATE	3999.206		
HOURLY PROCESS RATE	0.456530		
PROCESS UNITS	PT074	Million Cubic Feet Burned	
HIGHER HEATING VALUE	1007.6	mmBTU/mmcf	
OPERATING SCHEDULE	8760	hrs/yr	
NUMBER OF DEVICES	4.00	Average	
UNIT RATING	115.000	mmBTU/hr	
HEAT INPUT	460.00	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	4.68	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE lb/mmBTU
Nitrogen Oxides (as NO_2)	40.0	1.0000	48.935	195,701	97.85	22.34	0.0486
Reactive Hydrocarbons (ROC) as CH_4	4.1	1.0000	1.745	6,977	3.49	0.80	0.0017
Carbon Monoxide (CO)	80.0	1.0000	59.573	238,244	119.12	27.20	0.0591
Sulfur Dioxide (SO_2)	0.10	1.0000	0.166	664	0.33	0.08	0.0002
Particulates (as PM_{10}) (grains/dscf)	0.0013	1.0000	1.900	7,598	3.80	0.87	0.0019
Carbon Dioxide (CO_2)	9.2%	1.0000	107656.700	430,541,325	215270.66	49148.55	106.8447
Ammonia Slip (NH_3)							

Emission Factors @ 3% oxygen

NO_X = 40 ppmv (Selas Specification)

ROC = 4.1 ppmv (Costain Report)

CO = 80 ppmv (Selas Specification)

PM_{10} = 1.9 lb/mmcf (AP-42 Table 1.4-2, non-condensible filterable fraction, condensibles remain in 70 F water solution)

CO_2 = 9.2% (Selas Specification, 6.6% @ 8% oxygen)

Device Notes:

FSRU throughput 800 mmcf/day, 365 days/yr, 292 mmmcf/yr total

SCV sendout rate =200 mmscf/day (guarantee)

Throughput, mmcf/day	800	design
SCV Sendout, mmcf/day each	200	guarantee
Equivalent SCVs Operating	4.00	average

Table FSRU 11: Firewater Pumps Emission Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Firewater Pump, 600 KW		
FUEL TYPE/PROCESS INFO	California diesel, 15 ppm S		
TOTAL YEARLY PROCESS RATE	60	MW-hrs	
HOURLY PROCESS RATE	0.60	MW	from BHP estimates
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	137030	BTU/gal	USEPA AP-42
OPERATING SCHEDULE	100	hrs/yr	
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	5.85	mmBTU/hr	
DRY Fd	9190	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.19	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	326	1.0000	12.3460	741	0.37	7.41	5.600	4.176
Reactive Hydrocarbons (ROC) as CH_4	134	1.0000	1.7637	106	0.05	1.06	0.800	0.597
Carbon Monoxide (CO)	334	1.0000	7.7162	463	0.23	4.63	3.500	2.610
Sulfur Dioxide (SO_2)	0.3	1.0000	0.015	1	0.00	0.01	0.007	0.005
Particulates (as PM_{10}) (grains/dscf)	0.0097	1.0000	0.4409	26	0.01	0.26	0.200	0.149
Carbon Dioxide (CO_2)	4.26%	1.0000	1543.2439	92,595	46	926	700	522
Ammonia Slip (NH_3)								

* USEPA Tier 2 Standards (>560 kw)

NO_X + ROC = 6.4 g/kw-hr

CO = 3.5 g/kw-hr

PM_{10} = 0.2 g/kw-hr

CO_2 = 700 g/kw-hr (AP-42, Table 3.3-1)

Diesel Fuel Usage 4,270 gal/yr

Table FSRU 12: Emergency Generator Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Emergency Generator, 4200 KW		
FUEL TYPE/PROCESS INFO	California diesel, 15 ppm S		
TOTAL YEARLY PROCESS RATE	420	MW-hrs	
HOURLY PROCESS RATE	4.20	MW	from BHP estimates
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	137030	BTU/gal	USEPA AP-42
OPERATING SCHEDULE	100	hrs/yr	
HEAT RATE	8533	BTU/KW-hr	
CONVERSION EFFICIENCY	40.0%	percent	
HEAT INPUT	35.84	mmBTU/hr	
DRY Fd	9190	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	1.17	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	372	1.0000	12.3460	5,185	2.59	51.85	5.600	4.176
Reactive Hydrocarbons (ROC) as CH_4	153	1.0000	1.7637	741	0.37	7.41	0.800	0.597
Carbon Monoxide (CO)	382	1.0000	7.7162	3,241	1.62	32.41	3.500	2.610
Sulfur Dioxide (SO_2)	0.3	1.0000	0.013	6	0.00	0.06	0.006	0.004
Particulates (as PM_{10}) (grains/dscf)	0.0111	1.0000	0.4409	185	0.09	1.85	0.200	0.149
Carbon Dioxide (CO_2)	4.87%	1.0000	1543.2439	648,162	324	6,482	700	522
Ammonia Slip (NH_3)								

