Table 9A-1-2 Potential Emissions From Combustion Sources
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F)	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr)	8,760

Generator Operational Parameters:

Normal Hours of Operation:	100

Boiler/Heater Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Titan 130 Turbine	20,500	hp	Natural Gas	26.6	43.1	2.41	2.58	4.4	4.4	4.4	10.80	90,075	6.52	2.27	90,915	10.2	0.962
Solar Mars 100 Turbine	15,900	hp	Natural Gas	21.9	35.5	1.97	2.12	3.60	3.60	3.60	8.90	74,298	5.37	1.87	74,991	8.12	0.785
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.9	23.8	1.36	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	5.77	0.525
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	11.2	18.0	1.01	1.08	1.83	1.83	1.83	4.53	37,813	2.7	0.95	38,165	4.29	0.410
Caterpillar G3516C Egen	2,098	hp	Natural Gas	0.116	0.45	0.123	0.000	0.028	0.028	0.03	0.007	103	1.03	0.00	129	0.00	0.021
Boiler	10.7	MMBtu/hr	Natural Gas	2.30	3.86	0.253	0.028	0.087	0.087	0.087	0.262	5,514	0.106	0.101	5,546	0.00	0.087
Total (tons/yr)				**77.0**	**125**	**7.13**	**7.24**	**12.3**	**12.3**	**12.3**	**30.5**	**257,782**	**19.4**	**6.46**	**260,193**	**28.4**	**2.79**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Selective Catalytic Reduction	44%	-	-
Oxidation Catalyst	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Titan 130 Turbine	20,500	hp	Natural Gas	14.8	8.62	1.21	2.58	4.4	4.4	4.4	10.80	90,075	6.52	2.27	90,915	10.2	0.962
Solar Mars 100 Turbine	15,900	hp	Natural Gas	12.1	7.09	0.987	2.12	3.60	3.60	3.60	8.90	74,298	5.37	1.87	74,991	8.12	0.785
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	8.25	4.76	0.680	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	5.77	0.525
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	6.23	3.59	0.505	1.08	1.83	1.83	1.83	4.53	37,813	2.73	0.954	38,165	4.29	0.410
Caterpillar G3516C Egen	2,098	hp	Natural Gas	0.116	0.45	0.123	0.000	0.028	0.028	0.028	0.007	103	1.03	0.00	129	0.00	0.021
Boiler	10.7	MMBtu/hr	Natural Gas	2.30	3.86	0.253	0.028	0.087	0.087	0.087	0.262	5,514	0.106	0.101	5,546	0.00	0.087
Total (tons/yr)				**43.8**	**28.4**	**3.75**	**7.24**	**12.3**	**12.3**	**12.3**	**30.5**	**257,782**	**19.4**	**6.46**	**260,193**	**28.4**	**2.79**

Notes:
(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) Emergency Generator emissions are calculated by the following formula: Power Rating * Run Hours * EF / 2000
Power Rating = Engine hp rating (hp)
EF = Emission Factor from either manufacturer's data or AP-42 (lb/hp-hr)
2000 = the amount of lbs in a ton
(3) Boiler/Heater emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF)
Power Rating = Boiler/Heater Heat Capacity (MMBtu/hr)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
(4) Turbines are equipped with Selective Catalytic Reduction (SCR) and oxidation catalyst for control of NOx (44%), CO (80%), and VOC (50%)
(5) Emergency generator engine hp taken from manufacturer data
(6) Boiler assumed to have low-NOx burners
(7) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(8) See Emissions Factors table for Emissions Factors for each operating scenario.

Table 9A-1-3 Event Based Potential Emissions From Combustion Sources
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Titan 130 Turbine	20,500	hp	Natural Gas	100	0.095	8.85	0.101	58.1	0.404	68.2
Solar Mars 100 Turbine	15,900	hp	Natural Gas	100	0.070	6.18	0.071	41.5	0.284	48.6
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.040	3.66	0.042	26.0	0.168	30.2
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	100	0.035	3.22	0.037	20.50	0.148	24.20
Total (tons/yr)					**0.240**	**21.9**	**0.251**	**146**	**1.00**	**171**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Titan 130 Turbine	20,500	hp	Natural Gas	100	0.120	10.38	0.119	63.6	0.476	75.5
Solar Mars 100 Turbine	15,900	hp	Natural Gas	100	0.085	7.46	0.085	46.0	0.340	54.5
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.055	4.67	0.053	28.8	0.212	34.1
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	100	0.020	1.650	0.019	10.20	0.076	12.10
Total (tons/yr)					**0.280**	**24.2**	**0.276**	**149**	**1.10**	**176**
Total SUSD Emissions (tons/yr)					**0.520**	**46.1**	**0.527**	**295**	**2.11**	**347**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1,691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2,803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Titan 130 Turbine	100	2.216	2.293	75.6	1,893	0.125
Solar Mars 100 Turbine	100	2.216	2.293	75.6	1,893	0.125
Solar Taurus 70 Turbine	100	2.216	2.293	75.6	1,893	0.125
Solar Taurus 60 Turbine	100	2.216	2.293	75.6	1,893	0.125
Total (tons/yr)		**8.87**	**9.17**	**303**	**7,573**	**0.500**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Titan 130 Turbine	100	3.67	3.80	125	3,139	0.207
Solar Mars 100 Turbine	100	3.67	3.80	125	3,139	0.207
Solar Taurus 70 Turbine	100	3.67	3.80	125	3,139	0.207
Solar Taurus 60 Turbine	100	3.67	3.80	125	3,139	0.207
Total (tons/yr)		**14.7**	**15.2**	**502**	**12,555**	**0.830**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
ACP-1	1	1.167	1.21	39.8	996	0.066
Total (tons/yr)		**1.167**	**1.21**	**39.8**	**996**	**0.066**
Total Blowdown Emissions (tons/yr)		**24.7**	**25.6**	**844**	**21,124**	**1.40**

