ATTACHMENT 4

DETAILED EMISSION CALCULATIONS FOR THE COMBUSTION TURBINE

Table A-1. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, Base Load

Data		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		183,700.0		159,200.0		142,500.0
Heat Rate (Btu/kwh)		10,070.0		10,320.0		10,650.0
CT Exhaust Flow						
Mass Flow (lb/hr)		3,743,000		3,390,000		3,189,000
Temperature (oF)		1,060		1,102		1,127
Moisture (% Vol.)		11.59		12.40		12.71
Oxygen (% Vol.)		10.96		10.95		11.03
Molecular Weight		28.25		28.15		28.10
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		183,700.0		159,200.0		142,500.0
Heat Rate (Btu/kwh)		10,070.0		10,320.0		10,650.0
Heat Input (MMBtu/hr)		1,849.9		1,642.9		1,517.6
Fuel Oil Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
Heat Input (MMBtu/hr)		1,849.9		1,642.9		1,517.6
Heat Content,LHV (Btu/lb)		18,550		18,550		18,550
Fuel Oil (lb/hr)		99,722.9		88,568.4		81,812.7
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,743,000		3,390,000		3,189,000
Temperature (°F)		1,060		1,102		1,127
Molecular Weight		28.25		28.15		28.10
Volume Flow (acfm)		2,450,287		2,288,314		2,190,589
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,743,000		3,390,000		3,189,000
Temperature (°F)		68		68		68
Molecular Weight		28.25		28.15		28.10
Volume Flow (scfm)		851,152		773,514		728,816
HRSG Stack Data						
Stack Height (ft)		180		180		180
Diameter (ft)		18.0		18.0		18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		2,450,287		2,288,314		2,190,589
CT Temperature (°F)		1,060		1,102		1,127
HRSG Temperature (°F)		205		205		205
Volume Flow (acfm) from HRSG		1,072,001		974,218		917,922
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		1,072,001		974,218		917,922
Diameter (ft)		18.0		18.0		18.0
Velocity (ft/sec)		70.2		63.8		60.1

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: General Electric, 1992.

Table A-2. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, Base Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer						
Basis, lb/hr (manufactur.) (1)		17.0		17.0		17.0
lb/hr		17.0		17.0		17.0
TPY		2.6		2.6		2.6
Sulfur Dioxide (lb/hr)= Fuel oil (lb/hr) x sulfur content(fraction) x (lb SO2/lb S) x fraction emitted as SO2						
Fuel Oil (lb/hr)		99,722.9		88,568.4		81,812.7
Sulfur content (%)		0.05		0.05		0.05
lb SO2/lb S (64/32)		2.0		2.0		2.0
SO2 Fraction emitted		1.00		1.00		1.00
lb/hr		99.72		88.57		81.81
TPY		15.0		13.3		12.3
Nitrogen Oxides (lb/hr)= NOx(ppm) x ([20.9 x (1 - Moisture(%)/100)] - Oxygen(%)) x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]						
Basis, ppm* (1)		42.0		42.0		42.0
Moisture (%)		11.59		12.4		12.71
Oxygen (%)		10.96		10.95		11.03
Volume Flow (acfm)		2,450,287		2,288,314		2,190,589
Temperature (°F)		1060		1102		1127
lb/hr		326.2		290.2		268.0
TPY		48.9		43.5		40.2
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		30.0		30.0		30.0
Moisture (%)		11.59		12.4		12.71
Volume Flow (acfm)		2,450,287		2,288,314		2,190,589
Temperature (°F)		1060		1102		1127
lb/hr		98.4		88.6		83.2
TPY		14.8		13.3		12.5
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		4.0		3.9		4.1
Moisture (%)		11.59		12.4		12.71
Volume Flow (acfm)		2,450,287		2,288,314		2,190,589
Temperature (°F)		1060		1102		1127
lb/hr		7.50		6.58		6.50
TPY		1.1		1.0		1.0
Lead (lb/hr)= Lead (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (2)		8.9		8.9		8.9
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		1.65E-02		1.46E-02		1.35E-02
TPY		2.47E-03		2.19E-03		2.03E-03

* corrected to 15% O2 dry conditions
+ corrected to dry conditions

Source: (1) General Electric, 1992; (2) EPA, 1990

Table A-3. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, Base Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Arsenic (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		4.2		4.2		4.2
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		7.77E-03		6.90E-03		6.37E-03
TPY		1.17E-03		1.04E-03		9.56E-04
Beryllium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		2.5		2.5		2.5
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		4.62E-03		4.11E-03		3.79E-03
TPY		6.94E-04		6.16E-04		5.69E-04
Mercury (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		3		3		3
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		5.55E-03		4.93E-03		4.55E-03
TPY		8.32E-04		7.39E-04		6.83E-04
Fluoride (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (2)		14		14		14
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		6.02E-02		5.35E-02		4.94E-02
TPY		9.03E-03		8.02E-03		7.41E-03
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8		8		8
SO2 (lb/hr)		99.7		88.6		81.8
lb H2SO4/lb SO2 (98/64)		1.53		1.53		1.53
lb/hr		1.22E+01		1.08E+01		1.00E+01
TPY		1.83E+00		1.63E+00		1.50E+00

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Sources: (1) EPA, 1990; (2) EPA, 1980

Table A-4. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, Base Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Manganese (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		14		14		14
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		2.59E-02		2.30E-02		2.12E-02
TPY		3.88E-03		3.45E-03		3.19E-03
Nickel (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		170		170		170
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		3.14E-01		2.79E-01		2.58E-01
TPY		4.72E-02		4.19E-02		3.87E-02
Cadmium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		10.5		10.5		10.5
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		1.94E-02		1.73E-02		1.59E-02
TPY		2.91E-03		2.59E-03		2.39E-03
Chromium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		47.5		47.5		47.5
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		8.79E-02		7.80E-02		7.21E-02
TPY		1.32E-02		1.17E-02		1.08E-02
Copper (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		280		280		280
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		5.18E-01		4.60E-01		4.25E-01
TPY		7.77E-02		6.90E-02		6.37E-02
Vanadium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		69.5		69.5		69.5
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		1.29E-01		1.14E-01		1.05E-01
TPY		1.93E-02		1.71E-02		1.58E-02
Selenium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		23.42		23.42		23.42
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		4.33E-02		3.85E-02		3.55E-02
TPY		6.50E-03		5.77E-03		5.33E-03
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		0.278		0.278		0.278
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		5.14E-04		4.57E-04		4.22E-04
TPY		7.71E-05		6.85E-05		6.33E-05
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		405		405		405
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		7.49E-01		6.65E-01		6.15E-01
TPY		1.12E-01		9.98E-02		9.22E-02

Source: (1) EPA, 1990

Table A-5. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, Base Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Antimony (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		9.4		9.4		9.4
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		4.04E-02		3.59E-02		3.32E-02
TPY		6.06E-03		5.38E-03		4.97E-03
Barium (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		8.4		8.4		8.4
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		3.61E-02		3.21E-02		2.96E-02
TPY		5.42E-03		4.81E-03		4.44E-03
Cobalt (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		3.9		3.9		3.9
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		1.68E-02		1.49E-02		1.38E-02
TPY		2.51E-03		2.23E-03		2.06E-03
Zinc (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		294		294		294
HIR (MMBtu/hr)		1,849.9		1,642.9		1,517.6
lb/hr		1.26E+00		1.12E+00		1.04E+00
TPY		1.90E-01		1.68E-01		1.56E-01
Chlorine (lb/hr)= Basis (ppm) x Fuel oil (lb/hr) ÷ 1,000,000 (adj. for ppm)						
Basis, ppm		0.5		0.5		0.5
Fuel Oil (lb/hr)		99,722.9		88,568.4		81,812.7
lb/hr		4.99E-02		4.43E-02		4.09E-02
TPY		7.48E-03		6.64E-03		6.14E-03

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Source: (1) EPA, 1979

Table A-6. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, Base Load

Data		Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		170,700.0	151,900.0	147,100.0	142,700.0	131,800.0
Heat Rate (Btu/kwh)		9,460.0	9,750.0	9,860.0	9,970.0	10,230.0
CT Exhaust Flow						
Mass Flow (lb/hr)		3,582,000	3,322,000	3,262,000	3,202,000	3,077,000
Temperature (oF)		1,078	1,110	1,117	1,124	1,140
Moisture (% Vol.)		7.61	8.83	9.21	10.05	9.91
Oxygen (% Vol.)		12.71	12.56	12.51	12.36	12.48
Molecular Weight		28.46	28.33	28.28	28.19	28.20
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		170,700.0	151,900.0	147,100.0	142,700.0	131,800.0
Heat Rate (Btu/kwh)		9,460.0	9,750.0	9,860.0	9,970.0	10,230.0
Heat Input (MMBtu/hr)		1,614.8	1,481.0	1,450.4	1,422.7	1,348.3
Natural Gas Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
(cf/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/cf)						
Heat Input (MMBtu/hr)		1,614.8	1,481.0	1,450.4	1,422.7	1,348.3
Heat Content,LHV (Btu/lb)		21,515	21,515	21,515	21,515	21,515
Natural Gas (lb/hr)		75,055.6	68,836.9	67,413.7	66,126.8	62,668.6
Heat Content,LHV (Btu/cf)		950	950	950	950	950
Natural Gas (cf/hr)		1,699,813	1,558,974	1,526,743	1,497,599	1,419,278
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,582,000	3,322,000	3,262,000	3,202,000	3,077,000
Temperature (°F)		1,078	1,110	1,117	1,124	1,140
Molecular Weight		28.46	28.33	28.28	28.19	28.20
Volume Flow (acfm)		2,354,349	2,239,805	2,212,530	2,188,744	2,123,643
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,582,000	3,322,000	3,262,000	3,202,000	3,077,000
Temperature (°F)		68	68	68	68	68
Molecular Weight		28.46	28.33	28.28	28.19	28.20
Volume Flow (scfm)		808,255	753,259	740,784	729,581	700,802
HRSG Stack Data						
Stack Height (ft)		180	180	180	180	180
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		2,354,349	2,239,805	2,212,530	2,188,744	2,123,643
CT Temperature (°F)		1,078	1,110	1,117	1,124	1,140
HRSG Temperature (°F)		205	205	205	205	205
Volume Flow (acfm) from HRSG		1,017,973	948,707	932,995	918,885	882,639
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		1,017,973	948,707	932,995	918,885	882,639
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Velocity (ft/sec)		66.7	62.1	61.1	60.2	57.8

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: General Electric, 1992.

Table A-7. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, Base Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460	8460	8460	8460	8460
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer					
Basis, lb/hr (manufactur.) (1)	9.0	9.0	9.0	9.0	9.0
lb/hr	9.0	9.0	9.0	9.0	9.0
TPY	38.07	38.07	38.07	38.07	38.07
Sulfur Dioxide (lb/hr)= Natural gas (cf/hr) x sulfur content(gr/100 cf) x 1 lb/7000 gr x (lb SO2/lb S) + 100					
Natural Gas (cf/hr)	1,699,813	1,558,974	1,526,743	1,497,599	1,419,278
Basis, gr/100 cf	1.0	1.0	1.0	1.0	1.0
lb SO2/lb S (64/32)	2.0	2.0	2.0	2.0	2.0
lb/hr	4.86	4.45	4.36	4.28	4.06
TPY	20.54	18.84	18.45	18.10	17.15
Nitrogen Oxides (lb/hr)= NOx(ppm) x ([20.9 x (1 - Moisture(%)/100)] - Oxygen(%)) x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]					
Basis, ppm* (1)	25.0	25.0	25.0	25.0	25.0
Moisture (%)	7.61	8.83	9.21	10.05	9.91
Oxygen (%)	12.71	12.56	12.51	12.36	12.48
Volume Flow (acfm)	2,354,349	2,239,805	2,212,530	2,188,744	2,123,643
Temperature (°F)	1078	1110	1117	1124	1140
lb/hr	161.9	148.5	145.3	142.6	135.0
TPY	684.72	627.98	614.78	603.09	571.14
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]					
Basis, ppm+ (1)	15.0	15.0	15.0	15.0	15.0
Moisture (%)	7.61	8.83	9.21	10.05	9.91
Volume Flow (acfm)	2,354,349	2,239,805	2,212,530	2,188,744	2,123,643
Temperature (°F)	1078	1110	1117	1124	1140
lb/hr	48.8	44.9	44.0	42.9	41.3
TPY	206.55	189.96	186.03	181.52	174.63
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]					
Basis, ppm+ (1)	1.5	1.5	1.5	1.6	1.5
Moisture (%)	7.61	8.83	9.21	10.05	9.91
Volume Flow (acfm)	2,354,349	2,239,805	2,212,530	2,188,744	2,123,643
Temperature (°F)	1078	1110	1117	1124	1140
lb/hr	2.79	2.57	2.51	2.62	2.36
TPY	11.80	10.85	10.63	11.06	9.98
Lead (lb/hr)= Negligible					
Basis, lb/10E+12 Btu	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

* corrected to 15% O2 dry conditions
\+ corrected to dry conditions

Source: General Electric, 1992.

Table A-8. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, Base Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Arsenic (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Beryllium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Mercury (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Fluoride (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8	8	8	8	8
SO2 (lb/hr)		4.86	4.45	4.36	4.28	4.06
lb H2SO4/lb SO2 (98/64)		1.53	1.53	1.53	1.53	1.53
lb/hr		5.95E-01	5.46E-01	5.34E-01	5.24E-01	4.97E-01
TPY		2.52E+00	2.31E+00	2.26E+00	2.22E+00	2.10E+00

Source: (1) EPA, 1990

Table A-9. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, Base Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Manganese (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Nickel (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Cadmium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Chromium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Copper (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Vanadium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Selenium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		1.113	1.113	1.113	1.113	1.113
HIR (MMBtu/hr)		1,614.8	1,481.0	1,450.4	1,422.7	1,348.3
lb/hr		1.80E-03	1.65E-03	1.61E-03	1.58E-03	1.50E-03
TPY		7.60E-03	6.97E-03	6.83E-03	6.70E-03	6.35E-03
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		88.12	88.12	88.12	88.12	88.12
HIR (MMBtu/hr)		1,614.8	1,481.0	1,450.4	1,422.7	1,348.3
lb/hr		1.42E-01	1.31E-01	1.28E-01	1.25E-01	1.19E-01
TPY		6.02E-01	5.52E-01	5.41E-01	5.30E-01	5.03E-01

Source: (1) EPA, 1990

Table A-10. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, Base Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460		8460		8460
Antimony (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Barium (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Cobalt (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Zinc (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Chlorine (lb/hr)= Negligible					
Basis, ppm	NA	NA	NA	NA	NA
Natural gas (cf)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

Table A-1A. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, 70 Percent Load

Data		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		129,200.0		111,000.0		98,500.0
Heat Rate (Btu/kwh)		11,430.0		11,800.0		12,280.0
CT Exhaust Flow						
Mass Flow (lb/hr)		2,837,000		2,619,000		2,510,000
Temperature (oF)		1,166		1,192		1,200
Moisture (% Vol.)		11.96		12.40		12.48
Oxygen (% Vol.)		10.57		10.81		11.07
Molecular Weight		28.23		28.16		28.13
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		129,200.0		111,000.0		98,500.0
Heat Rate (Btu/kwh)		11,430.0		11,800.0		12,280.0
Heat Input (MMBtu/hr)		1,476.8		1,309.8		1,209.6
Fuel Oil Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
Heat Input (MMBtu/hr)		1,476.8		1,309.8		1,209.6
Heat Content,LHV (Btu/lb)		18,550		18,550		18,550
Fuel Oil (lb/hr)		79,609.5		70,609.2		65,206.5
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,837,000		2,619,000		2,510,000
Temperature (°F)		1,166		1,192		1,200
Molecular Weight		28.23		28.16		28.13
Volume Flow (acfm)		1,988,010		1,869,045		1,802,083
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,837,000		2,619,000		2,510,000
Temperature (°F)		68		68		68
Molecular Weight		28.23		28.16		28.13
Volume Flow (scfm)		645,553		597,370		573,193
HRSG Stack Data						
Stack Height (ft)		180		180		180
Diameter (ft)		18.0		18.0		18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		1,988,010		1,869,045		1,802,083
CT Temperature (°F)		1,166		1,192		1,200
HRSG Temperature (°F)		200		200		200
Volume Flow (acfm) from HRSG		806,941		746,713		716,491
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		806,941		746,713		716,491
Diameter (ft)		18.0		18.0		18.0
Velocity (ft/sec)		52.9		48.9		46.9

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: General Electric, 1992.

Table A-2A. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, 70 Percent Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer						
Basis, lb/hr (manufactur.) (1)		17.0		17.0		17.0
lb/hr		17.0		17.0		17.0
TPY		2.6		2.6		2.6
Sulfur Dioxide (lb/hr)= Fuel oil (lb/hr) x sulfur content(fraction) x (lb SO2/lb S) x fraction emitted as SO2						
Fuel Oil (lb/hr)		79,609.5		70,609.2		65,206.5
Sulfur content (%)		0.05		0.05		0.05
lb SO2/lb S (64/32)		2.0		2.0		2.0
SO2 Fraction emitted		1.00		1.00		1.00
lb/hr		79.61		70.61		65.21
TPY		11.9		10.6		9.8
Nitrogen Oxides (lb/hr)= NOx(ppm) x ([20.9 x (1 - Moisture(%)/100)] - Oxygen(%)) x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]						
Basis, ppm* (1)		42.0		42.0		42.0
Moisture (%)		11.96		12.4		12.48
Oxygen (%)		10.57		10.81		11.07
Volume Flow (acfm)		1,988,010		1,869,045		1,802,083
Temperature (°F)		1166		1192		1200
lb/hr		257.7		228.4		211.0
TPY		38.7		34.3		31.7
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		30.0		30.0		30.0
Moisture (%)		11.96		12.4		12.48
Volume Flow (acfm)		1,988,010		1,869,045		1,802,083
Temperature (°F)		1166		1192		1200
lb/hr		74.3		68.4		65.6
TPY		11.1		10.3		9.8
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		4.0		4.0		4.1
Moisture (%)		11.96		12.4		12.48
Volume Flow (acfm)		1,988,010		1,869,045		1,802,083
Temperature (°F)		1166		1192		1200
lb/hr		5.66		5.21		5.12
TPY		0.8		0.8		0.8
Lead (lb/hr)= Lead (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (2)		8.9		8.9		8.9
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		1.31E-02		1.17E-02		1.08E-02
TPY		1.97E-03		1.75E-03		1.61E-03

* corrected to 15% O2 dry conditions
\+ corrected to dry conditions

Source: (1) General Electric, 1992; (2) EPA, 1990

Table A-3A. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, 70 Percent Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Arsenic (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		4.2		4.2		4.2
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		6.20E-03		5.50E-03		5.08E-03
TPY		9.30E-04		8.25E-04		7.62E-04
Beryllium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		2.5		2.5		2.5
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		3.69E-03		3.27E-03		3.02E-03
TPY		5.54E-04		4.91E-04		4.54E-04
Mercury (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		3		3		3
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		4.43E-03		3.93E-03		3.63E-03
TPY		6.65E-04		5.89E-04		5.44E-04
Fluoride (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (2)		14		14		14
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		4.80E-02		4.26E-02		3.94E-02
TPY		7.21E-03		6.39E-03		5.90E-03
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8		8		8
SO2 (lb/hr)		79.6		70.6		65.2
lb H2SO4/lb SO2 (98/64)		1.53		1.53		1.53
lb/hr		9.75E+00		8.65E+00		7.99E+00
TPY		1.46E+00		1.30E+00		1.20E+00

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Sources: (1) EPA, 1990; (2) EPA, 1980

Table A-4A. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, 70 Percent Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Manganese (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		14		14		14
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		2.07E-02		1.83E-02		1.69E-02
TPY		3.10E-03		2.75E-03		2.54E-03
Nickel (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		170		170		170
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		2.51E-01		2.23E-01		2.06E-01
TPY		3.77E-02		3.34E-02		3.08E-02
Cadmium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		10.5		10.5		10.5
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		1.55E-02		1.38E-02		1.27E-02
TPY		2.33E-03		2.06E-03		1.91E-03
Chromium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		47.5		47.5		47.5
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		7.01E-02		6.22E-02		5.75E-02
TPY		1.05E-02		9.33E-03		8.62E-03
Copper (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		280		280		280
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		4.13E-01		3.67E-01		3.39E-01
TPY		6.20E-02		5.50E-02		5.08E-02
Vanadium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		69.5		69.5		69.5
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		1.03E-01		9.10E-02		8.41E-02
TPY		1.54E-02		1.37E-02		1.26E-02
Selenium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		23.42		23.42		23.42
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		3.46E-02		3.07E-02		2.83E-02
TPY		5.19E-03		4.60E-03		4.25E-03
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		0.278		0.278		0.278
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		4.11E-04		3.64E-04		3.36E-04
TPY		6.16E-05		5.46E-05		5.04E-05
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		405		405		405
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		5.98E-01		5.30E-01		4.90E-01
TPY		8.97E-02		7.96E-02		7.35E-02

Source: (1) EPA, 1990

Table A-5A. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Distillate Oil, 70 Percent Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Antimony (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		9.4		9.4		9.4
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		3.23E-02		2.86E-02		2.64E-02
TPY		4.84E-03		4.29E-03		3.96E-03
Barium (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		8.4		8.4		8.4
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		2.88E-02		2.56E-02		2.36E-02
TPY		4.32E-03		3.84E-03		3.54E-03
Cobalt (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		3.9		3.9		3.9
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		1.34E-02		1.19E-02		1.10E-02
TPY		2.01E-03		1.78E-03		1.64E-03
Zinc (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		294		294		294
HIR (MMBtu/hr)		1,476.8		1,309.8		1,209.6
lb/hr		1.01E+00		8.95E-01		8.26E-01
TPY		1.51E-01		1.34E-01		1.24E-01
Chlorine (lb/hr)= Basis (ppm) x Fuel oil (lb/hr) ÷ 1,000,000 (adj. for ppm)						
Basis, ppm		0.5		0.5		0.5
Fuel Oil (lb/hr)		79,609.5		70,609.2		65,206.5
lb/hr		3.98E-02		3.53E-02		3.26E-02
TPY		5.97E-03		5.30E-03		4.89E-03

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Source: (1) EPA, 1979

Table A-6A. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, 70 Percent Load

Data		Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		119,900.0	106,500.0	103,100.0	99,500.0	90,900.0
Heat Rate (Btu/kwh)		10,770.0	11,070.0	11,340.0	11,510.0	11,890.0
CT Exhaust Flow						
Mass Flow (lb/hr)		2,744,000	2,595,000	2,560,000	2,524,000	2,454,000
Temperature (oF)		1,177	1,195	1,199	1,200	1,200
Moisture (% Vol.)		7.84	8.98	9.34	10.14	9.89
Oxygen (% Vol.)		12.46	12.41	12.39	12.28	12.52
Molecular Weight		28.45	28.32	28.27	28.18	28.20
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		119,900.0	106,500.0	103,100.0	99,500.0	90,900.0
Heat Rate (Btu/kwh)		10,770.0	11,070.0	11,340.0	11,510.0	11,890.0
Heat Input (MMBtu/hr)		1,291.3	1,179.0	1,169.2	1,145.2	1,080.8
Natural Gas Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
(cf/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/cf)						
Heat Input (MMBtu/hr)		1,291.3	1,179.0	1,169.2	1,145.2	1,080.8
Heat Content,LHV (Btu/lb)		21,515	21,515	21,515	21,515	21,515
Natural Gas (lb/hr)		60,019.7	54,796.9	54,341.3	53,230.1	50,234.8
Heat Content,LHV (Btu/cf)		950	950	950	950	950
Natural Gas (cf/hr)		1,359,287	1,241,005	1,230,688	1,205,521	1,137,685
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,744,000	2,595,000	2,560,000	2,524,000	2,454,000
Temperature (°F)		1,177	1,195	1,199	1,200	1,200
Molecular Weight		28.45	28.32	28.27	28.18	28.20
Volume Flow (acfm)		1,920,685	1,845,077	1,827,352	1,808,470	1,757,157
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,744,000	2,595,000	2,560,000	2,524,000	2,454,000
Temperature (°F)		68	68	68	68	68
Molecular Weight		28.45	28.32	28.27	28.18	28.20
Volume Flow (scfm)		619,500	588,641	581,580	575,224	558,903
HRSG Stack Data						
Stack Height (ft)		180	180	180	180	180
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		1,920,685	1,845,077	1,827,352	1,808,470	1,757,157
CT Temperature (°F)		1,177	1,195	1,199	1,200	1,200
HRSG Temperature (°F)		200	200	200	200	200
Volume Flow (acfm) from HRSG		774,375	735,801	726,975	719,030	698,629
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		774,375	735,801	726,975	719,030	698,629
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Velocity (ft/sec)		50.7	48.2	47.6	47.1	45.8

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: General Electric, 1992.