* USEPA Tier 2 Standards (>560 kw)

NO_X + ROC = 6.4 g/kw-hr

CO = 3.5 g/kw-hr

PM_{10} = 0.2 g/kw-hr

CO_2 = 700 g/kw-hr (AP-42, Table 3.3-1)

Diesel Fuel Usage 26,152 gal/yr

Table FSRU 13: Freefall Lifeboat emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Freefall Lifeboat Engine, 75 BHP (56 KW)		
FUEL TYPE/PROCESS INFO	California diesel, 15 ppm S		
TOTAL YEARLY PROCESS RATE	2.8	MW-hrs	
HOURLY PROCESS RATE	0.056	MW	from BHP estimates
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	137030	BTU/gal	USEPA AP-42
OPERATING SCHEDULE	50	hrs/yr	
HEAT RATE	11377	BTU/KW-hr	
CONVERSION EFFICIENCY	30.0%	percent	
HEAT INPUT	0.64	mmBTU/hr	
DRY Fd	9190	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.02	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	324	1.0000	14.3301	40	0.02	0.80	6.500	4.847
Reactive Hydrocarbons (ROC) as CH_4	143	1.0000	2.2046	6	0.00	0.12	1.000	0.746
Carbon Monoxide (CO)	410	1.0000	11.0232	31	0.02	0.62	5.000	3.729
Sulfur Dioxide (SO_2)	0.3	1.0000	0.018	0	0.00	0.00	0.008	0.006
Particulates (as PM_{10}) (grains/dscf)	0.0167	1.0000	0.8819	2	0.00	0.05	0.400	0.298
Carbon Dioxide (CO_2)	3.65%	1.0000	1543.2439	4,321	2	86	700	522

* USEPA Tier 2 Standards (>37 kw, <75 kw)

NO_X + ROC = 7.5 g/kw-hr

CO = 5.0 g/kw-hr

PM_{10} = 0.4 g/kw-hr

CO_2 = 700 g/kw-hr (AP-42, Table 3.3-1)

Diesel Fuel Usage 232 gal/yr

Table FSRU 14: Diesel Storage Tank Emissions Summary

SIC	1321	
PROCESS EQPT DESCRIPTION	Standby Diesel Fuel Storage Tank, 4000 gallon	
FUEL TYPE/PROCESS INFO	Rule 431.2 California Diesel, 15 ppm S	
TOTAL YEARLY PROCESS RATE	120.626	
AVERAGE HOURLY PROCESS RATE	0.014	
MAXIMUM HOURLY PROCESS RATE	0.014	
PROCESS UNITS	PT031	1000 GALLONS THROUGHPUT
HIGHER HEATING VALUE	137.03	mmBTU/mgal
NUMBER OF DEVICES	1	
HRS/YEAR	8760	
TOTAL YEARLY PROCESS RATE	59.7	
AVERAGE HOURLY PROCESS RATE	0.0068	
MAXIMUM HOURLY PROCESS RATE	0.0068	
PROCESS UNITS	PT079	POUNDS (VOC)

EMITTENT NAME	EMITTENT PPM	CTL EF LBS/UNIT	AVERAGE LBS/YR	AVERAGE TONS/YR	AVERAGE LBS/HR	MAXIMUM LBS/HR	AVERAGE grams/sec	MAXIMUM grams/sec
Nitrogen Oxides (as NO_2)								
Reactive Hydrocarbons (ROC) as CH_4		1.0	59.7	0.030	0.007	0.007	8.59E-04	8.59E-04
Carbon Monoxide (CO)								
Sulfur Dioxide (SO_2)								
Particulates (as PM_{10}) (grains/dscf)								
Carbon Dioxide (CO_2)								
Ammonia Slip (NH_3)								

