Attachment A-1
Potential Emissions from WPG Pretreatment Heater
Puget Sound Energy - Liquefied Natural Gas Project
Tacoma, Washington

Pollutant	Emission Factor (lb/MMcf)	Potential Emissions	
		Hourly[a] (lbs/hr)	Annual[b] (tons/yr)
Criteria Pollutants			
$PM/PM_{10}/PM_{2.5}$	7.6 [1]	0.063	0.27
SO_2	15 [c]	0.126	0.55
NO_X	53 [d]	0.436	1.91
CO	40 [d]	0.332	1.45
VOC	5.5 [1]	0.045	0.20
Lead	0.0005 [1]	4.1E-06	1.8E-05
Hazardous Air Pollutants			
Arsenic	2.0E-04 [3]	1.6E-06	7.2E-06
Benzene	2.1E-03 [3]	1.7E-05	7.6E-05
Beryllium	1.2E-05 [3]	9.9E-08	4.3E-07
Cadmium	1.1E-03 [3]	9.1E-06	4.0E-05
Chromium(total)	1.4E-03 [3]	1.2E-05	5.0E-05
Cobalt	8.4E-05 [3]	6.9E-07	3.0E-06
Formaldehyde	7.5E-02 [3]	6.2E-04	2.7E-03
Hexane	1.8E+00 [3]	1.5E-02	6.5E-02
Lead	5.0E-04 [1]	4.1E-06	1.8E-05
Manganese	3.8E-04 [3]	3.1E-06	1.4E-05
Mercury	2.6E-04 [3]	2.1E-06	9.4E-06
Naphthalene	6.1E-04 [3]	5.0E-06	2.2E-05
Nickel	2.1E-03 [3]	1.7E-05	7.6E-05
Polycyclic Organic Matter	7.0E-04 [3]	5.7E-06	2.5E-05
2-Methylnaphthalene	2.4E-05 [3]	2.0E-07	8.7E-07
3-Methylchloranthrene	1.8E-06 [3]	1.5E-08	6.5E-08
7,12-Dimethylbenz(a)anthracene	1.6E-05 [3]	1.3E-07	5.8E-07
Acenaphthene	1.8E-06 [3]	1.5E-08	6.5E-08
Acenaphthylene	1.8E-06 [3]	1.5E-08	6.5E-08
Anthracene	2.4E-06 [3]	2.0E-08	8.7E-08
Benz(a)anthracene	1.8E-06 [3]	1.5E-08	6.5E-08
Benzo(a)pyrene	1.2E-06 [3]	9.9E-09	4.3E-08
Benzo(b)fluoranthene	1.8E-06 [3]	1.5E-08	6.5E-08
Benzo(g,h,i)perylene	1.2E-06 [3]	9.9E-09	4.3E-08
Benzo(k)fluoranthene	1.8E-06 [3]	1.5E-08	6.5E-08
Chrysene	1.8E-06 [3]	1.5E-08	6.5E-08
Dibenzo(a,h)anthracene	1.2E-06 [3]	9.9E-09	4.3E-08
Fluoranthene	3.0E-06 [3]	2.5E-08	1.1E-07
Fluorene	2.8E-06 [3]	2.3E-08	1.0E-07
Indeno(1,2,3-cd)pyrene	1.8E-06 [3]	1.5E-08	6.5E-08
Naphthalene	6.1E-04 [3]	5.0E-06	2.2E-05
Phenanathrene	1.7E-05 [3]	1.4E-07	6.1E-07
Pyrene	5.0E-06 [3]	4.1E-08	1.8E-07
Selenium	2.4E-05 [3]	2.0E-07	8.7E-07
Toluene	3.4E-03 [3]	2.8E-05	1.2E-04
Total HAPs		**0.016**	**0.068**

Attachment A-1
Potential Emissions from WPG Pretreatment Heater
Puget Sound Energy - Liquefied Natural Gas Project
Tacoma, Washington

Calculations:

[a] Hourly Emissions (lb/hr) = [Maximum Heat Input (MMBtu/hr)] / [Fuel Heating Value (Btu/scf)] x [Emission Factor (lb/MMcf)]

[b] Annual Emissions (tons/yr) = [Maximum Fuel Usage (scf/hr)] x [1 MMscf/1,000,000 scf] x [Emission Factor (lb/MMcf)] x [Operating Hours (hrs/yr)] / [2,000 lbs/ton]