Table 9A-1-4 Combustion Source Criteria Pollutant Emission Factors
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Solar Turbine Normal Operation Emission Factors (lb/hr)															
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**	**NH3**
Solar Taurus 60 Turbine	Natural Gas	lb/hr	2.40	4.00	0.230	0.25	0.42	0.42	0.42	1.03	8633	0.62	0.22	8713	0.979
Solar Taurus 70 Turbine	Natural Gas	lb/hr	3.18	5.30	0.310	0.33	0.55	0.55	0.55	1.37	11411	0.83	0.29	11517	1.317
Solar Mars 100 Turbine	Natural Gas	lb/hr	4.68	7.90	0.450	0.48	0.82	0.82	0.82	2.03	16963	1.23	0.43	17121	1.854
Solar Titan 130 Turbine	Natural Gas	lb/hr	5.70	9.60	0.550	0.59	1.00	1.00	1.00	2.46	20565	1.49	0.52	20757	2.33

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) NH3 emission rates based on a 10 ppm ammonia slip from the SCR based on manufacturer information
(5) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(6) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Taurus 60 Turbine	Natural Gas	lb/hr	32.0	24.0	0.460	18.7	1,600	9.20
Solar Taurus 70 Turbine	Natural Gas	lb/hr	42.4	31.8	0.620	24.7	2,120	12.4
Solar Mars 100 Turbine	Natural Gas	lb/hr	62.4	47.4	0.900	36.4	3,160	18.0
Solar Titan 130 Turbine	Natural Gas	lb/hr	76.0	57.6	1.10	44.33	3,840	22.0

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown Efs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Taurus 60 Turbine	Natural Gas	lb/event	0.7	64.3	0.7	410	3.0	484	0.4	33.0	0.4	204	1.5	242
Solar Taurus 70 Turbine	Natural Gas	lb/event	0.8	73.1	0.8	519	3.4	603	1.1	93.4	1.1	575	4.2	681
Solar Mars 100 Turbine	Natural Gas	lb/event	1.4	123.5	1.4	829	5.7	971	1.7	149.2	1.7	920	6.8	1090
Solar Titan 130 Turbine	Natural Gas	lb/event	1.9	176.9	2.0	1161	8.1	1363	2.4	207.6	2.4	1272	9.5	1510

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Engine and Boiler Emission Factors															
Equipment Type	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**	**NH3**
Boiler < 100 MMBtu	Natural Gas	lb/MMscf	50	84	5.5	0.6	1.9	1.9	1.9	5.7	120000	2.3	2.2	120713	0.00
Engine 2 SLB	Natural Gas	lb/MMBtu	3.17	0.386	0.12	0.000588	0.0384	0.0384	0.0384	0.00991	110	1.45	0	146	0.00
1500 KW Caterpillar Egen	Natural Gas	lb/hp-hr	0.001102	0.004298	0.001168	4.08E-06	0.0002663	0.0002663	0.000266	6.87E-05	0.98078	0.00983	0	1	0.00

Notes
(1) NOx, CO, VOC, and PMF-10 Emission Factors for Boilers < 100 MMBtu from ETI Combustion Analysis June 2015
(2) All other emission factors for natural gas boilers taken from AP-42 Tables 1.4-1 & 1.4-2
(3) Emission Factors for 2 SLB engine taken from AP-42 Table 3.2-1
(4) NOx, CO, VOC, CO2, and CH4 emission factors for Caterpillar Egens taken from Caterpillar Manufacturer data
(5) SO2, PMF, PMF-10, PMF-2.5, PMC, and N2O Emission factors for Caterpillar Egens taken from AP-42 Table 3.2-1 and converted using manufacturer fuel data
(6) Assume PMF=PMF-10=PMF-2.5
(7) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(8) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR 98]