Table A-7A. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, 70 Percent Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460	8460	8460	8460	8460
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer					
Basis, lb/hr (manufactur.) (1)	9.0	9.0	9.0	9.0	9.0
lb/hr	9.0	9.0	9.0	9.0	9.0
TPY	38.07	38.07	38.07	38.07	38.07
Sulfur Dioxide (lb/hr)= Natural gas (cf/hr) x sulfur content(gr/100 cf) x 1 lb/7000 gr x (lb SO2/lb S) ÷ 100					
Natural Gas (cf/hr)	1,359,287	1,241,005	1,230,688	1,205,521	1,137,685
Basis, gr/100 cf	1.0	1.0	1.0	1.0	1.0
lb SO2/lb S (64/32)	2.0	2.0	2.0	2.0	2.0
lb/hr	3.88	3.55	3.52	3.44	3.25
TPY	16.43	15.00	14.87	14.57	13.75
Nitrogen Oxides (lb/hr)= NOx(ppm) x ([20.9 x (1 - Moisture(%)/100)] - Oxygen(%)) x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]					
Basis, ppm* (1)	25.0	25.0	25.0	25.0	25.0
Moisture (%)	7.84	8.98	9.34	10.14	9.89
Oxygen (%)	12.46	12.41	12.39	12.28	12.52
Volume Flow (acfm)	1,920,685	1,845,077	1,827,352	1,808,470	1,757,157
Temperature (°F)	1177	1195	1199	1200	1200
lb/hr	127.9	118.1	115.7	113.5	107.1
TPY	540.88	499.71	489.59	480.01	452.93
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]					
Basis, ppm+ (1)	15.0	15.0	15.0	15.0	15.0
Moisture (%)	7.84	8.98	9.34	10.14	9.89
Volume Flow (acfm)	1,920,685	1,845,077	1,827,352	1,808,470	1,757,157
Temperature (°F)	1177	1195	1199	1200	1200
lb/hr	37.3	35.0	34.5	33.8	32.9
TPY	157.92	148.20	145.84	142.98	139.31
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]					
Basis, ppm+ (1)	1.5	1.5	1.5	1.6	1.5
Moisture (%)	7.84	8.98	9.34	10.14	9.89
Volume Flow (acfm)	1,920,685	1,845,077	1,827,352	1,808,470	1,757,157
Temperature (°F)	1177	1195	1199	1200	1200
lb/hr	2.13	2.00	2.00	2.06	1.88
TPY	9.02	8.47	8.44	8.71	7.96
Lead (lb/hr)= Negligible					
Basis, lb/10E+12 Btu	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

* corrected to 15% 02 dry conditions
\+ corrected to dry conditions

Source: General Electric, 1992.

Table A-8A. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, 70 Percent Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Arsenic (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Beryllium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Mercury (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Fluoride (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8	8	8	8	8
SO2 (lb/hr)		3.88	3.55	3.52	3.44	3.25
lb H2SO4/lb SO2 (98/64)		1.53	1.53	1.53	1.53	1.53
lb/hr		4.76E-01	4.34E-01	4.31E-01	4.22E-01	3.98E-01
TPY		2.01E+00	1.84E+00	1.82E+00	1.78E+00	1.68E+00

Source: (1) EPA, 1990

Table A-9A. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, 70 Percent Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Manganese (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Nickel (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Cadmium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Chromium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Copper (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Vanadium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Selenium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		1.113	1.113	1.113	1.113	1.113
HIR (MMBtu/hr)		1,291.3	1,179.0	1,169.2	1,145.2	1,080.8
lb/hr		1.44E-03	1.31E-03	1.30E-03	1.27E-03	1.20E-03
TPY		6.08E-03	5.55E-03	5.50E-03	5.39E-03	5.09E-03
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		88.12	88.12	88.12	88.12	88.12
HIR (MMBtu/hr)		1,291.3	1,179.0	1,169.2	1,145.2	1,080.8
lb/hr		1.14E-01	1.04E-01	1.03E-01	1.01E-01	9.52E-02
TPY		4.81E-01	4.39E-01	4.36E-01	4.27E-01	4.03E-01

Source: (1) EPA, 1990

Table A-10A. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-GE PG7221(FA), Dry Low NOx II Combustion System, Natural Gas, 70 Percent Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460		8460		8460
Antimony (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Barium (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Cobalt (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Zinc (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Chlorine (lb/hr)= Negligible					
Basis, ppm	NA	NA	NA	NA	NA
Natural gas (cf)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

Table A-19. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, Base Load

Data		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		171,970.0		162,330.0		147,180.0
Heat Rate (Btu/kwh)		9,280.0		9,560.0		9,850.0
CT Exhaust Flow						
Mass Flow (lb/hr)		3,502,180		3,509,380		3,311,800
Temperature (oF)		1,104		1,104		1,121
Moisture (% Vol.)		10.60		11.91		12.57
Oxygen (% Vol.)		11.92		11.88		11.83
Molecular Weight		28.33		28.17		28.09
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		171,970.0		162,330.0		147,180.0
Heat Rate (Btu/kwh)		9,280.0		9,560.0		9,850.0
Heat Input (MMBtu/hr)		1,595.9		1,551.9		1,449.7
Fuel Oil Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
Heat Input (MMBtu/hr)		1,595.9		1,551.9		1,449.7
Heat Content,LHV (Btu/lb)		18,450		18,450		18,450
Fuel Oil (lb/hr)		86,497.6		84,112.5		78,575.8
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,502,180		3,509,380		3,311,800
Temperature (°F)		1,104		1,104		1,121
Molecular Weight		28.33		28.17		28.09
Volume Flow (acfm)		2,351,909		2,370,209		2,267,804
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,502,180		3,509,380		3,311,800
Temperature (°F)		68		68		68
Molecular Weight		28.33		28.17		28.09
Volume Flow (scfm)		793,995		800,173		757,369
HRSG Stack Data						
Stack Height (ft)		180		180		180
Diameter (ft)		18.0		18.0		18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		2,351,909		2,370,209		2,267,804
CT Temperature (°F)		1,104		1,104		1,121
HRSG Temperature (°F)		205		205		205
Volume Flow (acfm) from HRSG		1,000,012		1,007,794		953,883
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		1,000,012		1,007,794		953,883
Diameter (ft)		18.0		18.0		18.0
Velocity (ft/sec)		65.5		66.0		62.5

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: Westinghouse, 1992.

Table A-20. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, Base Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer						
Basis, lb/hr (manufactur.) (1)		39.5		39.0		36.7
lb/hr		39.5		39.0		36.7
TPY		5.9		5.9		5.5
Sulfur Dioxide (lb/hr)= Fuel oil (lb/hr) x sulfur content(fraction) x (lb SO2/lb S) x fraction emitted as SO2						
Fuel Oil (lb/hr)		86,497.6		84,112.5		78,575.8
Sulfur content (%)		0.05		0.05		0.05
lb SO2/lb S (64/32)		2.0		2.0		2.0
SO2 Fraction emitted		1.00		1.00		1.00
lb/hr		89.35		86.22		81.33
TPY		13.4		12.9		12.2
Nitrogen Oxides (lb/hr)= NOx(ppm) x {[20.9 x (1 - Moisture(%)/100)] - Oxygen(%)} x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]						
Basis, ppm* (1)		44.5		42.7		42.7
Moisture (%)		10.6		11.91		12.57
Oxygen (%)		11.92		11.88		11.83
Volume Flow (acfm)		2,351,909		2,370,209		2,267,804
Temperature (°F)		1104		1104		1121
lb/hr		290.1		270.9		252.9
TPY		43.5		40.6		37.9
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		52.0		51.6		51.5
Moisture (%)		10.6		11.91		12.57
Volume Flow (acfm)		2,351,909		2,370,209		2,267,804
Temperature (°F)		1104		1104		1121
lb/hr		160.9		158.4		148.7
TPY		24.1		23.8		22.3
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		10.6		10.5		10.5
Moisture (%)		10.6		11.91		12.57
Volume Flow (acfm)		2,351,909		2,370,209		2,267,804
Temperature (°F)		1104		1104		1121
lb/hr		18.74		18.44		17.32
TPY		2.8		2.8		2.6
Lead (lb/hr)= Lead (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (2)		8.9		8.9		8.9
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		1.42E-02		1.38E-02		1.29E-02
TPY		2.13E-03		2.07E-03		1.94E-03

* corrected to 15% O2 dry conditions
+ corrected to dry conditions

Source: (1) Westinghouse, 1992; (2) EPA, 1990

Table A-21. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
Westinghouse 501F, Conventional Combustor, Distillate Oil, Base Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Arsenic (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		4.2		4.2		4.2
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		6.70E-03		6.52E-03		6.09E-03
TPY		1.01E-03		9.78E-04		9.13E-04
Beryllium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		2.5		2.5		2.5
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		3.99E-03		3.88E-03		3.62E-03
TPY		5.98E-04		5.82E-04		5.44E-04
Mercury (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		3		3		3
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		4.79E-03		4.66E-03		4.35E-03
TPY		7.18E-04		6.98E-04		6.52E-04
Fluoride (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (2)		14		14		14
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		5.19E-02		5.05E-02		4.72E-02
TPY		7.79E-03		7.57E-03		7.08E-03
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8		8		8
SO2 (lb/hr)		89.4		86.2		81.3
lb H2SO4/lb SO2 (98/64)		1.53		1.53		1.53
lb/hr		1.09E+01		1.06E+01		9.96E+00
TPY		1.64E+00		1.58E+00		1.49E+00

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Sources: (1) EPA, 1990; (2) EPA, 1980

Table A-22. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, Base Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Manganese (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		14		14		14
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		2.23E-02		2.17E-02		2.03E-02
TPY		3.35E-03		3.26E-03		3.04E-03
Nickel (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		170		170		170
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		2.71E-01		2.64E-01		2.46E-01
TPY		4.07E-02		3.96E-02		3.70E-02
Cadmium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		10.5		10.5		10.5
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		1.68E-02		1.63E-02		1.52E-02
TPY		2.51E-03		2.44E-03		2.28E-03
Chromium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		47.5		47.5		47.5
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		7.58E-02		7.37E-02		6.89E-02
TPY		1.14E-02		1.11E-02		1.03E-02
Copper (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		280		280		280
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		4.47E-01		4.35E-01		4.06E-01
TPY		6.70E-02		6.52E-02		6.09E-02
Vanadium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		69.5		69.5		69.5
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		1.11E-01		1.08E-01		1.01E-01
TPY		1.66E-02		1.62E-02		1.51E-02
Selenium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		23.42		23.42		23.42
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		3.74E-02		3.63E-02		3.40E-02
TPY		5.61E-03		5.45E-03		5.09E-03
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		0.278		0.278		0.278
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		4.44E-04		4.31E-04		4.03E-04
TPY		6.65E-05		6.47E-05		6.05E-05
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		405		405		405
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		6.46E-01		6.29E-01		5.87E-01
TPY		9.69E-02		9.43E-02		8.81E-02

Source: (1) EPA, 1990

Table A-23. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, Base Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Antimony (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		9.4		9.4		9.4
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		3.49E-02		3.39E-02		3.17E-02
TPY		5.23E-03		5.09E-03		4.75E-03
Barium (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		8.4		8.4		8.4
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		3.12E-02		3.03E-02		2.83E-02
TPY		4.67E-03		4.54E-03		4.25E-03
Cobalt (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		3.9		3.9		3.9
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		1.45E-02		1.41E-02		1.31E-02
TPY		2.17E-03		2.11E-03		1.97E-03
Zinc (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		294		294		294
HIR (MMBtu/hr)		1,595.9		1,551.9		1,449.7
lb/hr		1.09E+00		1.06E+00		9.91E-01
TPY		1.64E-01		1.59E-01		1.49E-01
Chlorine (lb/hr)= Basis (ppm) x Fuel oil (lb/hr) ÷ 1,000,000 (adj. for ppm)						
Basis, ppm		0.5		0.5		0.5
Fuel Oil (lb/hr)		86,497.6		84,112.5		78,575.8
lb/hr		4.32E-02		4.21E-02		3.93E-02
TPY		6.49E-03		6.31E-03		5.89E-03

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Table A-24. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, Base Load

Data		Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		169,210.0	147,950.0	143,450.0	139,500.0	129,370.0
Heat Rate (Btu/kwh)		9,490.0	9,900.0	10,000.0	10,100.0	10,360.0
CT Exhaust Flow						
Mass Flow (lb/hr)		3,702,540	3,431,310	3,369,010	3,311,770	3,180,510
Temperature (oF)		1,063	1,086	1,092	1,098	1,111
Moisture (% Vol.)		7.26	8.45	8.82	9.32	9.56
Oxygen (% Vol.)		13.08	12.97	12.91	12.82	12.84
Molecular Weight		28.49	28.36	28.32	28.26	28.23
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		169,210.0	147,950.0	143,450.0	139,500.0	129,370.0
Heat Rate (Btu/kwh)		9,490.0	9,900.0	10,000.0	10,100.0	10,360.0
Heat Input (MMBtu/hr)		1,605.8	1,464.7	1,434.5	1,409.0	1,340.3
Natural Gas Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
(cf/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/cf)						
Heat Input (MMBtu/hr)		1,605.8	1,464.7	1,434.5	1,409.0	1,340.3
Heat Content,LHV (Btu/lb)		20,900	20,900	20,900	20,900	20,900
Natural Gas (lb/hr)		76,832.7	70,081.6	68,636.4	67,413.9	64,127.9
Heat Content,LHV (Btu/cf)		950	950	950	950	950
Natural Gas (cf/hr)		1,690,319	1,541,795	1,510,000	1,483,105	1,410,814
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,702,540	3,431,310	3,369,010	3,311,770	3,180,510
Temperature (°F)		1,063	1,086	1,092	1,098	1,111
Molecular Weight		28.49	28.36	28.32	28.26	28.23
Volume Flow (acfm)		2,407,465	2,275,544	2,246,146	2,221,160	2,152,966
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		3,702,540	3,431,310	3,369,010	3,311,770	3,180,510
Temperature (°F)		68	68	68	68	68
Molecular Weight		28.49	28.36	28.32	28.26	28.23
Volume Flow (scfm)		834,630	777,159	764,153	752,742	723,594
HRSG Stack Data						
Stack Height (ft)		180	180	180	180	180
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		2,407,465	2,275,544	2,246,146	2,221,160	2,152,966
CT Temperature (°F)		1,063	1,086	1,092	1,098	1,111
HRSG Temperature (°F)		205	205	205	205	205
Volume Flow (acfm) from HRSG		1,051,191	978,808	962,427	948,056	911,345
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		1,051,191	978,808	962,427	948,056	911,345
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Velocity (ft/sec)		68.8	64.1	63.0	62.1	59.7

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: Westinghouse, 1992.

Table A-25. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, Base Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460	8460	8460	8460	8460
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer					
Basis, lb/hr (manufactur.) (1)	6.60	6.10	6.00	5.90	5.70
lb/hr	6.60	6.10	6.00	5.90	5.70
TPY	27.92	25.80	25.38	24.96	24.11
Sulfur Dioxide (lb/hr)= Natural gas (cf/hr) x sulfur content(gr/100 cf) x 1 lb/7000 gr x (lb SO2/lb S) ÷ 100					
Natural Gas (cf/hr)	1,690,319	1,541,795	1,510,000	1,483,105	1,410,814
Basis, gr/100 cf	1.0	1.0	1.0	1.0	1.0
lb SO2/lb S (64/32)	2.0	2.0	2.0	2.0	2.0
lb/hr	4.83	4.41	4.31	4.24	4.03
TPY	20.43	18.63	18.25	17.92	17.05
Nitrogen Oxides (lb/hr)= NOx(ppm) x {[20.9 x (1 - Moisture(%)/100)] - Oxygen(%)} x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]					
Basis, ppm* (1)	25.5	25.5	25.4	25.5	25.5
Moisture (%)	7.26	8.45	8.82	9.32	9.56
Oxygen (%)	13.08	12.97	12.91	12.82	12.84
Volume Flow (acfm)	2,407,465	2,275,544	2,246,146	2,221,160	2,152,966
Temperature (°F)	1063	1086	1092	1098	1111
lb/hr	162.8	148.3	144.8	142.9	135.8
TPY	688.77	627.23	612.58	604.38	574.33
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]					
Basis, ppm+ (1)	10.3	10.4	10.3	10.4	10.2
Moisture (%)	7.26	8.45	8.82	9.32	9.56
Volume Flow (acfm)	2,407,465	2,275,544	2,246,146	2,221,160	2,152,966
Temperature (°F)	1063	1086	1092	1098	1111
lb/hr	34.8	32.3	31.3	30.9	29.1
TPY	147.02	136.45	132.34	130.91	123.09
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]					
Basis, ppm+ (1)	4.2	4.0	4.1	4.1	4.3
Moisture (%)	7.26	8.45	8.82	9.32	9.56
Volume Flow (acfm)	2,407,465	2,275,544	2,246,146	2,221,160	2,152,966
Temperature (°F)	1063	1086	1092	1098	1111
lb/hr	8.10	7.09	7.12	6.97	7.01
TPY	34.26	29.99	30.10	29.49	29.65
Lead (lb/hr)= Negligible					
Basis, lb/10E+12 Btu	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

* corrected to 15% O2 dry conditions
\+ corrected to dry conditions

Source: Westinghouse, 1992.