Table FSRU 14: Diesel Storage Tank Emissions Summary

SCAQMD AP-42 Fixed Roof Eqns.	Value	Units		
Number of Tanks	1			
Tank Diameter, D	40.000	ft		
Shell Height, Hs	15.380	ft	144,577	gallons
Vapor Outage Headspace, Hvo	7.690	ft		
Tank Capacity, C	3442.300	bbl		
Throughput, Q	2872	bbl/yr	120,626	gal/yr
Turnovers, N	0.834	#/yr		
True Vapor Pressure, P	0.009	psia		
Vapor Molecular Weight, Mv	130	lb/lb-mole		
Storage Temperature, Ts	65	F		
Delta Temp, Tv	25	F		
Paint Alpha, a	0.1700	a		
Product Factor, Kp	1.0000			
Vapor Space Volume, Vv	9663.5390	ft3		
Vapor Density, Wv	0.0002	lb/ft3		
Vapor Space Expansion Factor, Ke	0.0352			
Vapor Saturation Factor, Kv	0.9963			
Turnover Factor, Kn	1.0000			
Beathing Loss, Lb	25.6641	lb/yr		
Working Loss, Lw	3.3603	lb/yr		
Total Tank Losses, Lt	29.0244	lb/yr		

Table FSRU 14: Diesel Storage Tank Emissions Summary

Fugitive Components	lb/yr	EF, lb/hr	Count
Valves, Gas	0.0000	0.012	
Valves, Light Liquid	0.0000	0.016	
Valves, Heavy Liquid	67.0140	0.00051	15
Flanges, General	31.5360	0.0018	2
Pump Seals, Light Liquid	0.0000	0.11	
Pump Seals, Heavy Liquid	823.4400	0.047	2
Pressure Relief Valves	0.0000	0.23	
Low Pressure Correction Factor	0.0333		
Total Fugitive Losses, Lf	30.7238		
Total Emissions, Et	59.7482 lb/yr		

Index: Federal Waters Vessel Emission Summary Tables

Table No.	Table Name
Table FW 1	Federal Waters Vessels Emissions Summary
Table FW 2	Tug/Supply Vessel Main Engine Emission Summary
Table FW 3	Tug/Supply Vessel Generator Engine Emission Summary
Table FW 4	Tug/Supply Vessel Activity Summary
Table FW 5	Crew Boat Main Engine Emission Summary
Table FW 6	Crew Boat Generator Engine Emission Summary
Table FW 7	Crew Boat Activity Summary
Table FW 8	LNG Carrier Vessel Emission Summary
Table FW 9	LNG Carrier Vessel Activity Summary

Table FW 1: Federal Waters Vessels Emissions Summary

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year					
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2
2	Tug Supply Boat	15,000 BHP Mains	Gasified LNG & CA Diesel	91.7	12.8	60.3	0.02	1.2	11,911
1	Crew Boat	1,500 BHP Mains	Gasified LNG	2.1	0.3	1.4	0.00	0.0	278
1	LNG Carrier	60,000 BHP Total	Gasified LNG & CA Diesel	69.2	9.6	45.5	0.0	0.9	8,984
Total Emissions (gasified LNG & biodiesel pilot fuel)				**163.0**	**22.7**	**107.2**	**0.0**	**2.1**	**21,173**

Vessel Notes:

Assist tugs (pair) conducting LNG carrier to FSRU berthing operations 130 times per year, time & load weighted engine operation

Tug Supply boat making 52 round trips to FSRU per year, time & load weighted engine operation

Crew boat making 182 round trips to FSRU per year, time & load weighted engine operation

LNG carrier to FSRU berthing operations, 14 miles slow, 3 miles to FSRU with assist tugs, time & load weighted engine operation

Operating component in federal waters only (outside 3-mile limit)