Maximum Heat Input (MMBtu/hr) =	9	
Fuel Heating Value (Btu/scf) =	1,093	
Projected Hours of Operation (hrs/yr) =	8,760	

[c] SO_2 Emission Factor (lb/MMcf) = [Natural Gas Density (lb/cf)] x [Sulfur Content (ppm)] / 10^6 x [2 g-SO_2/g-S] x [10^6 cf/MMcf]

Natural gas density (lb/cf) =	0.046	
Sulfur Content of Fuel (ppm) =	166	

[d] Pollutant Emission Rate (lb/MMscf) = [Pollutant concentration by volume, dry basis (ppm_{dv})] x ([Maximum Fuel Usage (scf/hr)] x [Fuel Heating Value (Btu/scf)] x [Combustion Gas Generated (dscf/MMBtu)] x [Pollutant Molecular Weight (lb/lb-mole)] x [2.59×10^{-9} lb-mole/dscf per ppm] + [CO_2 Volume in Waste Gas (dscf/hr)]) x [20.9 / (20.9 - Percent Oxygen)]

Pollutant Concentration NO_X (ppm) =	40	[2]
Pollutant Concentration CO (ppm) =	50	[2]
Percent Oxygen =	3	[2]
Flue Gas Generated (dscf/MMBtu) =	8,710	[4]

Notes:

[1] EPA. 1998a. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 1.4, Table 1.4-2: Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion. AP-42. Office of Air Quality Planning and Standards, US Environmental Protection Agency. July.

[2] Vendor design specifications provided by CB&I.

[3] EPA. 1998b. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 1.4, Table 1.4-3: Emission Factors for Speciated Organic Compounds from Natural Combustion. AP-42. Office of Air Quality Planning and Standards, US Environmental Protection Agency. July.

[4] NSPS Subpart D.

Attachment A-2
Potential Emissions from Regeneration Pretreatment Heater
Puget Sound Energy - Liquefied Natural Gas Project
Tacoma, Washington

Pollutant	Emission Factor (lb/MMcf)	Potential Emissions	
		Hourly[(a)] (lbs/hr)	Annual[(b)] (tons/yr)
Criteria Pollutants			
$PM/PM_{10}/PM_{2.5}$	7.6 (1)	0.011	0.049
SO_2	15 (c)	0.022	0.10
NO_X	53 (d)	0.078	0.34
CO	40 (d)	0.059	0.26
VOC	5.5 (1)	0.0081	0.035
Lead	0.0005 (1)	7.3E-07	3.2E-06
Hazardous Air Pollutants			
Arsenic	2.0E-04 (3)	2.9E-07	1.3E-06
Benzene	2.1E-03 (3)	3.1E-06	1.3E-05
Beryllium	1.2E-05 (3)	1.8E-08	7.7E-08
Cadmium	1.1E-03 (3)	1.6E-06	7.1E-06
Chromium(total)	1.4E-03 (3)	2.0E-06	9.0E-06
Cobalt	8.4E-05 (3)	1.2E-07	5.4E-07
Formaldehyde	7.5E-02 (3)	1.1E-04	4.8E-04
Hexane	1.8E+00 (3)	2.6E-03	1.2E-02
Lead	5.0E-04 (1)	7.3E-07	3.2E-06
Manganese	3.8E-04 (3)	5.6E-07	2.4E-06
Mercury	2.6E-04 (3)	3.8E-07	1.7E-06
Naphthalene	6.1E-04 (3)	8.9E-07	3.9E-06
Nickel	2.1E-03 (3)	3.1E-06	1.3E-05
Polycyclic Organic Matter	7.0E-04 (3)	1.0E-06	4.5E-06
2-Methylnaphthalene	2.4E-05 (3)	3.5E-08	1.5E-07
3-Methylchloranthrene	1.8E-06 (3)	2.6E-09	1.2E-08
7,12-Dimethylbenz(a)anthracene	1.6E-05 (3)	2.3E-08	1.0E-07
Acenaphthene	1.8E-06 (3)	2.6E-09	1.2E-08
Acenaphthylene	1.8E-06 (3)	2.6E-09	1.2E-08
Anthracene	2.4E-06 (3)	3.5E-09	1.5E-08
Benz(a)anthracene	1.8E-06 (3)	2.6E-09	1.2E-08
Benzo(a)pyrene	1.2E-06 (3)	1.8E-09	7.7E-09
Benzo(b)fluoranthene	1.8E-06 (3)	2.6E-09	1.2E-08
Benzo(g,h,i)perylene	1.2E-06 (3)	1.8E-09	7.7E-09
Benzo(k)fluoranthene	1.8E-06 (3)	2.6E-09	1.2E-08
Chrysene	1.8E-06 (3)	2.6E-09	1.2E-08
Dibenzo(a,h)anthracene	1.2E-06 (3)	1.8E-09	7.7E-09
Fluoranthene	3.0E-06 (3)	4.4E-09	1.9E-08
Fluorene	2.8E-06 (3)	4.1E-09	1.8E-08
Indeno(1,2,3-cd)pyrene	1.8E-06 (3)	2.6E-09	1.2E-08
Naphthalene	6.1E-04 (3)	8.9E-07	3.9E-06
Phenanathrene	1.7E-05 (3)	2.5E-08	1.1E-07
Pyrene	5.0E-06 (3)	7.3E-09	3.2E-08
Selenium	2.4E-05 (3)	3.5E-08	1.5E-07
Toluene	3.4E-03 (3)	5.0E-06	2.2E-05
Total HAPs		**0.0028**	**0.012**