Table A-26. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, Base Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Arsenic (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Beryllium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Mercury (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Fluoride (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8	8	8	8	8
SO2 (lb/hr)		4.83	4.41	4.31	4.24	4.03
lb H2SO4/lb SO2 (98/64)		1.53	1.53	1.53	1.53	1.53
lb/hr		6.23E-01	5.68E-01	5.56E-01	5.46E-01	5.20E-01
TPY		2.63E+00	2.40E+00	2.35E+00	2.31E+00	2.20E+00

Source: (1) EPA, 1990

Table A-27. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, Base Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Manganese (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Nickel (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Cadmium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Chromium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Copper (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Vanadium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Selenium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		1.113	1.113	1.113	1.113	1.113
HIR (MMBtu/hr)		1,605.8	1,464.7	1,434.5	1,409.0	1,340.3
lb/hr		1.79E-03	1.63E-03	1.60E-03	1.57E-03	1.49E-03
TPY		7.56E-03	6.90E-03	6.75E-03	6.63E-03	6.31E-03
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		88.12	88.12	88.12	88.12	88.12
HIR (MMBtu/hr)		1,605.8	1,464.7	1,434.5	1,409.0	1,340.3
lb/hr		1.42E-01	1.29E-01	1.26E-01	1.24E-01	1.18E-01
TPY		5.99E-01	5.46E-01	5.35E-01	5.25E-01	5.00E-01

Source: (1) EPA, 1990

Table A-28. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, Base Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460		8460		8460
Antimony (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Barium (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Cobalt (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Zinc (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Chlorine (lb/hr)= Negligible					
Basis, ppm	NA	NA	NA	NA	NA
Natural gas (cf)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

Table A-19A. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, 70 Percent Load

Data		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		133,020.0		113,400.0		102,810.0
Heat Rate (Btu/kwh)		9,770.0		10,310.0		10,680.0
CT Exhaust Flow						
Mass Flow (lb/hr)		2,934,960		2,757,580		2,662,180
Temperature (oF)		1,130		1,130		1,130
Moisture (% Vol.)		10.43		11.58		12.09
Oxygen (% Vol.)		12.08		12.17		12.26
Molecular Weight		28.34		28.19		28.12
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		133,020.0		113,400.0		102,810.0
Heat Rate (Btu/kwh)		9,770.0		10,310.0		10,680.0
Heat Input (MMBtu/hr)		1,299.6		1,169.2		1,098.0
Fuel Oil Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
Heat Input (MMBtu/hr)		1,299.6		1,169.2		1,098.0
Heat Content,LHV (Btu/lb)		18,450		18,450		18,450
Fuel Oil (lb/hr)		70,439.3		63,368.8		59,512.8
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,934,960		2,757,580		2,662,180
Temperature (°F)		1,130		1,130		1,130
Molecular Weight		28.34		28.19		28.12
Volume Flow (acfm)		2,003,120		1,892,217		1,831,107
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,934,960		2,757,580		2,662,180
Temperature (°F)		68		68		68
Molecular Weight		28.34		28.19		28.12
Volume Flow (scfm)		665,187		628,359		608,066
HRSG Stack Data						
Stack Height (ft)		180		180		180
Diameter (ft)		18.0		18.0		18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		2,003,120		1,892,217		1,831,107
CT Temperature (°F)		1,130		1,130		1,130
HRSG Temperature (°F)		200		200		200
Volume Flow (acfm) from HRSG		831,484		785,449		760,082
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		831,484		785,449		760,082
Diameter (ft)		18.0		18.0		18.0
Velocity (ft/sec)		54.5		51.4		49.8

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: Westinghouse, 1992.

Table A-20A. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, 70 Percent Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer						
Basis, lb/hr (manufactur.) (1)		32.6		30.0		28.5
lb/hr		32.6		30.0		28.5
TPY		4.9		4.5		4.3
Sulfur Dioxide (lb/hr)= Fuel oil (lb/hr) x sulfur content(fraction) x (lb SO2/lb S) x fraction emitted as SO2						
Fuel Oil (lb/hr)		70,439.3		63,368.8		59,512.8
Sulfur content (%)		0.05		0.05		0.05
lb SO2/lb S (64/32)		2.0		2.0		2.0
SO2 Fraction emitted		1.00		1.00		1.00
lb/hr		72.69		65.65		61.77
TPY		10.9		9.8		9.3
Nitrogen Oxides (lb/hr)= NOx(ppm) x {[20.9 x (1 - Moisture(%)/100)] - Oxygen(%)} x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]						
Basis, ppm* (1)		42.5		42.5		42.7
Moisture (%)		10.43		11.58		12.09
Oxygen (%)		12.08		12.17		12.26
Volume Flow (acfm)		2,003,120		1,892,217		1,831,107
Temperature (°F)		1130		1130		1130
lb/hr		227.9		204.5		192.7
TPY		34.2		30.7		28.9
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		51.5		51.5		51.5
Moisture (%)		10.43		11.58		12.09
Volume Flow (acfm)		2,003,120		1,892,217		1,831,107
Temperature (°F)		1130		1130		1130
lb/hr		133.8		124.7		120.0
TPY		20.1		18.7		18.0
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		10.0		10.1		10.5
Moisture (%)		10.43		11.58		12.09
Volume Flow (acfm)		2,003,120		1,892,217		1,831,107
Temperature (°F)		1130		1130		1130
lb/hr		14.84		13.98		13.98
TPY		2.2		2.1		2.1
Lead (lb/hr)= Lead (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (2)		8.9		8.9		8.9
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		1.16E-02		1.04E-02		9.77E-03
TPY		1.73E-03		1.56E-03		1.47E-03

* corrected to 15% O2 dry conditions
\+ corrected to dry conditions

Source: (1) Westinghouse, 1992; (2) EPA, 1990

Table A-21A. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
Westinghouse 501F, Conventional Combustor, Distillate Oil, 70 Percent Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Arsenic (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		4.2		4.2		4.2
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		5.46E-03		4.91E-03		4.61E-03
TPY		8.19E-04		7.37E-04		6.92E-04
Beryllium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		2.5		2.5		2.5
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		3.25E-03		2.92E-03		2.75E-03
TPY		4.87E-04		4.38E-04		4.12E-04
Mercury (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		3		3		3
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		3.90E-03		3.51E-03		3.29E-03
TPY		5.85E-04		5.26E-04		4.94E-04
Fluoride (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (2)		14		14		14
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		4.23E-02		3.80E-02		3.57E-02
TPY		6.34E-03		5.71E-03		5.36E-03
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8		8		8
SO2 (lb/hr)		72.7		65.7		61.8
lb H2SO4/lb SO2 (98/64)		1.53		1.53		1.53
lb/hr		8.90E+00		8.04E+00		7.57E+00
TPY		1.34E+00		1.21E+00		1.14E+00

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Sources: (1) EPA, 1990; (2) EPA, 1980

Table A-22A. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, 70 Percent Load

Pollutant	Units	Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Manganese (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		14		14		14
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		1.82E-02		1.64E-02		1.54E-02
TPY		2.73E-03		2.46E-03		2.31E-03
Nickel (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		170		170		170
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		2.21E-01		1.99E-01		1.87E-01
TPY		3.31E-02		2.98E-02		2.80E-02
Cadmium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		10.5		10.5		10.5
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		1.36E-02		1.23E-02		1.15E-02
TPY		2.05E-03		1.84E-03		1.73E-03
Chromium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		47.5		47.5		47.5
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		6.17E-02		5.55E-02		5.22E-02
TPY		9.26E-03		8.33E-03		7.82E-03
Copper (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		280		280		280
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		3.64E-01		3.27E-01		3.07E-01
TPY		5.46E-02		4.91E-02		4.61E-02
Vanadium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		69.5		69.5		69.5
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		9.03E-02		8.13E-02		7.63E-02
TPY		1.35E-02		1.22E-02		1.14E-02
Selenium (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		23.42		23.42		23.42
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		3.04E-02		2.74E-02		2.57E-02
TPY		4.57E-03		4.11E-03		3.86E-03
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		0.278		0.278		0.278
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		3.61E-04		3.25E-04		3.05E-04
TPY		5.42E-05		4.88E-05		4.58E-05
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		405		405		405
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		5.26E-01		4.74E-01		4.45E-01
TPY		7.90E-02		7.10E-02		6.67E-02

Source: (1) EPA, 1990

Table A-23A. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Conventional Combustor, Distillate Oil, 70 Percent Load

Pollutant		Gas Turbine Fuel Oil 27 °F	* Not Available * Gas Turbine Fuel Oil 64 °F	Gas Turbine Fuel Oil 72 °F	* Not Available * Gas Turbine Fuel Oil 79 °F	Gas Turbine Fuel Oil 97 °F
A	B	C	D	E	F	G
Hours of Operation		300		300		300
Antimony (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		9.4		9.4		9.4
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		2.84E-02		2.55E-02		2.40E-02
TPY		4.26E-03		3.83E-03		3.60E-03
Barium (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		8.4		8.4		8.4
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		2.54E-02		2.28E-02		2.14E-02
TPY		3.81E-03		3.42E-03		3.22E-03
Cobalt (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		3.9		3.9		3.9
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		1.18E-02		1.06E-02		9.95E-03
TPY		1.77E-03		1.59E-03		1.49E-03
Zinc (lb/hr)= Basis (pg/J) x 2.324 x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, pg/J (1)		294		294		294
HIR (MMBtu/hr)		1,299.6		1,169.2		1,098.0
lb/hr		8.88E-01		7.99E-01		7.50E-01
TPY		1.33E-01		1.20E-01		1.13E-01
Chlorine (lb/hr)= Basis (ppm) x Fuel oil (lb/hr) ÷ 1,000,000 (adj. for ppm)						
Basis, ppm		0.5		0.5		0.5
Fuel Oil (lb/hr)		70,439.3		63,368.8		59,512.8
lb/hr		3.52E-02		3.17E-02		2.98E-02
TPY		5.28E-03		4.75E-03		4.46E-03

Note: Multiply by 2.324 to convert picogram/Joule (pg/J) to lb/10E+12 Btu.

Source: (1) EPA, 1979

Table A-24A. Design Information and Stack Parameters for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, 70 Percent Load

Data		Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		118,330.0	103,390.0	100,210.0	97,490.0	90,340.0
Heat Rate (Btu/kwh)		10,490.0	11,020.0	11,150.0	11,270.0	11,600.0
CT Exhaust Flow						
Mass Flow (lb/hr)		2,754,000	2,678,720	2,647,790	2,619,850	2,554,960
Temperature (oF)		1,130	1,130	1,130	1,130	1,130
Moisture (% Vol.)		7.30	8.32	8.68	9.12	9.29
Oxygen (% Vol.)		13.04	13.10	13.08	13.04	13.15
Molecular Weight		28.49	28.36	28.33	28.27	28.25
Heat Input (MMBtu/hr)= Power (kW) x Heat Rate (Btu/kwh) ÷ 1,000,000 Btu/MMBtu						
Power (kW)		118,330.0	103,390.0	100,210.0	97,490.0	90,340.0
Heat Rate (Btu/kwh)		10,490.0	11,020.0	11,150.0	11,270.0	11,600.0
Heat Input (MMBtu/hr)		1,241.3	1,139.4	1,117.3	1,098.7	1,047.9
Natural Gas Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb) (cf/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/cf)						
Heat Input (MMBtu/hr)		1,241.3	1,139.4	1,117.3	1,098.7	1,047.9
Heat Content,LHV (Btu/lb)		20,900	20,900	20,900	20,900	20,900
Natural Gas (lb/hr)		59,391.5	54,514.7	53,461.3	52,570.0	50,140.9
Heat Content,LHV (Btu/cf)		950	950	950	950	950
Natural Gas (cf/hr)		1,306,612	1,199,324	1,176,149	1,156,539	1,103,099
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,754,000	2,678,720	2,647,790	2,619,850	2,554,960
Temperature (°F)		1,130	1,130	1,130	1,130	1,130
Molecular Weight		28.49	28.36	28.33	28.27	28.25
Volume Flow (acfm)		1,869,744	1,826,635	1,807,837	1,792,201	1,749,383
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		2,754,000	2,678,720	2,647,790	2,619,850	2,554,960
Temperature (°F)		68	68	68	68	68
Molecular Weight		28.49	28.36	28.33	28.27	28.25
Volume Flow (scfm)		620,896	606,581	600,338	595,146	580,927
HRSG Stack Data						
Stack Height (ft)		180	180	180	180	180
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Volume Flow (acfm) from HRSG= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from CT		1,869,744	1,826,635	1,807,837	1,792,201	1,749,383
CT Temperature (°F)		1,130	1,130	1,130	1,130	1,130
HRSG Temperature (°F)		200	200	200	200	200
Volume Flow (acfm) from HRSG		776,120	758,226	750,423	743,932	726,159
Velocity (ft/sec)= Volume flow (acfm) from HRSG ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from HRSG		776,120	758,226	750,423	743,932	726,159
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Velocity (ft/sec)		50.8	49.7	49.1	48.7	47.6

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: Westinghouse, 1992.

Table A-25A. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-
Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, 70 Percent Load

Pollutant		Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Particulate (lb/hr)= Emission rate (lb/hr) from manufacturer						
Basis, lb/hr (manufactur.) (1)		4.90	4.80	4.70	4.70	4.60
lb/hr		4.90	4.80	4.70	4.70	4.60
TPY		20.73	20.30	19.88	19.88	19.46
Sulfur Dioxide (lb/hr)= Natural gas (cf/hr) x sulfur content(gr/100 cf) x 1 lb/7000 gr x (lb SO2/lb S) ÷ 100						
Natural Gas (cf/hr)		1,306,612	1,199,324	1,176,149	1,156,539	1,103,099
Basis, gr/100 cf		1.0	1.0	1.0	1.0	1.0
lb SO2/lb S (64/32)		2.0	2.0	2.0	2.0	2.0
lb/hr		3.73	3.43	3.36	3.30	3.15
TPY		15.79	14.49	14.21	13.98	13.33
Nitrogen Oxides (lb/hr)= NOx(ppm) x ([20.9 x (1 - Moisture(%)/100)] - Oxygen(%)) x 2116.8 x Volume flow (acfm) x 46 (mole. wgt NOx) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 5.9 x 1,000,000 (adj. for ppm)]						
Basis, ppm* (1)		25.4	25.4	25.4	25.4	25.4
Moisture (%)		7.3	8.32	8.68	9.12	9.29
Oxygen (%)		13.04	13.1	13.08	13.04	13.15
Volume Flow (acfm)		1,869,744	1,826,635	1,807,837	1,792,201	1,749,383
Temperature (°F)		1130	1130	1130	1130	1130
lb/hr		121.3	113.4	111.2	109.3	104.0
TPY		512.94	479.50	470.24	462.14	440.07
Carbon Monoxide (lb/hr)= CO(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 28 (mole. wgt CO) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		10.4	10.3	10.4	10.2	10.4
Moisture (%)		7.3	8.32	8.68	9.12	9.29
Volume Flow (acfm)		1,869,744	1,826,635	1,807,837	1,792,201	1,749,383
Temperature (°F)		1130	1130	1130	1130	1130
lb/hr		26.1	25.0	24.9	24.1	23.9
TPY		110.38	105.63	105.44	101.73	101.06
VOCs (lb/hr)= VOC(ppm) x [1 - Moisture(%)/100] x 2116.8 lb/ft2 x Volume flow (acfm) x 16 (mole. wgt as methane) x 60 min/hr ÷ [1545 x (CT temp.(°F) + 460°F) x 1,000,000 (adj. for ppm)]						
Basis, ppm+ (1)		4.2	4.3	4.4	4.5	3.8
Moisture (%)		7.3	8.32	8.68	9.12	9.29
Volume Flow (acfm)		1,869,744	1,826,635	1,807,837	1,792,201	1,749,383
Temperature (°F)		1130	1130	1130	1130	1130
lb/hr		6.02	5.96	6.01	6.06	4.99
TPY		25.47	25.20	25.42	25.65	21.10
Lead (lb/hr)= Negligible						
Basis, lb/10E+12 Btu		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA

* corrected to 15% O2 dry conditions
\+ corrected to dry conditions

Source: Westinghouse, 1992.

Table A-26A. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, 70 Percent Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Arsenic (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Beryllium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Mercury (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Fluoride (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8	8	8	8	8
SO2 (lb/hr)		3.73	3.43	3.36	3.30	3.15
lb H2SO4/lb SO2 (98/64)		1.53	1.53	1.53	1.53	1.53
lb/hr		4.81E-01	4.42E-01	4.33E-01	4.26E-01	4.06E-01
TPY		2.04E+00	1.87E+00	1.83E+00	1.80E+00	1.72E+00

Source: (1) EPA, 1990

Table A-27A. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, 70 Percent Load

Pollutant	Units	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8460	8460	8460	8460	8460
Manganese (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Nickel (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Cadmium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Chromium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Copper (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Vanadium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Selenium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		1.113	1.113	1.113	1.113	1.113
HIR (MMBtu/hr)		1,241.3	1,139.4	1,117.3	1,098.7	1,047.9
lb/hr		1.38E-03	1.27E-03	1.24E-03	1.22E-03	1.17E-03
TPY		5.84E-03	5.36E-03	5.26E-03	5.17E-03	4.93E-03
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		88.12	88.12	88.12	88.12	88.12
HIR (MMBtu/hr)		1,241.3	1,139.4	1,117.3	1,098.7	1,047.9
lb/hr		1.09E-01	1.00E-01	9.85E-02	9.68E-02	9.23E-02
TPY		4.63E-01	4.25E-01	4.16E-01	4.10E-01	3.91E-01

Source: (1) EPA, 1990

Table A-28A. Maximum Emissions for Additional Non-Regulated Pollutant for DESTEC Central Florida Cogeneration Facility-Westinghouse 501F, Dry Low NOx Combustor, Natural Gas, 70 Percent Load

Pollutant	Gas Turbine Natural Gas 27 °F	Gas Turbine Natural Gas 64 °F	Gas Turbine Natural Gas 72 °F	Gas Turbine Natural Gas 79 °F	Gas Turbine Natural Gas 97 °F
A B	C	D	E	F	G
Hours of Operation	8460		8460		8460
Antimony (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Barium (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Cobalt (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Zinc (lb/hr)= Negligible					
Basis, pg/J	NA	NA	NA	NA	NA
HIR (MMBtu/hr)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA
Chlorine (lb/hr)= Negligible					
Basis, ppm	NA	NA	NA	NA	NA
Natural gas (cf)	NA	NA	NA	NA	NA
lb/hr	NA	NA	NA	NA	NA
TPY	NA	NA	NA	NA	NA

Table A-11. Design Information for DESTEC Central Florida Cogeneration Facility-
Duct Burner, Supplemental Firing, Natural Gas

Data		Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		NA	NA	NA	NA	NA
Heat Rate (Btu/kwh)		NA	NA	NA	NA	NA
DB Exhaust Flow						
Mass Flow (lb/hr)		5,244	5,244	5,244	5,244	5,244
Temperature (oF)		205	205	205	205	205
Moisture (% Vol.)		NA	NA	NA	NA	NA
Oxygen (% Vol.)		NA	NA	NA	NA	NA
Molecular Weight		28.00	28.00	28.00	28.00	28.00
Heat Input (MMBtu/hr)= As given						
Power (kW)		NA	NA	NA	NA	NA
Heat Rate (Btu/kwh)		NA	NA	NA	NA	NA
Heat Input (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
Natural Gas Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
(cf/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/cf)						
Heat Input (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
Heat Content,LHV (Btu/lb)		23,839	23,839	23,839	23,839	23,839
Natural Gas (lb/hr)		4,194.8	4,194.8	4,194.8	4,194.8	4,194.8
Heat Content,LHV (Btu/cf)		950	950	950	950	950
Natural Gas (cf/hr)		105,263	105,263	105,263	105,263	105,263
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		5,244	5,244	5,244	5,244	5,244
Temperature (°F)		205	205	205	205	205
Molecular Weight		28.00	28.00	28.00	28.00	28.00
Volume Flow (acfm)		1,515	1,515	1,515	1,515	1,515
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		5,244	5,244	5,244	5,244	5,244
Temperature (°F)		68	68	68	68	68
Molecular Weight		28.00	28.00	28.00	28.00	28.00
Volume Flow (scfm)		1,203	1,203	1,203	1,203	1,203
HRSG Stack Data						
Stack Height (ft)		180	180	180	180	180
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Volume Flow (acfm) from DB= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from DB		1,515	1,515	1,515	1,515	1,515
Assumed DB Exhaust Temp.(°F)		205	205	205	205	205
HRSG Temperature (°F)		205	205	205	205	205
Volume Flow (acfm) from DB		1,515	1,515	1,515	1,515	1,515
Velocity (ft/sec)= Volume flow (acfm) from DB ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from DB		1,515	1,515	1,515	1,515	1,515
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Velocity (ft/sec)		0.1	0.1	0.1	0.1	0.1

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: Destec Engineering, Inc., 1992

Table A-12. Maximum Emissions for Criteria Pollutants for DESTEC Central Florida Cogeneration Facility-Duct Burner, Supplemental Firing, Natural Gas

Pollutant		Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8760	8760	8760	8760	8760
Particulate (lb/hr)= Basis (lb/MMBtu) x HIR (MMBtu/hr)						
Basis, lb/MMBtu		0.01	0.01	0.01	0.01	0.01
HIR, MMBtu/hr		100.0	100.0	100.0	100.0	100.0
lb/hr		1.00	1.00	1.00	1.00	1.00
TPY		4.38	4.38	4.38	4.38	4.38
Sulfur Dioxide (lb/hr)= Natural gas (cf/hr) x sulfur content(gr/100 cf) x 1 lb/7000 gr x (lb SO2/lb S) + 100						
Natural Gas (cf/hr)		105,263	105,263	105,263	105,263	105,263
Basis, gr/100 cf		1.0	1.0	1.0	1.0	1.0
lb SO2/lb S (64/32)		2.0	2.0	2.0	2.0	2.0
lb/hr		0.30	0.30	0.30	0.30	0.30
TPY		1.32	1.32	1.32	1.32	1.32
Nitrogen Oxides (lb/hr)= Basis (lb/MMBtu/hr) x HIR (MMBtu/hr)						
Basis, lb/MMBtu		0.10	0.10	0.10	0.10	0.10
HIR, MMBtu/hr		100.0	100.0	100.0	100.0	100.0
lb/hr		10.00	10.00	10.00	10.00	10.00
TPY		43.80	43.80	43.80	43.80	43.80
Carbon Monoxide (lb/hr)= Basis (lb/MMBtu) x HIR (MMBtu/hr)						
Basis, lb/MMBtu		0.10	0.10	0.10	0.10	0.10
HIR, MMBtu/hr		100.0	100.0	100.0	100.0	100.0
lb/hr		10.00	10.00	10.00	10.00	10.00
TPY		43.80	43.80	43.80	43.80	43.80
VOCs (lb/hr)= Basis (lb/MMBtu) x HIR (MMBtu/hr)						
Basis, lb/MMBtu		0.029	0.029	0.029	0.029	0.029
HIR, MMBtu/hr		100.0	100.0	100.0	100.0	100.0
lb/hr		2.90	2.90	2.90	2.90	2.90
TPY		12.70	12.70	12.70	12.70	12.70
Lead (lb/hr)= Negligible						
Basis, lb/MMBtu		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA

Table A-13. Maximum Emissions of Other Regulated Pollutants for DESTEC Central Florida Cogeneration Facility
Duct Burner, Supplemental Firing, Natural Gas