LNG Carrier & Tug Supply dual fuel is 99% gasified LNG / 1% CA diesel by weight

Crew boat is 100% gasified LNG

Table FW 2: Tug/Supply Vessel Main Engine Emission Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Tug Supply Main Generator Set Engines, 15,000 BHP, 2 vessels alternating port calls		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S & CA Diesel		
TOTAL YEARLY PROCESS RATE	21242	MW-hrs	
HOURLY PROCESS RATE	1.23	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/cu ft	Scarborough LNG
COMBINED ENGINE RATING	15000	BHP	from BHP estimates
LOAD FACTOR	11%	percent	from activity profile
OPERATING SCHEDULE	17264	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	12.00	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.37	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	2 Vessels ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	460	1.0000	8.2595	175,448	87.72	20.33	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	184	1.0000	1.1507	24,443	12.22	2.83	0.522	0.389
Carbon Monoxide (CO)	497	1.0000	5.4315	115,377	57.69	13.37	2.464	1.837
Sulfur Dioxide (SO_2)	0.07	1.0654	0.0017	36	0.02	0.00	0.001	0.001
Particulates (as PM_{10}) (grains/dscf)	0.0049	1.0744	0.1048	2,226	1.11	0.26	0.048	0.035
Carbon Dioxide (CO_2)	6.24%	1.0000	1072.6571	22,785,445	11,393	2,640	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Tug Supply dual fuel is 99% gasified LNG / 1% CA Diesel by weight

Power output 28,485,600 BHP-hr/yr

Table FW 3: Tug/Supply Vessel Generator Engines Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Tug Supply Auxiliary Generator, 150 BHP, 2 vessels alternating port calls		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S & CA Diesel		
TOTAL YEARLY PROCESS RATE	966	MW-hrs	
HOURLY PROCESS RATE	0.06	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/cu ft	Scarborough LNG
COMBINED ENGINE RATING	150	BHP	from BHP estimates
LOAD FACTOR	50%	percent	from activity profile
OPERATING SCHEDULE	17264	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	0.55	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.02	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	2 Vessels ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	460	1.0000	8.2595	7,975	3.99	0.92	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	184	1.0000	1.1507	1,111	0.56	0.13	0.522	0.389
Carbon Monoxide (CO)	497	1.0000	5.4315	5,244	2.62	0.61	2.464	1.837
Sulfur Dioxide (SO_2)	0.07	1.0654	0.0017	2	0.00	0.00	0.001	0.001
Particulates (as PM_{10}) (grains/dscf)	0.0049	1.0744	0.1048	101	0.05	0.01	0.048	0.035
Carbon Dioxide (CO_2)	6.24%	1.0000	1072.6571	1,035,702	518	120	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Tug Supply dual fuel is 99% gasified LNG / 1% CA Diesel by weight

Power output 1,294,800 BHP-hr/yr

Table FW 4: Tug/Supply Vessel Activity Summary

Assist Tugs

Berthing Activity	Miles	Speed	Time, hrs	Mains	Weighted	Mode 1	Mode 2	Gens	Weighted	Mode 1	Mode 2
[redacted]	3	18.5	0.16	51%	0.3%	2.7%	1.0%	50%	0.3%	0.7%	0.2%
[redacted]	3	5	0.60	43%	1.1%	8.4%	3.0%	50%	1.2%	2.5%	0.9%
[redacted]			0.04	100%	0.2%	1.3%	0.5%	50%	0.1%	0.2%	0.1%
[redacted]	0.3	1	0.30	22%	0.3%	2.1%	0.8%	50%	0.6%	1.2%	0.5%
[redacted]	0	min	21.80	10%	9.1%	70.9%	25.6%	50%	45.4%	90.8%	32.8%
[redacted]	0.3	1	0.30	22%	0.3%	2.1%	0.8%	50%	0.6%	1.2%	0.5%
[redacted]			0.04	100%	0.2%	1.3%	0.5%	50%	0.1%	0.2%	0.1%
[redacted]	3	5	0.60	43%	1.1%	8.4%	3.0%	50%	1.2%	2.5%	0.9%
[redacted]	3	18.5	0.16	51%	0.3%	2.7%	1.0%	50%	0.3%	0.7%	0.2%
Composite			**24.00**		**13%**	**100.0%**	**36.1%**		**50.0%**	**100.0%**	**36.1%**
Two Vessels (per week)			**120.0**								

Remarks - Berthing
2.5 berthings/wk = 130 berthings/yr
2.5 berthings/wk x 24 hrs x 2 vessels = 120 hrs/wk @ 13% power on mains
ship generators run all the time, so
2.5 berthings/wk x 24 hrs x 2 vessels = 120 hrs/wk @ 50% power on gens