Calculations:

(a) Hourly Emissions (lb/hr) = [Maximum Fuel Usage (scf/hr)] x [1 MMscf/1,000,000 scf] x [Emission Factor (lb/MMcf)]

Attachment A-2

Potential Emissions from Regeneration Pretreatment Heater

Puget Sound Energy - Liquefied Natural Gas Project

Tacoma, Washington

(b) Annual Emissions (tons/yr) = [Maximum Fuel Usage (scf/hr)] x [1 MMscf/1,000,000 scf] x [Emission Factor (lb/MMcf)] x [Operating Hours (hrs/yr)] / [2,000 lbs/ton]

Maximum Heat Input (MMBtu/hr) =	2
Fuel Heating Value (Btu/scf) =	1,093
Projected Hours of Operation (hrs/yr) =	8,760

(c) SO_2 Emission Factor (lb/MMcf) = [Natural Gas Density (lb/cf)] x [Sulfur Content (ppm)] / 10^6 x [2 g-SO_2/g-S] x [10^6 cf/MMcf]

Natural gas density (lb/cf) =	0.046
Sulfur Content of Fuel (ppm) =	166

(d) Pollutant Emission Rate (lb/MMscf) = [Pollutant concentration by volume, dry basis (ppm_{dv})] x [Maximum Heat Input Capacity (MMBtu/hr)] x [Combustion Gas Generated (dscf/MMBtu)] x [Pollutant Molecular Weight (lb/lb-mole)] x [2.59×10^{-9} lb-mole/dscf per ppm] x [20.9 / (20.9 - Percent Oxygen)]

Pollutant Concentration NO_X (ppm) =	40	(2)
Pollutant Concentration CO (ppm) =	50	(2)
Percent Oxygen =	3	(2)
Flue Gas Generated (dscf/MMBtu) =	8,710	(4)

Notes:

(1) AP-42, Chapter 1.4, Table 1.4-2, *Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion* (July 1998).

(2) Vender design specifications provided by CB&I.

(3) AP-42, Chapter 1.4, Table 1.4-3, *Emission Factors for Speciated Organic Compounds from Natural Gas Combustion* and Table 1.4-4, *Emission Factors for Metals from Natural Gas Combustion* (July 1998).

(4) NSPS Subpart D.

Attachment A-3
Potential Emissions for Emergency Generator
Puget Sound Energy - Liquefied Natural Gas Project
Tacoma, Washington