Pollutant	Units	Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8760	8760	8760	8760	8760
Arsenic (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Beryllium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Mercury (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Fluoride (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8	8	8	8	8
SO2 (lb/hr)		0.30	0.30	0.30	0.30	0.30
lb H2SO4/lb SO2 (98/64)		1.53	1.53	1.53	1.53	1.53
lb/hr		3.68E-02	3.68E-02	3.68E-02	3.68E-02	3.68E-02
TPY		1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.61E-01

Source: EPA, 1990

Table A-14. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-Duct Burner, Supplemental Firing, Natural Gas

Pollutant	Units	Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8760	8760	8760	8760	8760
Manganese (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Nickel (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Cadmium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Chromium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Copper (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Vanadium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Selenium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		1.113	1.113	1.113	1.113	1.113
HIR (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
lb/hr		1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04
TPY		4.87E-04	4.87E-04	4.87E-04	4.87E-04	4.87E-04
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		88.12	88.12	88.12	88.12	88.12
HIR (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
lb/hr		8.81E-03	8.81E-03	8.81E-03	8.81E-03	8.81E-03
TPY		3.86E-02	3.86E-02	3.86E-02	3.86E-02	3.86E-02

Source: (1) EPA, 1990

Table A-11A. Design Information for DESTEC Central Florida Cogeneration Facility-
Duct Burner, Supplemental Firing, Natural Gas

Data		Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
General						
Power (kW)		NA	NA	NA	NA	NA
Heat Rate (Btu/kwh)		NA	NA	NA	NA	NA
DB Exhaust Flow						
Mass Flow (lb/hr)		5,244	5,244	5,244	5,244	5,244
Temperature (oF)		200	200	200	200	200
Moisture (% Vol.)		NA	NA	NA	NA	NA
Oxygen (% Vol.)		NA	NA	NA	NA	NA
Molecular Weight		28.00	28.00	28.00	28.00	28.00
Heat Input (MMBtu/hr)= As given						
Power (kW)		NA	NA	NA	NA	NA
Heat Rate (Btu/kwh)		NA	NA	NA	NA	NA
Heat Input (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
Natural Gas Consumption (lb/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/lb)						
(cf/hr)= Heat Input (MMBtu/hr) x 1,000,000 Btu/MMBtu ÷ Fuel Heat Content, LHV (Btu/cf)						
Heat Input (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
Heat Content,LHV (Btu/lb)		23,839	23,839	23,839	23,839	23,839
Natural Gas (lb/hr)		4,194.8	4,194.8	4,194.8	4,194.8	4,194.8
Heat Content,LHV (Btu/cf)		950	950	950	950	950
Natural Gas (cf/hr)		105,263	105,263	105,263	105,263	105,263
Volume Flow (acfm)= [(Mass Flow (lb/hr) x 1,545 x (Temp. (°F)+ 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		5,244	5,244	5,244	5,244	5,244
Temperature (°F)		200	200	200	200	200
Molecular Weight		28.00	28.00	28.00	28.00	28.00
Volume Flow (acfm)		1,504	1,504	1,504	1,504	1,504
Volume Flow (scfm)= [(Mass Flow (lb/hr) x 1,545 x (68°F + 460°F)] ÷ [Molecular weight x 2116.8] ÷ 60 min/hr						
Mass Flow (lb/hr)		5,244	5,244	5,244	5,244	5,244
Temperature (°F)		68	68	68	68	68
Molecular Weight		28.00	28.00	28.00	28.00	28.00
Volume Flow (scfm)		1,203	1,203	1,203	1,203	1,203
HRSG Stack Data						
Stack Height (ft)		180	180	180	180	180
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Volume Flow (acfm) from DB= [Volume flow (acfm) x (HRSG temp.(°F)+ 460°F)] ÷ [CT temp.(°F)+ 460°F]						
Volume Flow (acfm) from DB		1,504	1,504	1,504	1,504	1,504
Assumed DB Exhaust Temp.(°F)		200	200	200	200	200
HRSG Temperature (°F)		200	200	200	200	200
Volume Flow (acfm) from DB		1,504	1,504	1,504	1,504	1,504
Velocity (ft/sec)= Volume flow (acfm) from DB ÷ [((diameter)²÷ 4) x 3.14159] ÷ 60 sec/min						
Volume Flow (acfm) from DB		1,504	1,504	1,504	1,504	1,504
Diameter (ft)		18.0	18.0	18.0	18.0	18.0
Velocity (ft/sec)		0.1	0.1	0.1	0.1	0.1

Note: Universal gas constant= 1,545 ft-lb(force)/°R; atmospheric pressure= 2,116.8 lb(force)/ft²

Source: Destec Engineering, Inc., 1992

Table A-13A. Maximum Emissions of Other Regulated Pollutants for DETEC Central Florida Cogeneration Facility
Duct Burner, Supplemental Firing, Natural Gas

Pollutant	Units	Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8760	8760	8760	8760	8760
Arsenic (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Beryllium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Mercury (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Fluoride (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Sulfuric Acid Mist (lb/hr) = Fraction of SO2 Emission Rate x SO2 Emission Rate x lb H2SO4/lb SO2						
Fraction SO2 (%)		8	8	8	8	8
SO2 (lb/hr)		0.30	0.30	0.30	0.30	0.30
lb H2SO4/lb SO2 (98/64)		1.53	1.53	1.53	1.53	1.53
lb/hr		3.68E-02	3.68E-02	3.68E-02	3.68E-02	3.68E-02
TPY		1.61E-01	1.61E-01	1.61E-01	1.61E-01	1.61E-01

Source: EPA, 1990

Table A-14A. Maximum Emissions of Non-Regulated Pollutants for DESTEC Central Florida Cogeneration Facility-Duct Burner, Supplemental Firing, Natural Gas

Pollutant	Units	Natural Gas 27 °F	Natural Gas 64 °F	Natural Gas 72 °F	Natural Gas 79 °F	Natural Gas 97 °F
A	B	C	D	E	F	G
Hours of Operation		8760	8760	8760	8760	8760
Manganese (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Nickel (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Cadmium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Chromium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Copper (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Vanadium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Selenium (lb/hr)= Negligible						
Basis, lb/10E+12 Btu (1)		NA	NA	NA	NA	NA
HIR (MMBtu/hr)		NA	NA	NA	NA	NA
lb/hr		NA	NA	NA	NA	NA
TPY		NA	NA	NA	NA	NA
Polycyclic Organic Matter (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		1.113	1.113	1.113	1.113	1.113
HIR (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
lb/hr		1.11E-04	1.11E-04	1.11E-04	1.11E-04	1.11E-04
TPY		4.87E-04	4.87E-04	4.87E-04	4.87E-04	4.87E-04
Formaldehyde (lb/hr)= Basis (lb/10E+12 Btu) x Heat Input Rate (MMBtu/hr) ÷ 1,000,000 MMBtu/10E+12 Btu						
Basis, lb/10E+12 Btu (1)		88.12	88.12	88.12	88.12	88.12
HIR (MMBtu/hr)		100.0	100.0	100.0	100.0	100.0
lb/hr		8.81E-03	8.81E-03	8.81E-03	8.81E-03	8.81E-03
TPY		3.86E-02	3.86E-02	3.86E-02	3.86E-02	3.86E-02

Source: (1) EPA, 1990

GE PG 7221 FA
DISTILLATE OIL
BASE LOAD
27°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS (BASE LOAD)

(From Table A-1 On Distillate Oil;
All Other Calculations on Spreadsheet are Identical.)

Table A-1: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

183,700 x 10,070/10^6 = 1,849.9 x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,849.9 x 10^6 ÷ 18,550 = 99,723 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,743,000 lb/hr x 1,545 x (1,060°F + 460°F) ÷ (28.25 x 2,116.8 lb/ft^2)
÷ 60(min/hr)

= 2,450,287 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,743,000 lb/hr x 1,545 x (68°F + 460°F) ÷ (28.25 x 2,116.8) ÷ 60

= 851,152 scfm

GE PG7221FA
Distillate Oil
Base Load
27°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,450,287 acfm x (205°F + 460°F) + (1,060°F + 460°F)

= 1,072,001 acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

1,072,001 ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

= 70.2 ft/sec

Table A-2:

PM emissions in tons per year

17 lb/hr x 300 hr/yr + 2,000 lb/ton

= 2.6 ton/yr

SO_2 Emissions--Oil (lb/hr)

99,722.9 lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

= 99.72 lb/hr

NO_x Emissions (lb/hr) - See Note B:

42 ppm x [20.9 x (1 - 11.59/100) - 10.96] x 2,116.8 lb/ft^2
x 2,450,287 ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (1,060°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

= 326.2 lb/hr

GE PG7221 FA
Distillate Oil
Base Load
27°F

CO Emissions (lb/hr) - See Note C:

30 ppm x (1 - 11.59/100) x 2,450,287 acfm x 2,116.8 lb/ft^2 x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (1,060°F + 460°F) x 10^6)

= 98.4 lb/hr

VOC Emissions (lb/hr) - See Note C:

~~3.5~~ 4.0 ppm x (1-11.59/100) x 2,450,287 acfm x 2,116.8 lb/ft^2 x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (1,060°F + 460°F) x 10^6)

= ~~6.56~~ 7.50 lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr

Table A-3:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

99,722.9 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x ~~0.05~~ 0.08 (converted)

= 12.2 lb/hr

Tables A-4 and A-5:

EPA emission factor as noted in printout; example for manganese:

1,849.9 (MMBtu) x 14 lb/10^{12} Btu

= 2.59 x 10^{-2} lb/hr

Emission Calculations, Tables A-3, A-4, A-5

Manufacturer/Model: GE PG7221FA
Fuel Type: Distillate Oil
Load: Base
Ambient Temperature: 27°F

Arsenic: 4.2 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 7.77×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.62×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.55×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 6.02×10^{-2} lb/hr

Nickel: 170.0 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.314 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.94×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 8.79×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.518 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.129 lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.33×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.14×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.749 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.04×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.61×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.68×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1849.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.26 lb/hr

Chlorine: 0.5 ppm x 99722.9 lb/hr fuel oil + 10^6 = 4.99×10^{-2} lb/hr

GE PG7221 FA
DISTILLATE OIL
BASE LOAD
72°F

7-29-92

12018C2/APPA-1
06/13/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT
EXAMPLE CALCULATIONS - ~~27~~ 72°F CONDITIONS (BASE LOAD)
(From Table A-1 On Distillate Oil;
All Other Calculations on Spreadsheet are Identical.)

Table A-1: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 159,200 x ~~10,070~~ 10,320 / 10^6 = ~~1,849.9~~ 1,642.9 x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,642.9 x 10^6 ÷ 18,550 = ~~99,723~~ 88,568.4 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 3,390,000 lb/hr x 1,545 x (~~1,060~~ 1,102°F + 460°F) ÷ (~~28.25~~ 28.15 x 2,116.8 lb/ft²)
÷ 60(min/hr)

= ~~2,450,287~~ 2,288,314 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 3,390,000 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.15 x 2,116.8) ÷ 60

= ~~851,152~~ 773,514 scfm

GE PG7221FA
Distillate Oil
Base Load
72°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

~~2,450,287~~ 2,288,314 acfm x (205°F + 460°F) ÷ (~~1,060~~ 1,102°F + 460°F)

- ~~1,072,001~~ 974,218 acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

~~1,072,001~~ 974,218 ft^3/min ÷ 60 ÷ (18.0^2 x 3.14159)

- ~~70.2~~ 63.8 ft/sec

Table A-2:

PM emissions in tons per year

17 lb/hr x 300 hr/yr ÷ 2,000 lb/ton

- 2.6 ton/yr

SO_2 Emissions--Oil (lb/hr)

~~99,722.9~~ 88,568.4 lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

- ~~99.72~~ 88.57 lb/hr

NO_x Emissions (lb/hr) - See Note B:

42 ppm x [20.9 x (1 - ~~11.59~~ 12.40/100) - ~~10.96~~ 10.95] x 2,116.8 lb/ft^2
x ~~2,450,287~~ 2,288,314 ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~ 1,102°F + 460°F)
x 5.9×10^6 (adjust for ppm)]

- ~~326.2~~ 290.2 lb/hr

GE PG7221 FA
Distillate Oil
Base Load
72°F

CO Emissions (lb/hr) - See Note C:

30 ppm x (1 - ~~11.59~~ 12.40/100) x ~~2,450,287~~ 2,288,314 acfm x 2,116.8 lb/ft^2 x 28 (molecular wgt. of carbon)

x 60 min/hr + (1,545 x (~~1,060~~ 1,102°F + 460°F) x 10^6)

= ~~98.4~~ 88.6 lb/hr

VOC Emissions (lb/hr) - See Note C:

~~3.5~~ 3.9 ppm x (1-~~11.59~~ 12.40/100) x ~~2,450,287~~ 2,288,314 acfm x 2,116.8 lb/ft^2 x 16 (molecular wgt. of methane)

x 60 min/hr + (1,545 x (~~1,060~~ 1,102°F + 460°F) x 10^6)

= ~~6.56~~ 6.58 lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x ~~1,849.9~~ 1,642.9 x 10^6 Btu/hr = ~~1.65~~ 1.46 x 10^{-2} lb/hr

Table A-3:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

~~99,722.9~~ 88,568.4 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x ~~0.05~~ 0.08 (converted)

= ~~12.2~~ 10.8 lb/hr

Tables A-4 and A-5:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9~~ 1,642.9 (MMBtu) x 14 lb/10^{12} Btu

= ~~2.59~~ 2.30 x 10^{-2} lb/hr

Emission Calculations, Tables A-3, A-4, A-5

Manufacturer/Model: GE PG7221FA
Fuel Type: Distillate Oil
Load: Base
Ambient Temperature: 72°F

Arsenic: 4.2 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 6.9×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.11×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.93×10^{-3} lb/hr

Fluoride: 14 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.35×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.279 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.73×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 7.8×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.460 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.114 lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.85×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.57×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.665 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.59×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.21×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.49×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1642.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.12 lb/hr

Chlorine: 0.5 ppm x 88568.4 lb/hr fuel oil + 10^6 = 4.43×10^{-2} lb/hr

GE PG7221FA
DISTILLATE OIL
BASE LOAD
97°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 97°F CONDITIONS (BASE LOAD)

(From Table A-1 On Distillate Oil;

All Other Calculations on Spreadsheet are Identical.)

Table A-1: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

142,500 10,650 1,517.6
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,517.6 81,812.7
~~1,849.9~~ x 10^6 ÷ 18,550 = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,189,000 1,127 28.10
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,190,589
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,189,000 28.10
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

= ~~851,152~~ scfm
728,816

GE PG7221FA
Distillate Oil
Base Load
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,190,589 ~~2,450,287~~ acfm x (205°F + 460°F) ÷ (1,127 ~~1,060~~°F + 460°F)

= 917,922 ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft³/min) ÷ Area (ft²) ÷ 60 sec/min

917,922 ~~1,072,001~~ ft³/min ÷ 60 ÷ (18.0² ÷ 4 x 3.14159)

= 60.1 ~~70.2~~ ft/sec

Table A-2:

PM emissions in tons per year

17 lb/hr x 300 hr/yr ÷ 2,000 lb/ton

= 2.6 ton/yr

SO_2 Emissions--Oil (lb/hr)

81,812.7 ~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

= 81.81 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

42 ppm x [20.9 x (1 - ~~11.59~~/100) - 12.71 ~~10.96~~] x 2,116.8 lb/ft² x 2,190,589 ~~2,450,287~~ ft³/min x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,127 ~~1,060~~°F + 460°F) x 5.9 x 10^6 (adjust for ppm)] x 11.03

= 268.0 ~~326.2~~ lb/hr

GE PG7221 FA
Distillate Oil
Base Load
97°F

CO Emissions (lb/hr) - See Note C:

30 ppm x (1 - ~~11.59~~ 12.71/100) x ~~2,450,287~~ 2,190,589 acfm x 2,116.8 lb/ft^2 x 28 (molecular wgt. of carbon)

x 60 min/hr + (1,545 x (~~1,060~~ 1,127°F + 460°F) x 10^6)

= ~~98.4~~ 83.2 lb/hr

VOC Emissions (lb/hr) - See Note C:

~~3.5~~ 4.1 ppm x (1-~~11.59~~ 12.71/100) x ~~2,450,287~~ 2,190,589 acfm x 2,116.8 lb/ft^2 x 16 (molecular wgt. of methane)

x 60 min/hr + (1,545 x (~~1,060~~ 1,127°F + 460°F) x 10^6)

= ~~6.56~~ 6.50 lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x ~~1,849.9~~ 1,517.6 x 10^6 Btu/hr = ~~1.65~~ 1.35 x 10^{-2} lb/hr

Table A-3:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

~~99,722.9~~ 81,812.7 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x ~~0.05~~ 0.08 (converted)

= ~~12.2~~ 10.0 lb/hr

Tables A-4 and A-5:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9~~ 1,517.6 (MMBtu) x 14 lb/10^{12} Btu

= ~~2.59~~ 2.12 x 10^{-2} lb/hr

Emission Calculations, Tables A-3, A-4, A-5

Manufacturer/Model: GE PG7221FA
Fuel Type: Distillate Oil
Load: Base
Ambient Temperature: 97°F

Arsenic: 4.2 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 6.37×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.79×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.55×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.94×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.258 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.59×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 7.21×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.425 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.105 lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.55×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.22×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.615 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.32×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.96×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.38×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1517.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.04 lb/hr

Chlorine: 0.5 ppm x 81,812.7 lb/hr fuel oil + 10^6 = 4.09×10^{-2} lb/hr

GE PG 7221 FA
NATURAL GAS
BASE LOAD
27 °F

12018C2/APPA-1
~~06/13/92~~
7/29/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS

(From Table A-6 On ~~Distillate Oil~~ Natural Gas; Base Load
All Other Calculations on Spreadsheet are Identical.)

Table A-~~5~~ 6: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

170,700 9460 1,614.8
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,614.8 21,515 75,055.6
~~1,849.~~9 x 10^6 ÷ ~~18,550~~ = ~~99,725~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,582,000 1,078 28.46
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,354,349
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,582,000 28.46
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

808,255
= ~~851,152~~ scfm

GE PG7221 FA
Natural Gas
Base Load
27°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,354,349 / ~~2,450,287~~ acfm x (205°F + 460°F) ÷ (1,078 / ~~1,060~~°F + 460°F)

= 1,017,973 / ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

1,017,973 / ~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

= 66.7 / ~~70.2~~ ft/sec

Table A-~~2~~ 7:

PM emissions in tons per year

9.0 / ~~17~~ lb/hr x 8460 / ~~300~~ hr/yr ÷ 2,000 lb/ton

= 38.07 / ~~2.6~~ ton/yr

SO_2 Emissions - ~~Oil~~ Gas (lb/hr)

1,699,813 cf/hr / ~~99,722.9 lb/hr~~ x 1.0 gr/100 cf / ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

= 4.86 / ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 / ~~42~~ ppm x [20.9 x (1 - 7.61 / ~~11.59~~/100) - 12.71 / ~~10.96~~] x 2,116.8 lb/ft^2

x 2,354,349 / ~~2,450,287~~ ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,078 / ~~1,060~~°F + 460°F)

x 5.9 x 10^6 (adjust for ppm)]

= 161.9 / ~~326.2~~ lb/hr

GE PG7221FA
Natural Gas
Base Load
27°F

CO Emissions (lb/hr) - See Note C:

15 ~~50~~ ppm x (1 - 7.61 ~~11.59~~/100) x 2,354,349 ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
x 60 min/hr ÷ (1,545 x (1,078 ~~1,060~~°F + 460°F) x 10^6)
= 48.8 ~~90.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 ~~3.5~~ ppm x (1-7.61 ~~11.59~~/100) x 2,354,349 ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
x 60 min/hr ÷ (1,545 x (1,078 ~~1,060~~°F + 460°F) x 10^6)
= 2.79 ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-8 ~~4~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,699,813 cf/hr x 1.0 gr/100cf x 2 lb SO_2/lb S x 1.0 lb/7000gr x 0.08 / 0.05 x 1.53 lb H_2S_4 / lb S

~~99,722.9 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S~~
(converted)
= 0.595 ~~12.2~~ lb/hr

Tables A-8, A-9, A-10 ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/29/92

Emission Calculations, Tables A-8, A-9, A-10

Manufacturer/Model: GE PG 7221 FA
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 27°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1614.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.8×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1614.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.142 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

'GE PG7221 FA
NATURAL GAS
BASE LOAD
64 °F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 64 ~~27~~°F CONDITIONS

(From Table A-6 On Natural Gas ~~Distillate Oil~~: Base Load

All Other Calculations on Spreadsheet are Identical.)