Federal Waters Transit	Miles	Speed	Time, hrs	Mains	Weighted	Mode 1	Mode 2	Gens	Weighted	Mode 1	Mode 2
[redacted]	0.7	5	0.1	14%	0.5%	3.3%	0.1%	50%	1.7%	3.5%	0.1%
[redacted]	0.3	1	0.3	12%	0.9%	6.1%	0.1%	50%	3.7%	7.5%	0.2%
[redacted]	0	stop	2.3	0%	0.0%	0.0%	0.0%	50%	28.7%	57.3%	1.4%
[redacted]	0.3	1	0.3	12%	0.9%	6.1%	0.1%	50%	3.7%	7.5%	0.2%
Cruise from Safety Zone to Boundary	18	18.5	1.0	51%	12.4%	84.4%	2.0%	50%	12.1%	24.2%	0.6%
Composite Each Way			**4.0**		**15%**	**100.0%**	**2.4%**		**50.0%**	**100.0%**	**2.4%**
Round Trip (per week)			**8.0**								

Remarks - Federal Waters Transit
1 roundtrip/week = 52 roundtrips/year
1 trips/wk x 8 hr/trip = 8 hrs/wk @ 15% power on mains
ship generators run all the time, so
1 trips/wk x 8 hr/trip = 8 hrs/wk @ 50% power on gens

Time Balance (hrs/wk)	Miles	Speed	Time, hrs	Mains	Weighted	Mode 1	Mode 2	Gens	Weighted	Mode 1	Mode 2
Hours per week (2 vessels)			336								
District Waters & Port Time			4								
In Federal Waters			332								
Berthing Activity			120	13%	4.6%						
Transit			8	15%	0.4%						
[redacted]			204	10%	6.1%	100.0%	61.4%	50%	50.0%	100.0%	61.4%
Total Time in Federal Waters			**332**		**11%**	**100.0%**	**61.4%**		**50%**	**100.0%**	**61.4%**
Per Year			**17,264**		**11%**				**50%**		

Remarks - Federal Waters
52 wks/yr x 332 hrs/wk = 17,264 hrs/yr (2 vessels) @ 11% power on mains
ship generators run all the time, so
17,264 hrs/yr @ 50% power

	29,780,400	28,485,600	1,294,800
	Modal Wt	**Mains**	**Gens**
Assist Stand-by/Local	8.3%	8.6%	2.4%
[redacted]	89.7%	89.4%	95.6%
[redacted]	0.1%	0.0%	1.4%
Transit to/from Boundary/Limit	2.0%	2.0%	0.6%
	100.0%	100.0%	100.0%

Table FW 5: Crew Boat Main Engine Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Crew Boat Main Engines, 1500 BHP		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S		
TOTAL YEARLY PROCESS RATE	468	MW-hrs	
HOURLY PROCESS RATE	0.51	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/cu ft	Scarborough LNG
COMBINED ENGINE RATING	1500	BHP	from BHP estimates
LOAD FACTOR	46%	percent	from activity profile
OPERATING SCHEDULE	910	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	5.02	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.15	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	3,867	1.93	4.25	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	539	0.27	0.59	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	2,543	1.27	2.79	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0000	0.0016	1	0.00	0.00	0.0007	0.0005
Particulates (as PM_{10}) (grains/dscf)	0.0023	1.0000	0.0975	46	0.02	0.05	0.044	0.033
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	502,253	251	552	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Power output 627,900 BHP-hr/yr

Table FW 6: Crew Boat Generator Engines Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Crew Boat Generator Engine, 150 BHP		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S		
TOTAL YEARLY PROCESS RATE	51	MW-hrs	
HOURLY PROCESS RATE	0.06	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/cu ft	Scarborough LNG
COMBINED ENGINE RATING	150	BHP	from BHP estimates
LOAD FACTOR	50%	percent	from activity profile
OPERATING SCHEDULE	910	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	0.55	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.017	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	420	0.21	0.46	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	59	0.03	0.06	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	276	0.14	0.30	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0000	0.0016	0	0.00	0.00	0.0007	0.0005
Particulates (as PM_{10}) (grains/dscf)	0.0023	1.0000	0.0975	5	0.00	0.01	0.044	0.033
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	54,593	27	60	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Power output 68,250 BHP-hr/yr