Pollutant	Emission Factor (lb/MMcf)			Potential Emissions Hourly[(a)] (lbs/hr)	Potential Emissions Annual[(b)] (tons/yr)
Criteria Pollutants					
$PM/PM_{10}/PM_{2.5}$	0.04	g/hp-hr	(1)	0.19	0.0024
SO_2	2.1E-04	lb/gal	(c)	0.022	0.00027
NO_X	6.09	g/hp-hr	(1)	30	0.37
CO	0.80	g/hp-hr	(1)	3.9	0.049
VOCs	0.15	g/hp-hr	(1)	0.73	0.0091
Hazardous Air Pollutants					
Total PAHs	2.1E-04	lb/MMBtu	(3)	3.1E-03	3.8E-05
Acenaphthylene	*9.2E-06*	*lb/MMBtu*	*(3)*	*1.3E-04*	*1.7E-06*
Acenaphthene	*4.7E-06*	*lb/MMBtu*	*(3)*	*6.8E-05*	*8.4E-07*
Fluorene	*1.3E-05*	*lb/MMBtu*	*(3)*	*1.8E-04*	*2.3E-06*
Phenanthrene	*4.1E-05*	*lb/MMBtu*	*(3)*	*5.9E-04*	*7.4E-06*
Anthracene	*1.2E-06*	*lb/MMBtu*	*(3)*	*1.8E-05*	*2.2E-07*
Fluoranthene	*4.0E-06*	*lb/MMBtu*	*(3)*	*5.8E-05*	*7.3E-07*
Pyrene	*3.7E-06*	*lb/MMBtu*	*(3)*	*5.4E-05*	*6.7E-07*
Benz(a)anthracene	*6.2E-07*	*lb/MMBtu*	*(3)*	*9.0E-06*	*1.1E-07*
Chrysene	*1.5E-06*	*lb/MMBtu*	*(3)*	*2.2E-05*	*2.8E-07*
Benzo(b)fluoranthene	*1.1E-06*	*lb/MMBtu*	*(3)*	*1.6E-05*	*2.0E-07*
Benzo(k)fluoranthene	*2.2E-07*	*lb/MMBtu*	*(3)*	*3.1E-06*	*3.9E-08*
Benzo(a)pyrene	*2.6E-07*	*lb/MMBtu*	*(3)*	*3.7E-06*	*4.6E-08*
Indeno(1,2,3-cd)pyrene	*4.1E-07*	*lb/MMBtu*	*(3)*	*6.0E-06*	*7.5E-08*
Dibenz(a,h)anthracene	*3.5E-07*	*lb/MMBtu*	*(3)*	*5.0E-06*	*6.2E-08*
Benzo(g,h,l)perylene	*5.6E-07*	*lb/MMBtu*	*(3)*	*8.0E-06*	*1.0E-07*
Acetaldehyde	2.5E-05	lb/MMBtu	(3)	3.6E-04	4.5E-06
Acrolein	7.9E-06	lb/MMBtu	(3)	1.1E-04	1.4E-06
Benzene	7.8E-04	lb/MMBtu	(3)	1.1E-02	1.4E-04
Formaldehyde	7.9E-05	lb/MMBtu	(3)	1.1E-03	1.4E-05
Naphthalene	1.3E-04	lb/MMBtu	(3)	1.9E-03	2.3E-05
Toluene	2.8E-04	lb/MMBtu	(3)	4.1E-03	5.1E-05
Xylenes	1.9E-04	lb/MMBtu	(3)	2.8E-03	3.5E-05
Total HAPs				**2.3E-02**	**2.8E-04**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (g/hp-hr)] x [Power Output (hp)] x [1 lb/453.6 g]

Hourly Emissions (lb/hr) = [Emission Factor (lb/gal)] x [Fuel Consumption (gal/hr)]

Hourly Emissions (lb/hr) = [Emission Factor (lbs/MMBtu)] x [Fuel Consumption (gal/hr)] x [Higher Heating Value (Btu/gal)] / [1,000,000 Btu/MMBtu]

Hourly Emissions (lb/hr) = [Emission Factor (lb/hr)] x [Number of Engines]

Power Output (hp) = 2,206 (1)

Fuel Consumption (gal/hr) = 105 (1)

High Heating Value (Btu/gal) = 138,000 (2)

(b) Annual emissions (tons/yr) = [Hourly Emissions (lb/hr)] / [2,000 lb/ton] x [Hours of Operation (hr/yr)]

Annual Operating Hours (hr) = 25

(c) SO_2 Emission Factor (lb/gal) = [Fuel Density (lb/gal)] x [Sulfur Content (ppm)] / [1,000,000] x [2 gmol-SO_2/gmol-S]

Sulfur Content (ppm) = 15 (4)

Density of Diesel (lb/gal) = 7.0

Attachment A-3
Potential Emissions for Emergency Generator
Puget Sound Energy - Liquefied Natural Gas Project
Tacoma, Washington

Notes:
(1) Manufacturer specifications.
(2) 40 CFR 98.
(3) AP-42, Chapter 3.4, Table 3.4-3. *Speciated Organic Compound Emission Factors For Large Uncontrolled Diesel Engines* (10/96) and Table 3.4-4. *PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines.*
(4) EPA Fuel Standard for Ultra-Low Sulfur Diesel