Table A-6 ~~5~~: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

151,900 9,750 1,481.0
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,481.0 21,515 68,836.9
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,322,000 1,110 28.33
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,239,805
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,322,000 28.33
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

753,259
= ~~851,152~~ scfm

GE PG7221 FA
Natural Gas
Base Load
64°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,239,805 ~~2,450,287~~ acfm x (205 ~~205~~°F + 460°F) + (1,110 ~~1,060~~°F + 460°F)

= 948,707 ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

948,707 ~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

= 62.1 ~~70.2~~ ft/sec

Table A-7 ~~8~~:

PM emissions in tons per year

9.0 ~~17~~ lb/hr x 8460 ~~300~~ hr/yr + 2,000 lb/ton

= 38.07 ~~2.6~~ ton/yr

SO_2 Emissions--Gas ~~Oil~~ (lb/hr)

1,558,974 cf/hr ~~99,722.9 lb/hr~~ x 1.0 gr/100 cf ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

= 4.45 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 ~~42~~ ppm x [20.9 x (1 - 8.83 ~~11.59~~/100) - 12.56 ~~10.96~~] x 2,116.8 lb/ft^2 x 2,239,805 ~~2,450,287~~ ft^3/min x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,110 ~~1,060~~°F + 460°F) x 5.9 x 10^6 (adjust for ppm)]

= 148.5 ~~126.2~~ lb/hr

GE PG7221 FA
Natural Gas
Base Load
64°F

CO Emissions (lb/hr) - See Note C:

15 (~~30~~) ppm x (1 - 8.83 (~~11.59~~)/100) x 2,239,805 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr + (1,545 x (1,110 (~~1,060~~)°F + 460°F) x 10^6)

= 44.9 (~~98.4~~) lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 (~~3.3~~) ppm x (1- 8.83 (~~11.59~~)/100) x 2,239,805 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr + (1,545 x (1,110 (~~1,060~~)°F + 460°F) x 10^6)

= 2.57 (~~6.56~~) lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-8 (~~3~~):

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,558,974 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr

~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08 (converted)

= 0.546 (~~12.2~~) lb/hr

Tables ~~A-4 and A-5~~ A-8, A-9, A-10:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/29/92

Emission Calculations, Tables A-8, A-9, A-10

Manufacturer/Model: GE PG7221FA
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 64°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1481.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.65×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1481.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.131 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

GE PG 7221 FA
NATURAL GAS
72°F
BASE LOAD

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 72 °F CONDITIONS

(From Table A-~~1~~ 6 On ~~Distillate Oil~~ Natural Gas; Base Load

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

147,100 9860 1,450.4
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,450.4 21,615 67,413.7
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,262,000 1,117 28.28
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,212,530
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,262,000 28.28
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

740,784
= ~~851,159~~ scfm

GE PG7221 FA
Natural Gas
72°F
Base Load

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,212,530
~~2,450,287~~ acfm x (205°F + 460°F) + (~~1,060~~ 1,117 °F + 460°F)

932,995
- ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

932,995
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

61.1
- ~~70.2~~ ft/sec

Table A-~~2~~ 7:

PM emissions in tons per year

9.0 8460
~~17~~ lb/hr x ~~300~~ hr/yr + 2,000 lb/ton

38.07
- ~~3.6~~ ton/yr

SO_2 Emissions--~~Oil~~ Gas (lb/hr)

1,526,743 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

4.36
- ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 9.21 12.51
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2

x ~~2,450,287~~ 2,212,530 ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (~~1,060~~ 1,117 °F + 460°F)

x 5.9 x 10^6 (adjust for ppm)]

145.3
- ~~326.2~~ lb/hr

GE PG7221FA
Natural Gas
Base Load
72°F

CO Emissions (lb/hr) - See Note C:

15 (~~50~~) ppm x (1 - 9.21 (~~11.59~~)/100) x 2,212,530 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (1,117 (~~1,060~~)°F + 460°F) x 10^6)

44.0 (~~98.4~~) lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 (~~3.5~~) ppm x (1- 9.21 (~~11.59~~)/100) x 2,212,530 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (1,117 (~~1,060~~)°F + 460°F) x 10^6)

2.51 (~~6.56~~) lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-8 (~~6~~):

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,526,743 cf/hr x 1.0 gr/100cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr x 0.08

~~99,722.9 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb SO_2 x 0.05~~

(converted) 1.53

0.534 (~~12.2~~) lb/hr

Tables A-8, A-9, A-10 (~~A-4 and A-5~~):

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7-30-92

Emission Calculations, Tables A-8, A-9, A-10

Manufacturer/Model: GE PG7221 FA
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 72°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1450.4 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.61×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1450.4 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.128 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 = NA lb/hr

GE PG 7221 FA
NATURAL GAS
79°F
BASE LOAD

12018C2/APPA-1
~~06/13/92~~
7/30/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 79 °F CONDITIONS

(From Table A-~~1~~ 6 On ~~Distillate Oil~~ Natural Gas; Base Load

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 142,700 x ~~10,070~~ 9970/10^6 = ~~1,849.9~~ 1,422.7 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,422.7 x 10^6 ÷ ~~18,550~~ 21,515 = ~~99,723~~ 66,126.8 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 3,202,000 lb/hr x 1,545 x (~~1,060~~ 1,124°F + 460°F) ÷ (~~28.25~~ 28.19 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 2,188,744 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 3,202,000 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.19 x 2,116.8) ÷ 60

= ~~851,152~~ 729,581 scfm

GE PG7221FA
Natural Gas
79°F
Base Load

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,188,744 ~~2,450,287~~ acfm x (205°F + 460°F) ÷ (1,124 ~~1,060~~°F + 460°F)

× 918,885 ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

916,885 ~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

× 60.2 ~~70.2~~ ft/sec

Table A-7 ~~2~~:

PM emissions in tons per year

9.0 ~~17~~ lb/hr x 8460 ~~300~~ hr/yr ÷ 2,000 lb/ton

× 38.07 ~~2.6~~ ton/yr

SO_2 Emissions--Gas ~~Oil~~ (lb/hr)

1,497,599 cf/hr ~~99,722.9 lb/hr~~ x 1.0 gr/100 cf ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

× 4.28 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 ~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - 10.05 ~~10.96~~] x 12.36 x 2,116.8 lb/ft^2

x 2,188,744 ~~2,450,287~~ ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,124 ~~1,060~~°F + 460°F)

x 5.9 x 10^6 (adjust for ppm)]

× 142.6 ~~326.2~~ lb/hr

PG 7221 FA
Natural Gas
Base Load
79°F

CO Emissions (lb/hr) - See Note C:

15 (10.05) (2,188,744)
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
(1,124)
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
42.9
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

1.6 (10.05) (2,188,744)
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
(1,124)
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
2.62
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

8
Table A-~~9~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,497,599 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr x 0.08
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~
(converted)
0.524
= ~~12.2~~ lb/hr

A-8, A-9, A-10
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/30/92

Emission Calculations, Tables A-8, A-9, A-10

Manufacturer/Model: GE PG7221 FA
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 79°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1422.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.58×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1422.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.125 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

GE PG 7221 FA
NATURAL GAS
BASE LOAD
97 °F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 97 ~~27~~ °F CONDITIONS

(From Table A-6 ~~1~~ On Natural Gas ~~Distillate Oil~~; Base Load

All Other Calculations on Spreadsheet are Identical.)

Table A-6 ~~1~~: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

131,800 10,230 1348.3
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1348.3 21,515 62,668.6
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,077,000 1,140 28.20
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~ °F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,123,643
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,077,000 28.20
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

700,802
= ~~851,152~~ scfm

GE PG 7221 FA
Natural Gas
Base Load
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,123,643 ~~2,450,287~~ acfm x (205°F + 460°F) ÷ (1,140 ~~1,060~~°F + 460°F)

882,639 - ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

882,639 ~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

57.8 - ~~70.2~~ ft/sec

Table A-7 ~~8~~:

PM emissions in tons per year

9.0 ~~17~~ lb/hr x 8460 ~~300~~ hr/yr ÷ 2,000 lb/ton

38.07 = ~~2.6~~ ton/yr

SO_2 Emissions--~~Oil~~ Gas (lb/hr)

1,419,278 cf/hr ~~99,722.9 lb/hr~~ x 1.0 gr/100 cf ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

4.06 = ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 ~~42~~ ppm x [20.9 x (1 - 9.91 ~~11.59~~/100) - 12.48 ~~10.96~~] x 2,116.8 lb/ft^2 x 2,123,643 ~~2,450,287~~ ft^3/min x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,140 ~~1,060~~°F + 460°F) x 5.9 x 10^6 (adjust for ppm)]

135.0 - ~~326.2~~ lb/hr

GE PG7221FA
Natural Gas
Base Load
97°F

CO Emissions (lb/hr) - See Note C:

15 9.91 2,123,643
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)

1,140
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

41.3
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 9.91 2,123,643
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)

1,140
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

2.36
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~0.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

8
Table A-~~5~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,419,278 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)

0.497
= ~~12.2~~ lb/hr

A-8, A-9, A-10
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/30/92

Emission Calculations, Tables A-8, A-9, A-10

Manufacturer/Model: GE PG7221 FA
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 97°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1348.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.50×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1348.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.119 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 = NA lb/hr

GE PG7221 FA
DISTILLATE OIL
70% LOAD
27 °F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS (70% LOAD)

(From Table A-1A On Distillate Oil;

All Other Calculations on Spreadsheet are Identical.)

Table A-1A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

129,200 11,430 1,476.8
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) + Fuel Heat Content (Btu/lb)

1,476.8 79,609.5
~~1,849.9~~ x 10^6 + 18,550 = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,837,000 1,166 28.23
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) + (~~28.25~~ x 2,116.8 lb/ft^2)

+ 60(min/hr)

1,988,010
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,837,000 28.23
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) + (~~28.25~~ x 2,116.8) + 60

= ~~851,152~~ scfm
645,553

GE PG7221FA
Distillate Oil
70% Load
27°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,988,010
~~2,450,287~~ acfm x (200 ~~205~~°F + 460°F) ÷ (1,166 ~~1,060~~°F + 460°F)

= ~~1,072,001~~ 806,941 acfm

Velocity (ft/sec):

Volume Flow (ft³/min) ÷ Area (ft²) ÷ 60 sec/min

806,941
~~1,072,001~~ ft³/min ÷ 60 ÷ (18.0² ÷ 4 x 3.14159)

= 52.9 ~~70.2~~ ft/sec

Table A-2A:

PM emissions in tons per year

17 lb/hr x 300 hr/yr ÷ 2,000 lb/ton

= 2.6 ton/yr

SO_2 Emissions--Oil (lb/hr)

79,609.5
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

= 79.61 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

42 ppm x [20.9 x (1 - ~~11.59~~ 11.96/100) - ~~10.96~~ 10.57] x 2,116.8 lb/ft²
x ~~2,450,287~~ 1,988,010 ft³/min
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,166 ~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

= 257.7 ~~326.2~~ lb/hr

GE PG7221 FA
Distillate Oil
70% Load
27°F

CO Emissions (lb/hr) - See Note C:

30 ppm x (1 - ~~11.59~~ 11.96/100) x ~~2,450,287~~ 1,988,010 acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,166°F + 460°F) x 10^6)

- ~~98.4~~ 74.3 lb/hr

VOC Emissions (lb/hr) - See Note C:

~~3.5~~ 4.0 ppm x (1-~~11.59~~ 11.96/100) x ~~2,450,287~~ 1,988,010 acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,166°F + 460°F) x 10^6)

- ~~6.56~~ 5.66 lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x ~~1,849.9~~ 1,476.8 x 10^6 Btu/hr = ~~1.65~~ 1.31 x 10^{-2} lb/hr

Table A-3A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

~~99,722.9~~ 79,609.5 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x ~~0.05~~ 0.08 (converted)

- ~~12.2~~ 9.75 lb/hr

Tables A-4A and A-5A:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9~~ 1,476.8 (MMBtu) x 14 lb/10^{12} Btu

- ~~2.59~~ 2.07 x 10^{-2} lb/hr

Emission Calculations, Tables A-3A, A-4A, A-5A

Manufacturer/Model: GE PG7221FA
Fuel Type: Distillate Oil
Load: 70%
Ambient Temperature: 27°F

Arsenic: 4.2 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 6.2×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.69×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.43×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.8×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.251 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.55×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 7.01×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.413 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.103 lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.46×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.11×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.598 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.23×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.88×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.34×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1476.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.01 lb/hr

Chlorine: 0.5 ppm x 79609.5 lb/hr fuel oil + 10^6 = 3.98×10^{-2} lb/hr

GE PG 7221 FA
DISTILLATE OIL
70% LOAD
72°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 72°F CONDITIONS (70% LOAD)

(From Table A-1AOn Distillate Oil;

All Other Calculations on Spreadsheet are Identical.)

Table A-1A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 111,000 x ~~10,070~~ 11,800 / 10^6 = ~~1,849.9~~ 1,309.8 x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) + Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,309.8 x 10^6 + 18,550 = ~~99,723~~ 70,609.2 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,619,000 lb/hr x 1,545 x (~~1,060~~ 1,192°F + 460°F) + (~~28.25~~ 28.16 x 2,116.8 lb/ft²)

+ 60(min/hr)

= ~~2,450,287~~ 1,869,045 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,619,000 lb/hr x 1,545 x (68°F + 460°F) + (~~28.25~~ 28.16 x 2,116.8) + 60

= ~~851,152~~ 597,370 scfm

GE PG 7221FA
Distillate Oil
70% Load
72°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

~~2,450,207~~ 1,869,045 acfm x (~~205~~ 200°F + 460°F) + (~~1,060~~ 1,192°F + 460°F)
- ~~1,072,001~~ 746,713 acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

~~1,072,001~~ 746,713 ft^3/min + 60 + (18.0^2 + 4 x 3.14159)
- ~~70.2~~ 48.9 ft/sec

Table A-2A:

PM emissions in tons per year

17 lb/hr x 300 hr/yr + 2,000 lb/ton

= 2.6 ton/yr

SO_2 Emissions--Oil (lb/hr)

~~99,722.9~~ 70,609.2 lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S
- ~~99.72~~ 70.61 lb/hr

NO_x Emissions (lb/hr) - See Note B:

42 ppm x [20.9 x (1 - ~~11.59~~ 12.40/100) - ~~10.96~~ 10.81] x 2,116.8 lb/ft^2
x ~~2,450,207~~ 1,869,045 ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (~~1,060~~ 1,192°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]
- ~~326.2~~ 228.4 lb/hr

GE PG7221FA
Distillate Oil
70% Load
72°F

CO Emissions (lb/hr) - See Note C:

30 ppm x (1 - ~~11.59~~ 12.40/100) x ~~2,450,287~~ 1,869,045 acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,192°F + 460°F) x 10^6)

= ~~98.4~~ 68.4 lb/hr

VOC Emissions (lb/hr) - See Note C:

~~3.5~~ 4.0 ppm x (1-~~11.59~~ 12.40/100) x ~~2,450,287~~ 1,869,045 acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,192°F + 460°F) x 10^6)

= ~~6.56~~ 5.21 lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x ~~1,849.9~~ 1,309.8 x 10^6 Btu/hr = ~~1.65~~ 1.17 x 10^{-2} lb/hr

Table A-3A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

~~99,722.9~~ 70,609.2 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x ~~0.05~~ 0.08 (converted)

= ~~12.2~~ 8.65 lb/hr

Tables A-4A and A-5A:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9~~ 1,309.8 (MMBtu) x 14 lb/10^{12} Btu

= ~~2.59~~ 1.83 x 10^{-2} lb/hr

Emission Calculations, Tables A-3A, A-4A, A-5A

Manufacturer/Model: PG7221FA
Fuel Type: Distillate Oil
Load: 70%
Ambient Temperature: 72°F

Arsenic: 4.2 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.5×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.27×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.93×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.26×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.223 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.38×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 6.22×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.367 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 9.1×10^{-2} lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.07×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.64×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.53 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.86×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.56×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.19×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1309.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.895 lb/hr

Chlorine: 0.5 ppm x 79609.5 lb/hr fuel oil + 10^6 = 3.53×10^{-2} lb/hr

GE PG 7221 FA
DISTILLATE OIL
70% LOAD
97 °F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~47~~ 97 °F CONDITIONS (70% LOAD)

(From Table A-1A On Distillate Oil;

All Other Calculations on Spreadsheet are Identical.)

Table A-1A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 98,500 x ~~10,070~~ 12,280/10^6 = ~~1,849.9~~ 1,209.6 x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) + Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,209.6 x 10^6 + 18,550 = ~~99,723~~ 65,206.5 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,510,000 lb/hr x 1,545 x (~~1,060~~ 1,200°F + 460°F) + (~~28.25~~ 28.13 x 2,116.8 lb/ft²)

+ 60(min/hr)

= ~~2,450,287~~ 1,802,083 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,510,000 lb/hr x 1,545 x (68°F + 460°F) + (~~28.25~~ 28.13 x 2,116.8) + 60

= ~~851,159~~ 573,193 scfm

GE PG7221 FA
Distillate Oil
70% Load
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,802,083 200 1,200
~~2,450,287~~ acfm x (~~285~~°F + 460°F) + (~~1,060~~°F + 460°F)

= ~~1,072,001~~ acfm
716,491

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

716,491
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

= ~~70.2~~ ft/sec
46.9

Table A-2A:

PM emissions in tons per year

17 lb/hr x 300 hr/yr ÷ 2,000 lb/ton

= 2.6 ton/yr

SO_2 Emissions--Oil (lb/hr)

65,206.5
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

= 65.21
~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

12.48 11.07
42 ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min
1,802,083
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~°F + 460°F)
1,200
x 5.9 x 10^6 (adjust for ppm)]

211.0
= ~~326.2~~ lb/hr

GE PG7221 FA
Distillate Oil
70% Load
97°F

CO Emissions (lb/hr) - See Note C:

30 ppm x (1 - ~~11.59~~ 12.48/100) x ~~2,450,287~~ 1,802,083 acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,200°F + 460°F) x 10^6)

= ~~98.4~~ 65.6 lb/hr

VOC Emissions (lb/hr) - See Note C:

~~3.5~~ 4.1 ppm x (1-~~11.59~~ 12.48/100) x ~~2,450,287~~ 1,802,083 acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,200°F + 460°F) x 10^6)

= ~~6.56~~ 5.12 lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x ~~1,849.9~~ 1,209.6 x 10^6 Btu/hr = ~~1.65~~ 1.08 x 10^{-2} lb/hr

Table A-3A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

~~99,722.9~~ 65,206.5 lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x ~~0.05~~ 0.08 (converted)

= ~~12.2~~ 7.99 lb/hr

Tables A-4A and A-5A:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9~~ 1,209.6 (MMBtu) x 14 lb/10^{12} Btu

= ~~2.59 x 10^{-2}~~ 1.69 x 10^{-2} lb/hr

Emission Calculations, Tables A-3A, A-4A, A-5A

Manufacturer/Model: GE PG7221 FA
Fuel Type: Distillate Oil
Load: 70%
Ambient Temperature: 97°F

Arsenic: 4.2 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.08×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.02×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.63×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.94×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.206 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.27×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.75×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.339 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 8.41×10^{-2} lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.83×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.36×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.490 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.64×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.36×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.10×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1209.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.826 lb/hr

Chlorine: 0.5 ppm x 65206.5 lb/hr fuel oil + 10^6 = 3.26×10^{-2} lb/hr

GE PG7221 FA
NATURAL GAS
70% LOAD
27°F

12018C2/APPA-1
~~06/13/92~~
7/30/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS

(From Table A-~~1~~ 6A On ~~Distillate Oil~~ Natural Gas; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

119,900 10,770 1291.3
~~183,700~~ x ~~10,070/10~~^{6} = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,291.3 21515 60,019.7
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,744,000 1,177 28.45
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft^2)

÷ 60(min/hr)

1,920,685
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,744,000 28.45
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

619,500
= ~~851,152~~ scfm

GE PG7221 FA
Natural Gas
70% LOAD
27°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,920,685 ~~2,450,287~~ acfm x (200 ~~205~~°F + 460°F) ÷ (1,177 ~~1,060~~°F + 460°F)

= 774,375 ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft³/min) ÷ Area (ft²) ÷ 60 sec/min

774,375 ~~1,072,001~~ ft³/min ÷ 60 ÷ (18.0² ÷ 4 x 3.14159)

= 50.7 ~~70.2~~ ft/sec

7A
Table A-~~2~~:

PM emissions in tons per year

9.0 ~~17~~ lb/hr x 8460 ~~300~~ hr/yr ÷ 2,000 lb/ton

= 38.07 ~~2.6~~ ton/yr

SO_2 Emissions - GAS ~~Oil~~ (lb/hr)

1,359,287 cf/hr ~~29,722.9 lb/hr~~ x 1.0 gr/100 cf ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

= 3.88 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 ~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - 7.84 ~~10.96~~] x 2,116.8 lb/ft² x 1,920,685 ~~2,450,287~~ ft³/min x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,177 Stet ~~1,545~~ x (1,177 ~~1,060~~°F + 460°F) x 5.9 x 10^6 (adjust for ppm)]

= 127.9 ~~326.2~~ lb/hr

GE PG7221 FA
Natural Gas
70% LOAD
27°F

CO Emissions (lb/hr) - See Note C:

15 7.84 1,920,685
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)
1,177
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
373
- ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 7.84 1,920,685
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)
1,177
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
2.13
- ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

8A
Table A-~~8~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,359,287 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/Hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)
0.476
- ~~12.2~~ lb/hr

A-8A, A-9A, A-10A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

1

7/30/92

Emission Calculations, Tables A-8A, A-9A, A-10A

Manufacturer/Model: GE PG7221 FA
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 27°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1291.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.44×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1291.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.114 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

GE PG 7221 FA
NATURAL GAS
70% LOAD
64°F

12018C2/APPA-1
~~06/13/92~~
7/30/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 64 °F CONDITIONS

(From Table A-~~1~~ 6A On ~~Distillate Oil~~ Natural Gas; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 106,500 x ~~10,070~~ 11,070/10^6 = ~~1,849.9~~ 1,179.0 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,179.0 x 10^6 ÷ ~~18,550~~ 21,515 = ~~99,723~~ 54,796.9 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,595,000 lb/hr x 1,545 x (~~1,060~~ 1,195°F + 460°F) ÷ (~~28.25~~ 28.32 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 1,845,077 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,595,000 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.32 x 2,116.8) ÷ 60

= ~~851,132~~ 588,641 scfm

GE PG7221 FA
Natural Gas
70% LOAD
61°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,845,077 200 1,195
~~2,450,287~~ acfm x (~~205~~°F + 460°F) + (~~1,060~~°F + 460°F)

735,801
- ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

735,901
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

48.2
- ~~70.2~~ ft/sec

A-7A
Table ~~A-2~~:

PM emissions in tons per year

9.0 8460
~~17~~ lb/hr x ~~300~~ hr/yr + 2,000 lb/ton

38.07
- ~~2.6~~ ton/yr

GAS
SO_2 Emissions--~~Oil~~ (lb/hr)

1,241,005 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/~~hr x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1lb/7000 gr

3.55
- ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 8.98 12.41
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min

1,845,077
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (~~1,060~~°F + 460°F)
1,195
x 5.9 x 10^6 (adjust for ppm)]