Table FW 7: Crew Boat Activity Summary

Crew Boats

Support Activity	Miles	Speed	Time, hrs	Mains	Weighted	Mode	Gens	Weighted	Mode
Boundary to FSRU	18	18	1.00	90%	18.0%	39.2%	50%	10.0%	20.0%
[redacted]	1.5	2	0.75	19%	2.9%	6.2%	50%	7.5%	15.0%
[redacted]	0.3	1	0.30	16%	1.0%	2.1%	50%	3.0%	6.0%
[redacted]	0	stop	0.90	13%	2.3%	5.1%	50%	9.0%	18.0%
[redacted]	0.3	1	0.30	16%	1.0%	2.1%	50%	3.0%	6.0%
[redacted]	1.5	2	0.75	19%	2.9%	6.2%	50%	7.5%	15.0%
Cruise to Boundary	18	18	1.00	90%	18.0%	39.2%	50%	10.0%	20.0%
Composite			**5.00**		**46%**	**100.0%**		**50%**	**100.0%**
Per Year			**910**		**46%**			**50%**	

Remarks - Federal Waters Transit

1 roundtrip/berthing = 2.5 per week + 1 crew change/week = 3.5 roundtrips/week or 182 roundtrips/year
182 trips/yr x 5 hrs/trip = 910 hrs/yr @ 46% power on mains
ship generators run all the time, so
182 trips/yr x 5 hrs/trip = 910 hrs/yr @ 50% power

BHP-hr/yr	696,150	627,900	68,250
	Modal Wt	**Mains**	**Gens**
Assist/Standby/Loiter	14.1%	12.4%	30.0%
[redacted]	4.9%	4.2%	12.0%
[redacted]	6.4%	5.1%	18.0%
Transit to/from Boundary/Limit	74.6%	78.3%	40.0%
	100.0%	100.0%	100.0%

Table FW 8: LNG Carrier Vessel Emission Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	LNG Carrier, 60,000 BHP Total		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S & CA Diesel		
TOTAL YEARLY PROCESS RATE	16752	MW-hrs	
HOURLY PROCESS RATE	5.37	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/cu ft	Scarborough LNG
COMBINED ENGINE RATING	60000	BHP	from BHP estimates
LOAD FACTOR	12%	percent	from activity profile
OPERATING SCHEDULE	3120	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	52.36	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	1.62	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	138,360	69.18	44.35	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	19,276	9.64	6.18	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	90,988	45.49	29.16	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0654	0.0017	29	0.01	0.01	0.0008	0.0006
Particulates (as PM_{10}) (grains/dscf)	0.0024	1.0744	0.1048	1,755	0.88	0.56	0.048	0.035
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	17,968,807	8,984	5,759	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

LNG Carrier dual fuel is 99% gasified LNG / 1% CA Diesel by weight

Table FW 9: LNG Carrier Vessel Activity Summary

LNG Carriers

Berthing Activity	Miles	Speed	Time, hrs	BHP	Percent	Weighted	Mode
25 to 16 miles	9.0	12	0.75	28500	48%	1.5%	12.4%
[redacted]	3.0	5	0.60	11400	19%	0.5%	4.0%
[redacted]	0.3	1	0.30	5440	9%	0.1%	0.9%
[redacted]	0.0	stop	20.70	5440	9%	7.8%	65.4%
[redacted]	0.3	1	0.30	5440	9%	0.1%	0.9%
[redacted]	3.0	5	0.60	11400	19%	0.5%	4.0%
16 to 25 miles	9.0	12	0.75	28500	48%	1.5%	12.4%
Composite			**24.00**			**12%**	**100.0%**
Per Year			**3120**			**12%**	

Remarks - Federal Waters Transit

2.5 berthings/wk = 130 berthings/yr

130 berthings/yr x 24 hrs = 3120 hrs/yr @ 12% power

	Modal Wt	Mode
Assist/Standby/Idle	7.9%	7.9%
[redacted]	1.9%	1.9%
[redacted]	65.4%	65.4%
Transit to/from Boundary/Limit	24.8%	24.8%
	100.0%	100.0%

Index: District Waters Vessel Emission Summary Tables

Table No.	Table Name
Table DW 1	District Waters Vessels Emissions Summary
Table DW 2	Tug/Supply Vessel Main Engine Emission Summary
Table DW 3	Tug/Supply Vessel Generator Engine Emission Summary
Table DW 4	Tug/Supply Vessel Activity Summary
Table DW 5	Crew Boat Main Engine Emission Summary
Table DW 6	Crew Boat Generator Engine Emission Summary
Table DW 7	Crew Boat Activity Summary

Table DW 1: District Waters Vessel Emission Summary

Quantity	Description	Rating (each)	Fuel	Annual Emissions, tons per year					
				NO_X	ROC	CO	SO_2	PM_{10}	CO_2
2	Tug Supply Boat	15,000 BHP Mains	Gasified LNG & CA Diesel	0.73	0.10	0.48	0.000	0.01	95
1	Crew Boat	1,500 BHP Mains	Gasified LNG	0.41	0.06	0.27	0.000	0.00	54
Total Emissions (gasified LNG & biodiesel pilot fuel)				**1.15**	**0.16**	**0.75**	**0.000**	**0.01**	**149**

Vessel Notes:

Tug Supply boat making 52 round trips to FSRU per year, time & load weighted engine operation

Crew boat making 172 round trips to FSRU per year, time & load weighted engine operation

Operating component in state waters only (inside 3-mile limit)

Tug Supply dual fuel is 99% gasified LNG / 1% CA Diesel by weight

Table DW 2: Tug/Supply Vessel Main Engine Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Tug Supply Main Generator Set Engines, 15,000 BHP, 2 vessels alternating port calls		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S & CA Diesel		
TOTAL YEARLY PROCESS RATE	174	MW-hrs	
HOURLY PROCESS RATE	3.36	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/scf	
COMBINED ENGINE RATING	15000	BHP	from BHP estimates
LOAD FACTOR	30%	percent	from activity profile
OPERATING SCHEDULE	52	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	32.72	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	1.010	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	1,441	0.721	27.716	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	201	0.100	3.861	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	948	0.474	18.227	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0654	0.0017	0	0.000	0.006	0.001	0.001
Particulates (as PM_{10}) (grains/dscf)	0.0024	1.0744	0.1048	18	0.009	0.352	0.048	0.035
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	187,175	93.588	3599.521	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Tug Supply dual fuel is 99% gasified LNG / 1% CA Diesel by weight

Table DW 3: Tug/Supply Vessel Generator Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Tug Supply Auxiliary Generator, 150 BHP, 2 vessels alternating port calls		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S & CA Diesel		
TOTAL YEARLY PROCESS RATE	3	MW-hrs	
HOURLY PROCESS RATE	0.06	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/scf	
COMBINED ENGINE RATING	150	BHP	from BHP estimates
LOAD FACTOR	50%	percent	from activity profile
OPERATING SCHEDULE	52	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	0.55	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.017	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	24	0.012	0.462	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	3	0.002	0.064	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	16	0.008	0.304	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0654	0.0017	0	0.000	0.000	0.001	0.001
Particulates (as PM_{10}) (grains/dscf)	0.0024	1.0744	0.1048	0	0.000	0.006	0.048	0.035
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	3,120	1.560	59.992	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Tug Supply dual fuel is 99% gasified LNG / 1% CA Diesel by weight

Table DW 4: Tug/Supply Vessel Activity Summary

District Waters Transit	Miles	Speed	Time, hrs	Mains	Weighted	Mode
Engine start & idle at dock	0	0	0.12	10%	1.2%	4.0%
Transit harbor zone outbound	0.75	5	0.15	14%	2.1%	7.0%
Due south to boundary	3.5	18.5	0.19	51%	9.7%	32.1%
Federal Waters						
Due north from boundary	3.5	18.5	0.19	51%	9.7%	32.1%
Transit harbor zone inbound	0.75	5	0.15	14%	2.1%	7.0%
Docking & engine stop	0	0	0.20	27%	5.4%	17.9%
Composite			**1.00**		**30%**	**100%**

Cruising in District waters per week **0.38**

Remarks - District Waters Transit

1 roundtrip/week = 52 roundtrips/year
52 trips/yr x 1 hr/trip = 52 hrs/yr @ 30% power on mains
ship generators run all the time, so
52 trips/yr x 1 hrs/trip = 52 hrs/yr @ 50% power