118.1
- ~~326.2~~ lb/hr

GE PG7221 FA
Natural Gas
70% Load
64°F

CO Emissions (lb/hr) - See Note C:

15 (~~30~~) ppm x (1 - ~~11.59~~ 8.98/100) x ~~2,450,287~~ 1,845,077 acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,195 °F + 460°F) x 10^6)

~~98.4~~ 35.0 lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 (~~3.5~~) ppm x (1 - ~~11.59~~ 8.98/100) x ~~2,450,287~~ 1,845,077 acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (~~1,060~~ 1,195 °F + 460°F) x 10^6)

~~6.56~~ 2.00 lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table ~~A-3~~ A-8A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,241,005 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/165 x 1.0 lb/7000 gr

~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.63 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08 (converted)

~~12.2~~ 0.434 lb/hr

Tables ~~A-4 and A-5~~ A-8A, A-9A, A-10A:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

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Emission Calculations, Tables A-8A, A-9A, A-10A

Manufacturer/Model: GE PG7221 FA
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 64°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1179.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.31×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1179.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.104 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

GE PG7221 FA
NATURAL GAS
70% LOAD
72°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 72 °F CONDITIONS

(From Table A-~~1~~ 6A On ~~Distillate Oil~~ NATURAL GAS; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

103,100 11,340 1169.2
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1169.2 21,515 54,341.3
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,560,000 1,199 28.27
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

1,827,352
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,560,000 28.27
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

581,580
= ~~851,152~~ scfm

GE PG 7221 FA
Natural Gas
70% LOAD
72°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,827,352 200 1,199
~~2,450,287~~ acfm x (~~205~~°F + 460°F) ÷ (~~1,060~~°F + 460°F)

726,975
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

726,975
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

47.6
= ~~70.2~~ ft/sec

7A
Table A-~~2~~:

PM emissions in tons per year

9.0 8460
~~17~~ lb/hr x ~~300~~ hr/yr ÷ 2,000 lb/ton

38.07
= ~~2.6~~ ton/yr

Gas
SO_2 Emissions--~~Oil~~ (lb/hr)

1,230,688 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

3.52
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 9.34 12.39
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min
1,827,352
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~°F + 460°F)
1,199
x 5.9 x 10^6 (adjust for ppm)]

115.7
= ~~326.2~~ lb/hr

GE PG7221FA
Natural Gas
70% Load
72°F

CO Emissions (lb/hr) - See Note C:

15 (~~30~~) ppm x (1 - 9.34 (~~11.59~~)/100) x 1,827,352 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (1,199 (~~1,060~~)°F + 460°F) x 10^6)

= 34.5 (~~98.4~~) lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 (~~3.5~~) ppm x (1-9.34 (~~11.59~~)/100) x 1,827,352 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (1,199 (~~1,060~~)°F + 460°F) x 10^6)

= 2.00 (~~6.56~~) lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-8A (~~3~~):

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,230,688 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.016/7000 gr ÷ (~~99,722.9 lb/hr x 0.0005 lb S/lb~~) x 3.06 (1.53) lb H_2SO_4/lb SO_2 x 0.08 (~~0.05~~)

(converted)

= 0.431 (~~12.2~~) lb/hr

Tables A-8A, A-9A, A-10A (~~A-4 and A-5~~):

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/30/92

Emission Calculations, Tables A-8A, A-9A, A-10A

Manufacturer/Model: GE PG7221FA
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 72°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1169.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.3×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1169.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.103 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

GE PG7221 FA
NATURAL GAS
70% LOAD
79°F

12018C2/APPA-1
~~06/13/92~~
7/30/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 79 °F CONDITIONS

(From Table A-~~1~~ 6A On ~~Distillate Oil~~ NATURAL GAS; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

99,500 11,510 1,145.2
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,145.2 21,515 53,230.1
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,524,000 1,200 28.18
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

1,808,470
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,524,000 28.18
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

575,224
= ~~851,152~~ scfm

GE PG7221 FA
Natural Gas
70% LOAD
79°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,808,470 200 1,200
~~2,450,287~~ acfm x (~~205~~°F + 460°F) + (~~1,060~~°F + 460°F)

719,030
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

719,030
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

47.1
= ~~70.2~~ ft/sec

7A
Table A-~~8~~:

PM emissions in tons per year

9.0 8460
~~17~~ lb/hr x ~~300~~ hr/yr + 2,000 lb/ton

38.07
= ~~2.6~~ ton/yr

GAS
SO_2 Emissions- ~~Oil~~ (lb/hr)

1,205,521 cf/hr 1.0 gr/100 cf
~~99.722 9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

3.44
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 10.14 12.28
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min
1,808,470
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (1,200 ~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

113.5
= ~~326.2~~ lb/hr

GE PG7221 FA
Natural Gas
70% LOAD
79°F

CO Emissions (lb/hr) - See Note C:

15 10.14 1,808 470
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
1,200
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
338
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

1.6 10.14 1,808 470
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
1,200
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
2.06
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

A-8A
Table ~~A-3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,205,521 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr 0.08
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~
(converted)
0.422
= ~~12.2~~ lb/hr

A-8A, A-9A, A-10A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/30/92

Emission Calculations, Tables A-8A, A-9A, A-10A

Manufacturer/Model: PG 7221 FA
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 79°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1145.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.27×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1145.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.101 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

GE PG 7221 FA
NATURAL GAS
70% LOAD
97 °F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 97 °F CONDITIONS

(From Table A-~~1~~ 6A On ~~Distillate Oil~~ NATURAL GAS; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 6A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 90,900 x ~~10,070~~ 11,890/10^6 = ~~1,849.9~~ 1,080.8 x 10^6 Btu/hr

NATURAL GAS
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.~~1,080.8 x 10^6 ÷ ~~18,550~~ 21,515 = ~~99,723~~ 50,234.8 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,454,000 lb/hr x 1,545 x (~~1,060~~ 1,200 °F + 460°F) ÷ (~~28.25~~ 28.20 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 1,757,157 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,454,000 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.20 x 2,116.8) ÷ 60

= ~~851,152~~ 558,903 scfm

GE PG7221 FA
Natural Gas
70% LOAD
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,757,157 200 1,200
~~2,450,287~~ acfm x (~~205~~°F + 460°F) + (~~1,060~~°F + 460°F)

698,629
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

698,629
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

45.8
= ~~70.2~~ ft/sec

7A
Table A-~~2~~:

PM emissions in tons per year

9.0 8460
~~17~~ lb/hr x ~~300~~ hr/yr + 2,000 lb/ton

38.07
= ~~2.6~~ ton/yr

GAS
SO_2 Emissions--~~Oil~~ (lb/hr)

1,137,685 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

3.25
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25 9.89 12.52
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min
1,757,157
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~°F + 460°F)
1,200
x 5.9 x 10^6 (adjust for ppm)]

107.1
= ~~326.2~~ lb/hr

GE PG7221 FA
NATURAL GAS
70% LOAD
97°F

CO Emissions (lb/hr) - See Note C:

15 9.89 1,757,157
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
1,200
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
32.9
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

1.5 9.89 1,757,157
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
1,200
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
1.88
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65×10^{-2} lb/hr~~

Table A-~~8~~ 8A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,137,685 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/hr x 0.00005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)
0.398
= ~~12.2~~ lb/hr

Tables ~~A-4 and A-5~~ A-8A, A-9A A-10A:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59×10^{-2} lb/hr~~

7/30/92

Emission Calculations, Tables A-8A, A-9A, A-10A

Manufacturer/Model: GE PG7221 FA
Fuel Type: NATURAL GAS
Load: 70%
Ambient Temperature: 97°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1080.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.2×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1080.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 9.52×10^{-2} lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 = NA lb/hr

WEST 501 F
DISTILLATE OIL
BASE LOAD
27 °F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS

(From Table A-~~1~~ 17 On Distillate Oil; BASE LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 19: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

171,970 9,280 1,595.9
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,595.9 18,450 86,498
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,502,180 1,104 33
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (28.~~25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,351,909
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,502,180 33
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (28.~~25~~ x 2,116.8) ÷ 60

793,995
= ~~851,152~~ scfm

WEST 501 F
DISTILLATE OIL
BASE LOAD
27 °F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,351,909 (~~2,450,287~~) acfm x (205°F + 460°F) + (1104 (~~1,060~~)°F + 460°F)

1,000,012 (~~1,072,001~~) acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

1,000,012 (~~1,072,001~~) ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

65.5 (~~70.2~~) ft/sec

20
Table A-~~2~~:

PM emissions in tons per year

39.5 (~~17~~) lb/hr x 300 hr/yr + 2,000 lb/ton

5.9 (~~2.6~~) ton/yr

SO_2 Emissions--Oil (lb/hr)

86,497.6 (~~99,722.9~~) lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

89.35 (~~99.72~~) lb/hr

NO_x Emissions (lb/hr) - See Note B:

44.5 (~~42~~) ppm x [20.9 x (1 - 10.6 (~~11.59~~)/100) - 11.92 (~~10.96~~)] x 2,116.8 lb/ft^2
x 2,351,909 (~~2,450,287~~) ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (1,104 (~~1,060~~)°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

290.1 (~~326.2~~) lb/hr

WEST 501 F
DISTILLATE OIL
BASE LOAD
27 °F

CO Emissions (lb/hr) - See Note C:

52 (~~30~~) ppm x (1 - 10.6 (~~11.59~~)/100) x 2,351,909 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 28 (molecular wgt. of carbon)
x 60 min/hr ÷ (1,545 x (1,104 (~~1,060~~)°F + 460°F) x 10^6)
= 160.9 (~~98.4~~) lb/hr

VOC Emissions (lb/hr) - See Note C:

10.6 (~~3.5~~) ppm x (1-10.6 (~~11.59~~)/100) x 2,351,909 (~~2,450,287~~) acfm x 2,116.8 lb/ft² x 16 (molecular wgt. of methane)
x 60 min/hr ÷ (1,545 x (1,104 (~~1,060~~)°F + 460°F) x 10^6)
= 18.7 (~~6.56~~) lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x 1,595.9 (~~1,849.9~~) x 10^6 Btu/hr = 1.42 (~~1.65~~) x 10^{-2} lb/hr

Table A-3:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist
86,498 (~~99,722.9~~) lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x 0.08 (~~0.05~~)
(converted)
= 10.9 (~~12.2~~) lb/hr

Tables 22 A-~~4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:
1,595.9 (~~1,849.9~~) (MMBtu) x 14 lb/10^{12} Btu
= 2.32 (~~2.59~~) x 10^{-2} lb/hr

8/26/92
~~7/31/92~~

Emission Calculations, Tables A-21, A-22, A-23

Manufacturer/Model: West 501F
Fuel Type: Distillate Oil
Load: Base
Ambient Temperature: 27°F

Arsenic: 4.2 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 6.7×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.99×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 4.79×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1595.4 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 5.19×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 2.71×10^{-2} lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.68×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 7.58×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.447 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.111 lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.74×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 4.44×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.646 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.49×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.11×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.45×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1595.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.09 lb/hr

Chlorine: 0.5 ppm x 88142.1 lb/hr fuel oil + 10^6 - 4.41×10^{-2} lb/hr

WEST 501 F
DISTILLATE OIL
BASE LOAD
72 °F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 72 °F CONDITIONS

(From Table A-~~1~~ 19 On Distillate Oil; BASE LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 19: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

162,330 9,560 1,551.9
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,551.9 18,450 84,112.5
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,509,380 1,104 17
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (28.~~25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,370,209
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,509,380 17
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (28.~~25~~ x 2,116.8) ÷ 60

800,173
= ~~851,152~~ scfm

WEST 501 F
DISTILLATE OIL
BASE LOAD
72 °F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,370,209 1,104
~~2,450,287~~ acfm x (205°F + 460°F) + (~~1,060~~°F + 460°F)

1,007,794
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

1,007,794
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

66.0
= ~~70.2~~ ft/sec

20
Table A-~~2~~:

PM emissions in tons per year

39
~~17~~ lb/hr x 300 hr/yr + 2,000 lb/ton

5.9
= ~~2.6~~ ton/yr

SO_2 Emissions--Oil (lb/hr)

84,112.5
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

86.22
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

42.7 91 11.88
~~42~~ ppm x [20.9 x (1 - 11.~~59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2

x ~~2,450,287~~ ft^3/min
2,370,209

1,104
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

270.9
= ~~326.2~~ lb/hr

WEST 501 F
DISTILLATE OIL
BASE LOAD
72°F

CO Emissions (lb/hr) - See Note C:

51.6 91 2,370,290
~~30~~ ppm x (1 - 11.~~59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)
1,104
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
158.4
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

10.5 91 2,370,209
~~3.5~~ ppm x (1-11.~~59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)
1,104
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
18.44
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr):

1,557.9 38
8.9 lb/10^{12} Btu x ~~1,849.~~9 x 10^6 Btu/hr = 1.~~65~~ x 10^{-2} lb/hr

21
Table A-~~3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist
84,112.5 8
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x 0.0~~8~~
(converted)
10.6
= ~~12.2~~ lb/hr

22
Table~~s~~ A-~~4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:
1,551.9
~~1,849.9~~ (MMBtu) x 14 lb/10^{12} Btu
2.17
= ~~2.59~~ x 10^{-2} lb/hr

~~7/31/92~~
8/26/92

Emission Calculations, Tables A-21, A-22, A-23

Manufacturer/Model: West. 501F
Fuel Type: Distillate Oil
Load: Base
Ambient Temperature: 72°F

Arsenic: 4.2 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 6.52 $\times 10^{-3}$ lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.88 $\times 10^{-3}$ lb/hr

Mercury: 3.0 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.66 $\times 10^{-3}$ lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 5.0 $\times 10^{-2}$ lb/hr

Nickel: 170 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.264 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.63 $\times 10^{-2}$ lb/hr

Chromium: 47.5 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 7.37 $\times 10^{-2}$ lb/hr

Copper: 280 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.435 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.108 lb/hr

Selenium: 23.42 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.63 $\times 10^{-2}$ lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 4.31 $\times 10^{-4}$ lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.629 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 3.36 $\times 10^{-2}$ lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 3.03 $\times 10^{-2}$ lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 1.41 $\times 10^{-2}$ lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 51.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 1.06 lb/hr

Chlorine: 0.5 ppm x 84,887.5 lb/hr fuel oil + 10^6 = 4.21 $\times 10^{-2}$ lb/hr

WEST 501 F
DISTILLATE OIL
BASE LOAD
97 °F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 97 °F CONDITIONS

(From Table A-~~I~~ 19 On Distillate Oil; BASE LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~I~~ 19: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

147,180 9,850 1,449.7
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,449.7 18,450 78,576
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,311,800 1,121 28.09
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,267,804
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,311,800 28.09
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

757,369
= ~~851,152~~ scfm

WEST 501 F
DISTILLATE OIL
BASE LOAD
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,267,804
~~2,450,287~~ acfm x (205°F + 460°F) ÷ (~~1,060~~ 1,121 °F + 460°F)

953,883
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

953,883
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

62.5
= ~~70.2~~ ft/sec

20
Table A-~~2~~:

PM emissions in tons per year

36.7
~~17~~ lb/hr x 300 hr/yr ÷ 2,000 lb/ton

5.5
= ~~2.6~~ ton/yr

SO_2 Emissions--Oil (lb/hr)

78,576
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

81.33
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

42.7 ~~42~~ ppm x [20.9 x (1 - 12.57 ~~11.59~~/100) - 11.83 ~~10.96~~] x 2,116.8 lb/ft^2
x 2,267,804 ~~2,450,287~~ ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,121 ~~1,060~~ °F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

252.9
= ~~326.2~~ lb/hr

WEST 501 F
DISTILLATE OIL
BASE LOAD
97 °F

CO Emissions (lb/hr) - See Note C:

51.5 / ~~30~~ ppm x (1 - 12.57 / ~~11.59~~/100) x 2,267,804 / ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)
x 60 min/hr ÷ (1,545 x (1,121 / ~~1,060~~°F + 460°F) x 10^6)
148.7 / ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

10.5 / ~~3.5~~ ppm x (1-12.57 / ~~11.59~~/100) x 2,267,804 / ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)
x 60 min/hr ÷ (1,545 x (1,121 / ~~1,060~~°F + 460°F) x 10^6)
17.32 / ~~6.56~~ lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x 1,449.7 / ~~1,849.9~~ x 10^6 Btu/hr = 1.29 / ~~1.65~~ x 10^{-2} lb/hr

21
Table A-~~3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist
78,576 / ~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x 0.08
(converted)
9.96 / ~~12.2~~ lb/hr

22
Tables A-~~4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:
1449.7 / ~~1,849.9~~ (MMBtu) x 14 lb/10^{12} Btu
2.03 / ~~2.59~~ x 10^{-2} lb/hr

~~7/31/92~~
8/26/92

Emission Calculations, Tables A-21, A-22, A-23

Manufacturer/Model: West. 501F
Fuel Type: Distillate Oil
Load: Base
Ambient Temperature: 97°F

Arsenic: 4.2 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~6.02 x 10^{-3}~~ 6.09 x 10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~3.59 x 10^{-3}~~ 3.62 x 10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~4.3 x 10^{-3}~~ 4.35 x 10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~4.7 x 10^{-2}~~ 4.72 x 10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~0.244~~ 0.246 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.52 x 10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 6.89 x 10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~0.402~~ 0.406 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~9.97 x 10^{-2}~~ 1.01 x 10^{-1} lb/hr

Selenium: 23.42 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~3.36 x 10^{-2}~~ 3.40 x 10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~3.99 x 10^{-4}~~ 4.03 x 10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.587 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~3.13 x 10^{-2}~~ 3.17 x 10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~2.86 x 10^{-2}~~ 2.89 x 10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.3 x 10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x ~~143.4~~ 49.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - ~~0.998~~ 0.991 lb/hr

Chlorine: 0.5 ppm x ~~79,347.4~~ 78,575.8 lb/hr fuel oil + 10^6 - ~~3.96 x 10^{-2}~~ 3.93 x 10^{-2} lb/hr

WEST. 501F
Natural Gas
Base LOAD
27°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS

(From Table A-~~1~~ 24 On ~~Distillate Oil~~ Natural Gas; Base LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 24: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

169,210 9,490 1,605.8
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.~~9 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,605.8 20,900 76,832.7
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,702,540 1,063 28.49
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,407,465
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,702,540 28.49
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

834,630
= ~~851,152~~ scfm

WEST. 501F
Natural Gas
Base Load
27°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,907,465 ~~2,450,287~~ acfm x (205°F + 460°F) ÷ (1,063 ~~1,060~~°F + 460°F)

= 1,051,191 ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

1,051,191 ~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

= 68.8 ~~70.2~~ ft/sec

Table A-25:

PM emissions in tons per year

6.6 ~~17~~ lb/hr x 8460 ~~300~~ hr/yr ÷ 2,000 lb/ton

= 27.92 ~~2.6~~ ton/yr

SO_2 Emissions- ~~Oil~~ Nat. Gas (lb/hr)

1,690,319 cf/hr ~~99,722.9 lb/hr~~ x 1 gr/100 cf ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

= 4.83 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

255 ~~42~~ ppm x [20.9 x (1 - 7.26 ~~11.59~~/100) - 13.08 ~~10.96~~] x 2,116.8 lb/ft^2

x 2,407,465 ~~2,450,287~~ ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,063 ~~1,060~~°F + 460°F)

x 5.9 x 10^6 (adjust for ppm)]

= 162.8 ~~326.2~~ lb/hr

WEST. 501F
Natural Gas
Base Load
27°F

CO Emissions (lb/hr) - See Note C:

10.3 7.26 2,407,465
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
1,063
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
34.8
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.2 7.26 2,407,465
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
1,063
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
8.10
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26
Table A-~~9~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,690,319 cf/hr x 1.0 gr/100cf x 2.0 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/hr~~ x 0.0005 lb S/lb x ~~5.06~~ lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted) 1.53
0.623
= ~~12.2~~ lb/hr

A-26, A-27, A-28:
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable
~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26, A-27, A-28

Manufacturer/Model: West. 501F
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 27°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x ~~1605.8~~ 1605.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.79×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x ~~1605.8~~ 1605.8 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.142 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

WEST. 501F
Natural Gas
Base LOAD
72°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~37~~ 72°F CONDITIONS

(From Table A-~~1~~ 24 On ~~Distillate Oil~~ Natural Gas; Base LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 24: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 143,450 x ~~10,070~~ 10,000 / 10^6 = ~~1,849.9~~ 1,434.5 x 10^6 Btu/hr

Natural Gas

~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.~~9 x 10^6 ÷ ~~18,550~~ 20,900 = ~~99,723~~ 68,636.4 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 3,369,010 lb/hr x 1,545 x (~~1,060~~ 1,092°F + 460°F) ÷ (~~28.25~~ 28.32 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 2,246,146 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 3,369,010 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.32 x 2,116.8) ÷ 60

= ~~851,152~~ 764,153 scfm

WEST. 501F
NATURAL GAS
BASE LOAD
72°F

12018C2/APPA-:
~~06/13/91~~
8/26/92

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,246,146
~~2,450,287~~ acfm x (205°F + 460°F) ÷ (1,092
~~1,060~~°F + 460°F)

962,427
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft³/min) ÷ Area (ft²) ÷ 60 sec/min

962,427
~~1,072,001~~ ft³/min ÷ 60 ÷ (18.0² ÷ 4 x 3.14159)

63.0
= ~~70.2~~ ft/sec

Table A-~~1~~ 25:

PM emissions in tons per year

6.0 8460
~~17~~ lb/hr x ~~300~~ hr/yr ÷ 2,000 lb/ton

25.38
= ~~2.6~~ ton/yr

Nat. GAS
SO_2 Emissions--~~Oil~~ (lb/hr)

1,510,800 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S X1.016/7000 gr

4.31
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.4
~~42~~ ppm x [20.9 x (1 - 8.82 ~~11.59~~/100) - 12.91 ~~10.96~~] x 2,116.8 lb/ft²
x 2,246,146 ~~2,450,287~~ ft³/min
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,092
~~1,060~~°F + 460°F) x 5.9 x 10^6 (adjust for ppm)]

144.8
= ~~126.2~~ lb/hr

WEST. 501F
Natural Gas
Base LOAD
72°F

CO Emissions (lb/hr) - See Note C:

10.3 8.82 2,246,146
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)

1,092
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)

31.3
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.1 8.82 2,246,146
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)

1,092
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)

7.12
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26
Table A-~~5~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,510,000 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)

0.556
= ~~12.2~~ lb/hr

A-26, A-27, A-28:
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26, A-27, A-28

Manufacturer/Model: West. 501F
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 72°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1434.5 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.60×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1434.5 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.126 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

West 501F
Natural Gas
Base Load
79°F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 79°F CONDITIONS

(From Table A-~~1~~ 24 On ~~Distillate Oil~~ Natural Gas; Base Load

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 24: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

139500 10,100 1,409.0
~~105,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,409.0 20,900 67,413.9
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,725~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

3,311,770 1,098 28.26
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,221,160
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

3,311,770 28.26
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

752,742
= ~~851,152~~ scfm

West. 501F
Natural Gas
Base Load
79°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,221,160
~~2,450,287~~ acfm x (205°F + 460°F) ÷ (~~1,060~~ 1,098 °F + 460°F)

948,056
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

948,056
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

62.1
= ~~70.2~~ ft/sec

Table A-~~1~~ 25:

PM emissions in tons per year

5.9 8460
~~17~~ lb/hr x ~~300~~ hr/yr ÷ 2,000 lb/ton

24.96
= ~~2.6~~ ton/yr

SO_2 Emissions--Oil (lb/hr)

1,489,105 cf/hr 1.0gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.016/7000 gr

4.24
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.5 9.32 12.82
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ 2,221,160 ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~ 1098 °F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

142.9
= ~~326.2~~ lb/hr

West 501F
Natural Gas
Base Load
79°F

CO Emissions (lb/hr) - See Note C:

10.4 9.32 2,221,160
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)

1,098
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

30.9
- ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.1 9.32 2,221,160
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)

1,098
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

6.97
- ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26
Table A-~~9~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,483,105 cf/hr x 1.09 gr/100 cf x 2 lb SO_2/lb S x 1 lb/7000 gr 0.08
~~99,722.0 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~
(converted)

0.546
- ~~12.~~2 lb/hr

A-26, A-27, A-28:
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26, A-27, A-28

Manufacturer/Model: West 501F
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 79°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1,409.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.56×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1,409.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.124 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

West 501F
Natural Gas
Base Load
97°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~47~~ 97°F CONDITIONS

(From Table A-~~1~~ 24 On ~~Distillate Oil~~ Natural Gas; Base load

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 24: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 129,570 x ~~10,070~~ 10,360/10^6 = ~~1,849.9~~ 1,340.3 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,340.3 x 10^6 ÷ ~~18,550~~ 20,900 = ~~99,725~~ 64,127.9 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 3,180,510 lb/hr x 1,545 x (~~1,060~~ 1,111°F + 460°F) ÷ (~~28.25~~ 28.23 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 2,152,966 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 3,180,510 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.23 x 2,116.8) ÷ 60

= ~~851,152~~ 723,594 scfm

West. 501F
Natural Gas
Base LOAD
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,152,966
~~2,450,287~~ acfm x (205°F + 460°F) + (1,111
~~1,060~~°F + 460°F)

911,345
- ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

911,345
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

59.7
- ~~70.~~2 ft/sec

25
Table A-~~2~~:

PM emissions in tons per year

5.7 8460
~~17~~ lb/hr x ~~300~~ hr/yr + 2,000 lb/ton

24.11
- ~~2.6~~ ton/yr

Nat. Gas
SO_2 Emissions- ~~Oil~~ (lb/hr)

1,410,814 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/~~lb x 2 lb SO_2/lb S X 1.0 lb/7000 gr

4.03
- ~~99.7~~2 lb/hr

NO_x Emissions (lb/hr) - See Note B:

855 9.56 12.84
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min
2,152,966
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (1,111
~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

135.8
- ~~320.2~~ lb/hr

WEST 501F
Natural Gas
Base Load
97°F

CO Emissions (lb/hr) - See Note C:

10.2 9.56 2,152,966
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)

1,111
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

29.1
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.3 9.56 2,152,966
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)

1,111
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

7.01
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26
Table A-~~9~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,410,814 cf/hr x 1.0 gr/100cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)

0.520
= ~~12.2~~ lb/hr

A-26, A-27, A-28:
Tables ~~A-4 and A-5~~.

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable
= ~~2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26, A-27, A-28

Manufacturer/Model: WEST. 501F
Fuel Type: Natural Gas
Load: Base
Ambient Temperature: 97°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1340.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.49 x 10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1340.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.118 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

WEST 501 F
DISTILLATE OIL
70% LOAD
27 °F

12018C2/APPA-1
~~06/13/92~~
6/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27°F CONDITIONS

(From Table A-~~X~~ 19A On Distillate Oil; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~X~~ 19A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

133,020 9,770 1,299.6
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,299.6 18,450 70,439.3
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,934,960 1,130 28.34
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

2,003,120
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,934,960 28.34
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) + 60

831,484
= ~~851,152~~ scfm

WEST 501 F
DISTILLATE OIL
70% LOAD
27 °F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

2,003,120 (200 °F + 460 °F) + (1,130 °F + 460 °F)
~~2,450,287~~ acfm x (~~205~~ °F + 460 °F) + (~~1,060~~ °F + 460 °F)

831,484
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

631,484
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

54.5
= ~~70.2~~ ft/sec

20A
Table A-~~2~~:

PM emissions in tons per year

32.6
~~17~~ lb/hr x 300 hr/yr ÷ 2,000 lb/ton

4.9
= ~~2.6~~ ton/yr

SO_2 Emissions--Oil (lb/hr)

70,439.3
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

72.69
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

42.5 (10.43 / 12.08)
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min
2,003,120
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~ °F + 460 °F)
x 5.9 x 10^6 (adjust for ppm)]
1,130

227.9
= ~~326.2~~ lb/hr

WEST 501 F
DISTILLATE OIL
70 % LOAD
27 °F

CO Emissions (lb/hr) - See Note C:

51.5 10.43 2,003,120
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)
1,130
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
133.8
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

10.0 10.43 2,003,120
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)
1,130
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
14.84
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr):

1,299.6 1.16
8.9 lb/10^{12} Btu x ~~1,849.9~~ x 10^6 Btu/hr = ~~1.65~~ x 10^{-2} lb/hr

21A
Table A-~~3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist
70,439.3
~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x 0.0~~5~~ 8
(converted)
8.90
= ~~12.2~~ lb/hr

224
Tables A-~~4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:
1,299.6
~~1,849.9~~ (MMBtu) x 14 lb/10^{12} Btu
1.82
= ~~2.59~~ x 10^{-2} lb/hr

~~7/31/92~~
8/26/92

Emission Calculations, Tables A-21A, A-22A, A-23A

Manufacturer/Model: WEST. 501F
Fuel Type: Distillate Oil
Load: 70%
Ambient Temperature: 27°F

Arsenic: 4.2 lb/10^{12} Btu x 1299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 5.46 x 10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.25 x 10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.90 x 10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 4.23 x 10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.221 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.36 x 10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 6.17 x 10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.364 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 9.03 x 10^{-2} lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.04 x 10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 3.61 x 10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.526 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 2.84 x 10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 2.54 x 10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.18 x 10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1,299.6 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.888 lb/hr

Chlorine: 0.5 ppm x 70,439.3 lb/hr fuel oil + 10^6 - 3.52 x 10^{-2} lb/hr

WEST 501 F
DISTILLATE OIL
70% LOAD
72 °F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 72 °F CONDITIONS

(From Table A-~~1~~ 19A On Distillate Oil; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 19A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

113,400 10,310 1,169.2
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,169.2 18,450 63,368.8
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,757,580 1,130 28.19
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

1,892,217
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,757,580 28.19
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

620,359
= ~~851,152~~ scfm

WEST 501 F
DISTILLATE OIL
70% LOAD
72°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

~~2,450,287~~ 1,892,217 acfm x (~~205~~ 200 °F + 460°F) + (~~1,060~~ 1,130 °F + 460°F)

- ~~1,072,001~~ 785,449 acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

~~1,072,001~~ 785,449 ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

- ~~70.2~~ 51.4 ft/sec

Table A-~~2~~ 20~~4~~:

PM emissions in tons per year

~~17~~ 30 lb/hr x 300 hr/yr + 2,000 lb/ton

- ~~2.6~~ 4.5 ton/yr

SO_2 Emissions--Oil (lb/hr)

~~99,722.9~~ 63,368.8 lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

- ~~99.72~~ 65.65 lb/hr

NO_x Emissions (lb/hr) - See Note B:

~~42~~ 42.5 ppm x [20.9 x (1 - ~~11.59~~ 11.58/100) - ~~10.96~~ 12.17] x 2,116.8 lb/ft^2
x 2,450,287 ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (~~1,060~~ 1,130 °F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

- ~~326.2~~ 204.5 lb/hr

WEST 501 F
DISTILLATE OIL
70% LOAD
72°F

CO Emissions (lb/hr) - See Note C:

515 / ~~30~~ ppm x (1 - 11.58 / ~~11.59~~/100) x 1,892,217 / ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)

x 60 min/hr ÷ (1,545 x (1,130 / ~~1,060~~°F + 460°F) x 10^6)

124.7 / ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

10.1 / ~~3.5~~ ppm x (1-11.58 / ~~11.59~~/100) x 1,892,217 / ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)

x 60 min/hr ÷ (1,545 x (1,130 / ~~1,060~~°F + 460°F) x 10^6)

13.98 / ~~6.56~~ lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x 1,169.2 / ~~1,849.9~~ x 10^6 Btu/hr ÷ 1.04 / ~~1.65~~ x 10^{-2} lb/hr

21A
Table A-~~3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

63,768.8 / ~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x 0.08
(converted)

8.04 / ~~12.2~~ lb/hr

22A
Tables A-~~4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

1,169.2 / ~~1,849.9~~ (MMBtu) x 14 lb/10^{12} Btu

1.64 / ~~2.59~~ x 10^{-2} lb/hr

~~7/31/92~~
8/26/92

Emission Calculations, Tables A-21A, A-22A, A-23A

Manufacturer/Model: West 501F
Fuel Type: Distillate Oil
Load: 70%
Ambient Temperature: 72°F

Arsenic: 4.2 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.9×10^{-3} lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.92×10^{-3} lb/hr

Mercury: 3.0 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.5×10^{-3} lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 3.80×10^{-2} lb/hr

Nickel: 170 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.199 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.2×10^{-2} lb/hr

Chromium: 47.5 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.55×10^{-2} lb/hr

Copper: 280 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.327 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 8.13×10^{-2} lb/hr

Selenium: 23.42 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.74×10^{-2} lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 3.25×10^{-4} lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.474 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 2.55×10^{-2} lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 2.28×10^{-2} lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 1.06×10^{-2} lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 69.2 MMBtu/hr + 10^6 MMBtu/10^{12} Btu
= 0.799 lb/hr

Chlorine: 0.5 ppm x 63,368.8 lb/hr fuel oil + 10^6 = 3.17×10^{-2} lb/hr

WEST 501 F
DISTILLATE OIL
70% LOAD
97 °F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 97 °F CONDITIONS

(From Table A-~~1~~ 19A On Distillate Oil; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 19A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

102,810 10,680 1,098
~~183,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Fuel Oil (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,098 18,450 59,512.8
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,662,180 1,130 28.12
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

1,831,107
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,662,180 28.12
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

608,066
= ~~851,152~~ scfm

WEST 501 F
DISTILLATE OIL
70% LOAD
97 °F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,831,107 ~~2,450,287~~ acfm x (200 ~~205~~°F + 460°F) + (1,130 ~~1,060~~°F + 460°F)

760,082 ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

760,082 ~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

49.8 ~~70.2~~ ft/sec

Table A-~~1~~ 20A:

PM emissions in tons per year

28.5 ~~17~~ lb/hr x 300 hr/yr + 2,000 lb/ton

4.3 ~~2.6~~ ton/yr

SO_2 Emissions--Oil (lb/hr)

59,512.8 ~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 2 lb SO_2/lb S

61.77 ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

42.7 ~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - 12.09 ~~10.96~~] x 2,116.8 lb/ft^2 x 1,831,107 ~~2,450,287~~ ft^3/min x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (1,130 ~~1,060~~°F + 460°F) x 5.9×10^6 (adjust for ppm)]

192.7 ~~326.2~~ lb/hr

WEST 501 F
DISTILLATE OIL
70% LOAD
97 °F

12018C2/APPA-3
~~06/12/92~~
8/26/92

CO Emissions (lb/hr) - See Note C:

51.5 ~~30~~ ppm x (1 - 12.09 ~~11.59~~/100) x 1,831,107 ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
x 60 min/hr ÷ (1,545 x (1,130 ~~1,060~~°F + 460°F) x 10^6)
= 120.0 ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

10.5 ~~3.5~~ ppm x (1-12.09 ~~11.59~~/100) x 1,831,107 ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
x 60 min/hr ÷ (1,545 x (1,130 ~~1,060~~°F + 460°F) x 10^6)
= 13.98 ~~6.56~~ lb/hr

Lead Emissions (lb/hr):

8.9 lb/10^{12} Btu x 1098 ~~1,849.9~~ x 10^6 Btu/hr = 9.77 ~~1.65~~ x 10^{-3} lb/hr

21A
Table A-~~3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist
59,512.8 ~~99,722.9~~ lb/hr x 0.0005 lb S/lb x 3.06 lb H_2SO_4/lb S x 0.08
(converted)
= 7.57 ~~12.2~~ lb/hr

22A
Tables A-~~4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:
1098 ~~1,849.9~~ (MMBtu) x 14 lb/10^{12} Btu
= 1.54 ~~2.59~~ x 10^{-2} lb/hr

7/31/92

Emission Calculations, Tables A-21A, A-22A, A-23A

Manufacturer/Model: West. 501F
Fuel Type: Distillate Oil
Load: 70%
Ambient Temperature: 97°F

Arsenic: 4.2 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4.61 $\times 10^{-3}$ lb/hr

Beryllium: 2.5 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.75 $\times 10^{-3}$ lb/hr

Mercury: 3.0 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.29 $\times 10^{-3}$ lb/hr

Fluoride: 14.0 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.57 $\times 10^{-2}$ lb/hr

Nickel: 170 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.187 lb/hr

Cadmium: 10.5 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.15 $\times 10^{-2}$ lb/hr

Chromium: 47.5 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 5.22 $\times 10^{-2}$ lb/hr

Copper: 280 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.307 lb/hr

Vanadium: 69.5 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 7.63 $\times 10^{-2}$ lb/hr

Selenium: 23.42 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 2.57 $\times 10^{-2}$ lb/hr

Polycyclic Organic Matter: 0.278 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 3.05 $\times 10^{-4}$ lb/hr

Formaldehyde: 405 lb/10^{12} Btu x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.445 lb/hr

Antimony: 9.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0 $\times 10^{-2}$ lb/hr

Barium: 8.4 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 4 $\times 10^{-2}$ lb/hr

Cobalt: 3.9 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 9.95 $\times 10^{-3}$ lb/hr

Zinc: 294 pg/J x 2.324 lb/10^{12} Btu/pg/J x 1098 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 0.750 lb/hr

Chlorine: 0.5 ppm x 59,512.8 lb/hr fuel oil + 10^6 = 2.98 $\times 10^{-2}$ lb/hr

West. 501F
Natural Gas
70% LOAD
27°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 27 ~~47~~°F CONDITIONS

(From Table A-24A On Natural Gas ~~Distillate Oil~~; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-24A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

118,330 10,490 1,241.3
~~189,700~~ x ~~10,070~~/10^6 = ~~1,849.9~~ x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,241.3 20,900 59,391.5
~~1,849.9~~ x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,754,000 1,130 28.49
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

1,869,744
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,754,000 28.49
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

620,896
= ~~851,152~~ scfm

West. 501F
Natural Gas
70% LOAD
27°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,869,744 ~~2,450,287~~ acfm x (200 ~~205~~°F + 460°F) ÷ (1,130 ~~1,060~~°F + 460°F)

776,120 - ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

776,120 ~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

50.8 - ~~70.2~~ ft/sec

Table A-~~1~~2A:

PM emissions in tons per year

4.9 ~~17~~ lb/hr x 8460 ~~300~~ hr/yr ÷ 2,000 lb/ton

20.73 - ~~2.6~~ ton/yr

SO_2 Emissions--~~Oil~~ GAS (lb/hr)

1,306,612 cf/hr 1.0gr/100cf

~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0#/7000gr

3.73 - ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.4 ~~42~~ ppm x [20.9 x (1 - 7.30 ~~11.59~~/100) - 13.04 ~~10.96~~] x 2,116.8 lb/ft^2

x 1,869,744 ~~2,450,287~~ ft^3/min

x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,130 ~~1,060~~°F + 460°F)

x 5.9×10^6 (adjust for ppm)]

121.3 - ~~326.2~~ lb/hr

West 501F
Natural Gas
70% LOAD
27°F

CO Emissions (lb/hr) - See Note C:

10.4 7.3 1,869,744
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)

1,130
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)

26.1
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.2 7.3 1,869,744
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)

1,130
x 60 min/hr + (1,545 x (~~1,060~~ F + 460°F) x 10^6)

6.02
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26A
Table A-~~3~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,306,612 cf/hr x 1.0gr/100cf x 2lb SO_2/lbS x 1.01b/7000gr 0.08
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ lb H_2SO_4/lb SO_2 x ~~0.05~~
1.53
(converted)

0.481
= ~~12.2~~ lb/hr

A-26A, A-27A, A-28A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26A, A-27A, A-28A

Manufacturer/Model: WEST. 501F
Fuel Type: NATURAL GAS
Load: 70%
Ambient Temperature: 27°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1241.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.38×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1241.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.109 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

West 501F
Natural Gas
70% load
64°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 64 °F CONDITIONS

(From Table A-~~1~~ 24A On ~~Distillate Oil~~ Natural Gas; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 24A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~183,700~~ 103,390 x ~~10,070~~ 11,020/10^6 = ~~1,849~~ 1,139.4 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,139.4 x 10^6 ÷ ~~18,550~~ 20,900 = ~~99,723~~ 54,514.7 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,678,720 lb/hr x 1,545 x (~~1,060~~ 1,130°F + 460°F) ÷ (~~28.25~~ 28.36 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 1,826,635 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,678,720 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.36 x 2,116.8) ÷ 60

= ~~851,152~~ 606,581 scfm

West 501F
Natural Gas
70% Load
64°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,826,635 / ~~2,450,287~~ acfm x (200 / ~~205~~°F + 460°F) ÷ (1,130 / ~~1,060~~°F + 460°F)

758,226 / - ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

758,226 / ~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

49.7 / - ~~70.2~~ ft/sec

25A
Table A-~~5~~:

PM emissions in tons per year

4.8 / ~~17~~ lb/hr x 8460 / ~~300~~ hr/yr ÷ 2,000 lb/ton

20.30 / - ~~2.6~~ ton/yr

G45
SO_2 Emissions--~~Oil~~ (lb/hr)

1,199,324 cf/hr / ~~99,722.9 lb/hr~~ x 1.0gr/100 cf / ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.016 / 7000 gr

3.43 / - ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.4 / ~~42~~ ppm x [20.9 x (1 - 8.32 / ~~11.59~~/100) - 13.1 / ~~10.96~~] x 2,116.8 lb/ft^2
x 1,826,635 / ~~2,450,287~~ ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,130 / ~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

113.4 / - ~~326.2~~ lb/hr

West. 501F
Natural Gas
70% Load
64°F

CO Emissions (lb/hr) - See Note C:

10.3 8.32 1,826,635
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
1,130
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)
25.0
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.3 8.32 1,826,635
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
1,130
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)
5.96
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65×10^{-2} lb/hr~~

26A
Table A-~~5~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,199,324 cf/hr x 1.0 gr/100 cf x 2 lb SO_3/lb S x 1.0 lb/7000 gr
99,722.9 lb/hr x 0.0005 lb S/lb x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)
0.442
= ~~12.2~~ lb/hr

A-26A, A-27A, A-28A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59×10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26A, A-27A, A-28A

Manufacturer/Model: West. 501F
Fuel Type: NATURAL GAS
Load: 70%
Ambient Temperature: 64°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x ~~1356~~ 1139.4 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 1.26×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x ~~1356~~ 1139.4 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 0.10 lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

West 501F
Nat Gas
70% Load
72°F

12018C2/APPA-1
~~06/13/90~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~27~~ 72 °F CONDITIONS

(From Table A-~~I~~ 24A On ~~Distillate Oil~~ Nat Gas 70% Load

All Other Calculations on Spreadsheet are Identical.)