Start/Stop/Idle	21.9%
Harbor Transit	14.0%
Cruise to/from Boundary	64.1%
	100.0%

Table DW 5: Crew Boat Main Engine Emission Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Crew Boat Main Engines, 1500 BHP		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S		
TOTAL YEARLY PROCESS RATE	90	MW-hrs	
HOURLY PROCESS RATE	0.53	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/scf	
COMBINED ENGINE RATING	1500	BHP	from BHP estimates
LOAD FACTOR	47%	percent	from activity profile
OPERATING SCHEDULE	172	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	5.13	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.158	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	747	0.373	4.342	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	104	0.052	0.605	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	491	0.246	2.856	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0000	0.0016	0	0.000	0.001	0.001	0.001
Particulates (as PM_{10}) (grains/dscf)	0.0023	1.0000	0.0975	9	0.004	0.051	0.044	0.033
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	96,995	48.498	563.925	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Table DW 6: Crew Boat Generator Engine Emissions Summary

SIC	1321		
PROCESS EQPT DESCRIPTION	Crew Boat Generator Engine, 150 BHP		
FUEL TYPE/PROCESS INFO	Scarborough LNG, 99.7% methane, 1 ppm S		
TOTAL YEARLY PROCESS RATE	10	MW-hrs	
HOURLY PROCESS RATE	0.06	MW	
PROCESS UNITS	PT071	MW-hrs	
HIGHER HEATING VALUE	1007.6	BTU/scf	
COMBINED ENGINE RATING	150	BHP	from BHP estimates
LOAD FACTOR	50%	percent	from activity profile
OPERATING SCHEDULE	172	hrs/yr	from activity profile
HEAT RATE	9751	BTU/KW-hr	
CONVERSION EFFICIENCY	35.0%	percent	
HEAT INPUT	0.55	mmBTU/hr	
DRY Fd	8710	dscf/mmBTU	USEPA Method 19
EXHAUST FLOW	0.017	mmdscf/hr	

EMITTENT NAME	EMITTENT PPM	CORR FACTOR	CTL EF LBS/UNIT	ACTUAL LBS/YR	ACTUAL TONS/YR	ACTUAL LBS/HR	RATE* g/kw-hr	RATE g/bhp-hr
Nitrogen Oxides (as NO_2)	230	1.0000	8.2595	79	0.040	0.462	3.746	2.794
Reactive Hydrocarbons (ROC) as CH_4	92	1.0000	1.1507	11	0.006	0.064	0.522	0.389
Carbon Monoxide (CO)	248	1.0000	5.4315	52	0.026	0.304	2.464	1.837
Sulfur Dioxide (SO_2)	0.03	1.0000	0.0016	0	0.000	0.000	0.001	0.001
Particulates (as PM_{10}) (grains/dscf)	0.0023	1.0000	0.0975	1	0.000	0.005	0.044	0.033
Carbon Dioxide (CO_2)	3.12%	1.0000	1072.6571	10,319	5.159	59.992	487	363

Gas Emission Factors (AP-42 Table 3.2-2)

NO_X = 0.847 lb/mmBTU

ROC = 0.118 lb/mmBTU

CO = 0.557 lb/mmBTU

SO_2 = 1.65 E-4 lb/mmBTU (for 1 ppm S)

PM_{10} = 0.010 lb/mmBTU

CO_2 = 110 lb/mmBTU

Table DW 7: Crew Boat Activity Summary

Crew Boats

District Waters Transit	Miles	Speed	Time, hrs	Mains	Weighted	Mode
Engine start & idle at dock	0	0	0.12	13%	1.6%	3.3%
Transit harbor zone outbound	0.75	5	0.15	24%	3.6%	7.7%
Due south to boundary	3.5	18.5	0.19	90%	17.1%	36.5%
Federal Waters						
Due north from boundary	3.5	18.5	0.19	90%	17.1%	36.5%
Transit harbor zone inbound	0.75	5	0.15	24%	3.6%	7.7%
Docking & engine stop	0	0	0.20	19%	3.8%	8.2%
District waters composite per trip			**1.00**		**47%**	**100%**
Cruising in District waters per week			**1.25**			

Remarks - District Waters Transit

1 roundtrip/berthing = 2.3 per week + 1 crew change/week = 3.3 roundtrips/week or 172 roundtrips/year
172 trips/yr x 1 hr/trip = 172 hrs/yr @ 47% power on mains
ship generators run all the time, so
172 trips/yr x 1 hrs/trip = 172 hrs/yr @ 50% power

Start/Stop/Idle	11.5%
Harbor Transit	15.4%
Cruise to/from Boundary	73.1%
	100.0%