Table A-~~I~~ 24A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~109,700~~ 100,210 x ~~10,070~~ 11,150 / 10^6 = ~~1,849.9~~ 1,117.3 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.9~~ 1,117.3 x 10^6 ÷ ~~18,550~~ 20,900 = ~~99,725~~ 53,461.3 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,647,790 lb/hr x 1,545 x (~~1,060~~ 1,130 °F + 460°F) ÷ (~~28.25~~ 28.33 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 1,807,837 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,647,790 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.33 x 2,116.8) ÷ 60

= ~~851,152~~ 600,338 scfm

Wlt 501F
Nat Gas
70% load
72°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,807,837 200 1,130
~~2,450,287~~ acfm x (~~205~~°F + 460°F) ÷ (~~1,060~~°F + 460°F)

750,423
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

750,423
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)

49.1
= ~~70.2~~ ft/sec

25A
Table A-~~2~~:

PM emissions in tons per year

4.7 8460
~~17~~ lb/hr x ~~300~~ hr/yr ÷ 2,000 lb/ton

19.88
= ~~2.6~~ ton/yr

GAS
SO_2 Emissions--~~Oil~~ (lb/hr)

1,176,149 cf/hr 1.09gr/100cf
~~99,722.8 lb/hr~~ x ~~0.0005 lb S/~~lb x 2 lb SO_2/lb S x 1.0 lb/7000 gr

336
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.4 8.68 13.08
~~42~~ ppm x [20.9 x (1 - ~~11.59~~/100) - ~~10.96~~] x 2,116.8 lb/ft^2
x ~~2,450,287~~ ft^3/min

1,807,837
x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

111.2
= ~~326.2~~ lb/hr

West 501F
Nat. Gas
70% load
72°F

CO Emissions (lb/hr) - See Note C:

10.4 8.68 1,807,837
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)

1,130
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)

24.9
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.4 8.68 1,807,837
~~3.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)

1,130
x 60 min/hr + (1,545 x (~~1,060~~°F + 460°F) x 10^6)

6.01
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26A
Table A-~~5~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,176,149 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)

0.433
= ~~12.2~~ lb/hr

A-26A, A-27A, A-28A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26A, A-27A, A-28A

Manufacturer/Model: West. 501F
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 72°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 1115.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.24×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 1115.3 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 9.82×10^{-2} lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 = NA lb/hr

Wet 501F
Natural Gas
70% Load
79°F

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - 79 ~~75~~°F CONDITIONS

(From Table A-24A ~~1~~ On Natural Gas ~~Distillate Oil~~; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-24A ~~1~~: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

97,490 11,270 1,098.7
~~103,700~~ x ~~10,070~~/10^6 = ~~1,849~~.9 x 10^6 Btu/hr

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

1,098.7 20,900 52,570
~~1,849~~.9 x 10^6 ÷ ~~18,550~~ = ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

2,619,850 1,130 28.27
~~3,743,000~~ lb/hr x 1,545 x (~~1,060~~°F + 460°F) ÷ (~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

1,792,201
= ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

2,619,850 28.27
~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ x 2,116.8) ÷ 60

595,146
= ~~851,152~~ scfm

Westt 501F
Natural Gas
70% Load
79°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,792,201 / ~~2,450,287~~ acfm x (200 / ~~205~~°F + 460°F) + (1,130 / ~~1,060~~°F + 460°F)

- ~~1,072,001~~ acfm
743,932

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

743,932 / ~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

48.7
- ~~70.2~~ ft/sec

25A
Table A-~~1~~:

PM emissions in tons per year

4.7 / ~~17~~ lb/hr x 8460 / ~~300~~ hr/yr + 2,000 lb/ton

19.88
- ~~2.6~~ ton/yr

SO_2 Emissions--GAS / ~~Oil~~ (lb/hr)

1,156,539 cf/hr / ~~99,722.9 lb/hr~~ x 1.09gr/100 cf / ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S X1.0 lb/7000 gr

3.30
- ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.4 / ~~42~~ ppm x [20.9 x (1 - 9.12 / ~~11.59~~/100) - 13.04 / ~~10.96~~] x 2,116.8 lb/ft^2
x 1,792,201 / ~~2,450,287~~ ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (1,130 / ~~1,060~~°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

109.3
- ~~326.2~~ lb/hr

West 501F
Natural Gas
70% load
79°F

CO Emissions (lb/hr) - See Note C:

10.2 9.12 1,792,201
~~90~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 28
(molecular wgt. of carbon)

1,130
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

24.1
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

4.5 9.12 1,792,201
~~9.5~~ ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft^2 x 16
(molecular wgt. of methane)

1,130
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)

6.06
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-~~5~~ 26A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,156,539 cf/hr x 1.0gr/100cf x 2lb SO_2/lb S x 1.0lb/7000gr
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)

0.426
= ~~12.2~~ lb/hr

A-26A, A-27A, A-28A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

= ~~2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26A, A-27A, A-28A

Manufacturer/Model: West. 501F
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 79°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x ~~1098.7~~ 1098.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.22×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x ~~1098.7~~ 1098.7 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 9.68×10^{-2} lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

Unit 501F
Natural Gas
70% Load
97°F

12018C2/APPA-1
~~06/13/92~~
8/26/92

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~77~~ 97 °F CONDITIONS

(From Table A-~~1~~ 24A On ~~Distillate Oil~~ Natural Gas; 70% LOAD

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 24A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr):

Power (kW) x Heat Rate (10^6 Btu/kWh)

~~103,700~~ 90,340 x ~~10,070~~ 11,600/10^6 = ~~1,049.9~~ 1,047.9 x 10^6 Btu/hr

~~Fuel Oil~~ Nat. Gas (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,049.9~~ 1,047.9 x 10^6 ÷ ~~18,550~~ 20,900 = ~~99,723~~ 50,140.9 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 2,554,960 lb/hr x 1,545 x (~~1,060~~ 1,130 °F + 460°F) ÷ (~~28.25~~ 28.25 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 1,749,383 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 2,554,960 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.25 x 2,116.8) ÷ 60

= ~~851,152~~ 580,927 scfm

Wlst 501F
Natural Gas
70% Load
97°F

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,749,383
~~2,450,287~~ acfm x (200 ~~205~~°F + 460°F) + (1,130 ~~1,060~~°F + 460°F)

- ~~1,072,001~~ 726,159 acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

726,159
~~1,072,001~~ ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

47.6
- ~~70.2~~ ft/sec

25A
Table A-~~1~~:

PM emissions in tons per year

4.6 8460
~~17~~ lb/hr x ~~300~~ hr/yr + 2,000 lb/ton

19.46
- ~~2.6~~ ton/yr

GAS
SO_2 Emissions--~~Oil~~ (lb/hr)

1,103,099 cf/hr 1.09 gr/100 cf
~~99,723.9 lb/~~hr x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

3.15
- ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) - See Note B:

25.4
~~42~~ ppm x [20.9 x (1 - ~~11.59~~ 9.29/100) - ~~10.96~~ 13.15] x 2,116.8 lb/ft^2
x ~~2,450,287~~ 1,749,383 ft^3/min
x 46 (molecular wgt NO_2) x 60 min/hr + [1,545 x (~~1,060~~ 1,130°F + 460°F)
x 5.9 x 10^6 (adjust for ppm)]

104.0
- ~~326.~~2 lb/hr

Wlst 501F
Natural Gas
70% Load
97°F

CO Emissions (lb/hr) - See Note C:

10.4 9.29 1,749,383
~~30~~ ppm x (1 - ~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 28
(molecular wgt. of carbon)
1,130
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
23.9
= ~~98.4~~ lb/hr

VOC Emissions (lb/hr) - See Note C:

3.8 9.29 1,749,383
~~3.~~5 ppm x (1-~~11.59~~/100) x ~~2,450,287~~ acfm x 2,116.8 lb/ft² x 16
(molecular wgt. of methane)
1,130
x 60 min/hr ÷ (1,545 x (~~1,060~~°F + 460°F) x 10^6)
4.99
= ~~6.56~~ lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.8 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

26A
Table A-~~8~~:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

1,103,099 cf/hr x 1.0gr/100 cf x 2lb SO_2/lb S x 1.01b/7000gr
~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08
(converted)
0.406
= ~~12.2~~ lb/hr

A-26A A-27A A-28A
Tables ~~A-4 and A-5~~:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-26A, A-27A, A-28A

Manufacturer/Model: West. 501F
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: 97°F

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x ~~1047.9~~ 1047.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.16×10^{-3} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x ~~1047.9~~ 1047.9 MMBtu/hr + 10^6 MMBtu/10^{12} Btu - 9.23×10^{-2} lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu - NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 - NA lb/hr

Duct Burner - Supplemental Firing
Natural Gas
Base LOAD
All temperatures

DESTEC CENTRAL FLORIDA COGENERATION PROJECT

EXAMPLE CALCULATIONS - ~~47°F~~ All temperatures given CONDITIONS

(From Table A-~~1~~ 11 On ~~Distillate Oil~~ Natural Gas; Base Load

All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 11: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr): 100 mmBtu/hr (given)

~~Power (kW) x Heat Rate (10^6 Btu/kWh)~~

~~183,700 x 10,070/10^6 = 1,849.9 x 10^6 Btu/hr~~

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

100.0 / ~~1,849.9~~ x 10^6 ÷ 23,839 / ~~18,550~~ = 4,194.8 / ~~99,723~~ lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

5,244 / ~~3,743,000~~ lb/hr x 1,545 x (205 / ~~1,060~~°F + 460°F) ÷ (28.00 / ~~28.25~~ x 2,116.8 lb/ft²)

÷ 60(min/hr)

= 1,575 / ~~2,450,287~~ acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

5,244 / ~~3,743,000~~ lb/hr x 1,545 x (68°F + 460°F) ÷ (28.00 / ~~28.25~~ x 2,116.8) ÷ 60

= 1,203 / ~~851,152~~ scfm

Duct Burner - Supplemental Firing
Natural Gas
Base Load
All temperatures

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

~~2,450,287~~ 1,515 acfm x (205°F + 460°F) + (~~1,060~~ 205°F + 460°F)

- ~~1,072,001~~ 1,515 acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) + Area (ft^2) + 60 sec/min

~~1,072,001~~ 1,515 ft^3/min + 60 + (18.0^2 + 4 x 3.14159)

- ~~70.2~~ 0.1 ft/sec

Table A-~~2~~ 12:

PM emissions in tons per year

~~17 lb/hr x 300 hr/yr~~ 0.01 lb/mmBtu x 100 mmBtu/hr x 8760 hr/yr + 2,000 lb/ton

- ~~2.6~~ 4.38 ton/yr

SO_2 Emissions - ~~Oil~~ Gas (lb/hr)

~~99.7221 lb/hr~~ 105,263 cf/hr x ~~0.0005 lb S/lb~~ 1.0 gr/100cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr

- ~~99.72~~ 0.30 lb/hr

NO_x Emissions (lb/hr) - ~~See Note B~~:

~~42 ppm x [20.9 x (1 - 11.59/100) - 10.96] x 2,116.8 lb/ft^2 x 2,450,287 ft^3/min~~

~~x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,060°F + 460°F) x 5.9 x 10^6 (adjust for ppm)]~~

~~326.2 lb/hr~~

0.10 lb/mmBtu x 100.0 mmBtu/hr = 10.0 lb/hr

Duct Burner - Supplemental Firing
Natural Gas
Base Load
All temperatures

CO Emissions (lb/hr) - ~~See Note C~~:

~~30 ppm x (1 - 11.59/100) x 2,450,287 acfm x 2,116.8 lb/ft^2 x 28 (molecular wgt. of carbon) x 60 min/hr ÷ (1,545 x (1,060°F + 460°F) x 10^6)~~

~~= 98.4 lb/hr~~

0.10 lb/MMBtu x 100.0 MMBtu/hr = 10 lb/hr

VOC Emissions (lb/hr) - ~~See Note C~~:

~~3.5 ppm x (1-11.59/100) x 2,450,287 acfm x 2,116.8 lb/ft^2 x 16 (molecular wgt. of methane) x 60 min/hr ÷ (1,545 x (1,060°F + 460°F) x 10^6)~~

~~= 6.56 lb/hr~~ 0.029 lb/MMBtu x 100.0 MMBtu/hr = 2.90 lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-~~5~~ 13:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

105,263 cf/hr x 100 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr x ~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08 (converted)

~~12.2~~ 3.68×10^{-2} lb/hr

Tables ~~A-4 and A-5~~ A-13, A-14:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

Emission Calculations, Tables A-13, A-14

Manufacturer/Model: Duct Burner
Fuel Type: Natural Gas
Load: 100%
Ambient Temperature: All temperatures

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 100.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.11×10^{-4} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 100.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 8.81×10^{-3} lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 = NA lb/hr

Duct Burner-Supplemental Firing
Natural Gas
70% Load
All Temperatures

DESTEC CENTRAL FLORIDA COGENERATION PROJECT
EXAMPLE CALCULATIONS - ~~27°F~~ All temperatures CONDITIONS
(From Table A-~~1~~ 11A On ~~Distillate Oil~~ Natural Gas; 70% LOAD
All Other Calculations on Spreadsheet are Identical.)

Table A-~~1~~ 11A: (Note: all other data not calculated but supplied by Manufacturer)

Heat Input (10^6 Btu/hr): 100.0 mmBtu/hr (given)

~~Power (kW) x Heat Rate (10^6 Btu/kWh)~~

~~183,700 x 10,070/10^6 = 1,849.9 x 10^6 Btu/hr~~

Natural Gas
~~Fuel Oil~~ (lb/hr):

Heat Input (10^6 Btu/hr) ÷ Fuel Heat Content (Btu/lb)

~~1,849.~~100.0 9 x 10^6 ÷ ~~18,550~~ 23,839 = ~~99,723~~ 4,194.8 lb/hr

Volume Flow (acfm) - See Note A:

V = mRT/PM

~~3,743,000~~ 5,244 lb/hr x 1,545 x (~~1,060~~ 200°F + 460°F) ÷ (~~28.25~~ 28.00 x 2,116.8 lb/ft²)

÷ 60(min/hr)

= ~~2,450,287~~ 1,504 acfm

Volume Flow (scfm) - See Note A:

Same as volume flow (acfm) except adjusted for standard temperature of 68°F

~~3,743,000~~ 5,244 lb/hr x 1,545 x (68°F + 460°F) ÷ (~~28.25~~ 28.00 x 2,116.8) ÷ 60

= ~~851,152~~ 1,203 scfm

Duct Burner - Supplemental Firing
Natural Gas
70% LOAD
All Temperatures

Volume Flow from HRSG (acfm):

CT Exhaust adjusted for temperature

1,504 200 200
~~2,450,287~~ acfm x (~~205~~°F + 460°F) + (~~1,060~~°F + 460°F)
1,604
= ~~1,072,001~~ acfm

Velocity (ft/sec):

Volume Flow (ft^3/min) ÷ Area (ft^2) ÷ 60 sec/min

1,504
~~1,072,001~~ ft^3/min ÷ 60 ÷ (18.0^2 ÷ 4 x 3.14159)
0.1
= ~~70.2~~ ft/sec

12A
Table A-~~2~~:

PM emissions in tons per year

0.01 lb/mmBtu x 100.0 mmBtu/hr x 8760 hr/yr ÷ 2000 lb/ton

~~17 lb/hr x 300 hr/yr ÷ 2,000 lb/ton~~

4.38
= ~~2.6~~ ton/yr

SO_2 Emissions--Oil (lb/hr)

105,263 cf/hr 1.0 gr/100 cf
~~99,722.9 lb/hr~~ x ~~0.0005 lb S/lb~~ x 2 lb SO_2/lb S x 1.0 lb/7000 gr

0.30
= ~~99.72~~ lb/hr

NO_x Emissions (lb/hr) ~~- See Note B~~:

~~42 ppm x [20.9 x (1 - 11.59/100) ÷ 10.96] x 2,116.8 lb/ft²~~
~~x 2,450,287 ft³/min~~

~~x 46 (molecular wgt NO_2) x 60 min/hr ÷ [1,545 x (1,060°F + 460°F)~~
~~x 5.9 x 10^6 (adjust for ppm)]~~

~~= 326.2 lb/hr~~

0.1 lb/mmBtu x 100.0 mmBtu/hr = 10.0 lb/hr

Duct Burner - Supplemental Firing
Natural Gas
70% LOAD
All Temperatures

CO Emissions (lb/hr) ~~- See Note C~~:

~~30 ppm x (1 - 11.59/100) x 2,450,287 acfm x 2,116.8 lb/ft^2 x 28 (molecular wgt. of carbon)~~

~~x 60 min/hr ÷ (1,545 x (1,060°F + 460°F) x 10^6)~~

~~= 98.4 lb/hr~~

0.10 lb/mmBtu x 100.0 mmBtu/hr = 10.0 lb/hr

VOC Emissions (lb/hr) ~~- See Note C:~~

~~3.5 ppm x (1-11.59/100) x 2,450,287 acfm x 2,116.8 lb/ft^2 x 16 (molecular wgt. of methane)~~

~~x 60 min/hr ÷ (1,545 x (1,060°F + 460°F) x 10^6)~~

~~= 6.56 lb/hr~~

0.029 lb/mmBtu x 100.0 mmBtu/hr = 2.90 lb/hr

Lead Emissions (lb/hr): Not Applicable

~~8.9 lb/10^{12} Btu x 1,849.9 x 10^6 Btu/hr = 1.65 x 10^{-2} lb/hr~~

Table A-~~5~~ 13A:

H_2SO_4 Mist Emissions (lb/hr):

Based on 8 percent of sulfur converted to acid mist

105,263 cf/hr x 1.0 gr/100 cf x 2 lb SO_2/lb S x 1.0 lb/7000 gr

~~99,722.9 lb/hr x 0.0005 lb S/lb~~ x ~~3.06~~ 1.53 lb H_2SO_4/lb SO_2 x ~~0.05~~ 0.08

(converted)

3.68×10^{-2}

= ~~12.2~~ lb/hr

Tables ~~A-4 and A-5~~ A-13A, A-14A:

EPA emission factor as noted in printout; example for manganese:

~~1,849.9 (MMBtu) x 14 lb/10^{12} Btu~~ Not Applicable

~~= 2.59 x 10^{-2} lb/hr~~

7/31/92

Emission Calculations, Tables A-13A, A-14A

Manufacturer/Model: Duct Burner
Fuel Type: Natural Gas
Load: 70%
Ambient Temperature: All temperatures

Arsenic: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Beryllium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Mercury: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Fluoride: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Nickel: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cadmium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chromium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Copper: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Vanadium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Selenium: _____ lb/10^{12} Btu x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Polycyclic Organic Matter: 1.113 lb/10^{12} Btu x 100.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 1.11×10^{-4} lb/hr

Formaldehyde: 88.12 lb/10^{12} Btu x 100.0 MMBtu/hr + 10^6 MMBtu/10^{12} Btu = 8.81×10^{-3} lb/hr

Antimony: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Barium: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Cobalt: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Zinc: _____ pg/J x 2.324 lb/10^{12} Btu/pg/J x _____ MMBtu/hr + 10^6 MMBtu/10^{12} Btu = NA lb/hr

Chlorine: _____ ppm x _____ lb/hr fuel oil + 10^6 = NA lb/hr

NOTE A

Volume is calculated based on ideal gas law:

$$PV = mRT/M$$

where: P = pressure = 2116.8 lb/ft^2
m = mass flow of gas (lb/hr)
R = universal gas constant = 1545
M = molecular weight of gas
T = temperature (°R)

NOTE B

NO_x is calculated by correcting to 15% O_2 dry conditions using ideal gas law and moisture and O_2 conditions.

Oxygen correction:

$$V_{NOx\ (15\%)} = \frac{V_{NOx\ Dry} * 5.9}{20.9 - \%O_{2\ Dry}}$$

(From 40 CFR Part 60; Appendix A, Method 20, Equation 20-4)

$$V_{NOx\ Dry} = V_{NOx\ (15\%)}\ (20.9 - \%O_{2\ Dry}) / 5.9$$

$$\%O_{2\ Dry} = \%O_{2\ Act} / (1 - \%H_2O)\ ;\ \%O_{2\ Act} = \%O_{2\ Dry}\ (1 - \%H_2O)$$

(From Method 20; Equation 20-1)

$$V_{NOx\ Act} = V_{NOx\ Dry}\ (1 - \%H_2O);$$ (From Method 20; Equation 20-1)

Substituting:

$$V_{NOx\ Act} = V_{NOx\ 15\%}\ (20.9 - \%O_{2\ Dry})\ (1 - \%H_2O) / 5.9$$

$$= V_{NOx\ (15\%)}\ [20.9 - (\%O_{2\ Act} / (1 - \%H_2O))]\ (1 - \%H_2O) / 5.9$$

$$= V_{NOx\ (15\%)}\ [20.9\ (1 - \%H_2O) - \%O_2) / 5.9$$

$$m_{NOx} = \frac{PVM_{NOx}}{RT} = V_{NOx\ (15\%)}\ [20.9\ (1 - \%H_2O) - \%O_2) * P * M_{NOx} / (RT * 5.9)$$

NOTE C

Same as D except only moisture correction is used:

$$V_{CO\ Act} = V_{CO\ Dry}\ (1 - \%H_2O)$$

$$m_{CO} = PV_{CO\ Act}M_{CO} / RT$$
$$= PV_{CO\ Dry}\ (1 - \%H_2O)\ M_{CO} / RT$$

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

4APT-AEB

JUL 15 1992

RECEIVED
JUL 20 1992
Bureau of
Air Regulation

Mr. Clair H. Fancy, P.E., Chief
Bureau of Air Regulation
Florida Department of Environmental
Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

RE: Central Florida Power Limited Partnership,
Central Florida Cogeneration Plant (PSD-FL-190)

Dear Mr. Fancy:

This is to acknowledge receipt of the Prevention of Significant Deterioration (PSD) permit application package for the above referenced facility. The proposed facility will be a combined cycle cogeneration power plant, nominally rated at 206 megawatts for the facility. The proposed project consists of one advanced technology heavy-duty industrial gas turbine electric generating unit, with a duct burner-fired heat recovery steam generator, and a steam turbine generator.

The applicant proposes to limit NO_x emissions from the combustion turbine through advanced dry low-NO_x combustors and water injection, to limit NO_x emissions from the duct burner through combustion design, to limit CO emissions from the combustion turbine and duct burner through combustion design, and to limit VOC, PM/PM_{10}, Be, and As emissions from the combustion turbine through combustion control and the use of clean fuels.

We have reviewed the package as submitted and have no adverse comments. Thank you for the opportunity to review and comment on the package. If you have any questions or comments, please contact Mr. Scott Davis of my staff at (404) 347-5014.

Sincerely yours,

Jewell A. Harper, Chief
Air Enforcement Branch
Air, Pesticides, and Toxics
Management Division

cc: M. Bays
C. Holladay
B. Thomas, SW Dist.
C. Shaw, NPS
R. Kosky, KBN
CHF/PL