Table 9A-1-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Annual HAP Emissions (lb/yr)									
Quantity @ ACP-1		1	1	1	1	1	1	1	1
Pollutant	HAP?	Solar Taurus 60 Turbine	Solar Taurus 70 Turbine	Solar Mars 100 Turbine	Solar Titan 130 Turbine	Boiler < 100 MMBtu	Boiler < 100 MMBtu	Boiler < 100 MMBtu	1500 KW Caterpillar Egen
		7700	10915	15900	20500	10.7	0.5	0.2	2098
		hp	hp	hp	hp	MMBTU/hr	MMBTU/hr	MMBTU/hr	hp
		7965	7205	7395	7025				
		Btu/hp-hr	Btu/hp-hr	Btu/hp-hr	Btu/hp-hr				
1,1,2,2-Tetrachloroethane	Yes								0.035
1,1,2-Trichloroethane	Yes								0.028
1,1-Dichloroethane	Yes								0.021
1,2,3-Trimethylbenzene	No								0.019
1,2,4-Trimethylbenzene	No								0.059
1,2-Dichloroethane	Yes								0.023
1,2-Dichloropropane	Yes								0.024
1,3,5-Trimethylbenzene	No								0.010
1,3-Butadiene	Yes								0.438
1,3-Dichloropropene	Yes								0.023
2,2,4-Trimethylpentane	Yes								0.452
2-Methylnaphthalene	No					0.002	0.000	0.000	0.011
3-Methylchloranthrene	No					0.0002	0.0000	0.0000	
7,12-Dimethylbenz(a)anthracene	No					0.001	0.000	0.000	
Acenaphthene	No					0.0002	0.0000	0.0000	0.001
Acenaphthylene	No					0.0002	0.0000	0.0000	0.002
Acetaldehyde	Yes								4.142
Acrolein	Yes								4.153
Anthracene	No					0.0002	0.0000	0.0000	0.000
Benz(a)anthracene	No					0.0002	0.0000	0.0000	0.000
Benzene	Yes					0.193	0.009	0.004	1.036
Benzo(a)pyrene	No					0.0001	0.0000	0.0000	0.000
Benzo(b)fluoranthene	No					0.0002	0.0000	0.0000	0.000
Benzo(e)pyrene	No								0.000
Benzo(g,h,i)perylene	No					0.0001	0.0000	0.0000	0.000
Benzo(k)fluoranthene	No					0.0002	0.0000	0.0000	0.000
Biphenyl	Yes								0.002
Butane	No					192.978	9.018	3.607	2.536
Butyr/Isobutyraldehyde	No								0.233
Carbon Tetrachloride	Yes								0.032
Chlorobenzene	Yes								0.024
Chloroethane	Yes								
Chloroform	Yes								0.025
Chrysene	No					0.0002	0.0000	0.0000	0.000
Cyclohexane	No								0.164
Cyclopentane	No								0.051
Dibenzo(a,h)anthracene	No					0.0001	0.0000	0.0000	
Dichlorobenzene	Yes					0.110	0.005	0.002	
Ethane	No					284.872	13.312	5.325	37.847
Ethylbenzene	Yes								0.058
Ethylene Dibromide	Yes								0.039
Fluoranthene	No					0.0003	0.0000	0.0000	0.000
Fluorene	No					0.0003	0.0000	0.0000	0.001
Formaldehyde	Yes	773.647	992.029	1483.207	1816.631	6.892	0.322	0.129	29.466
Hexane (or n-Hexane)	Yes					165.409	7.729	3.092	0.238
Indeno(1,2,3-c,d)pyrene	No					0.0002	0.0000	0.0000	0.000
Isobutane	No								2.002
Methanol	Yes								1.324
Methylcyclohexane	No								0.180
Methylene Chloride	Yes								0.078
n-Nonane	No								0.016
n-Octane	No								0.040
Naphthalene	Yes					0.056	0.003	0.001	0.051
PAH	Yes								0.072
Pentane (or n-Pentane)	No					238.925	11.165	4.466	0.817
Perylene	No								0.000
Phenanthrene	No					0.002	0.000	0.000	0.002
Phenol	Yes								0.022
Propane	No					147.031	6.871	2.748	15.320
Propylene Oxide	Yes								
Pyrene	No					0.0005	0.0000	0.0000	0.000
Styrene	Yes								0.029
Tetrachloroethane	No								
Toluene	Yes					0.312	0.015	0.006	0.514
Vinyl Chloride	Yes								0.013
Xylene	Yes								0.143
Arsenic	Yes					0.018	0.001	0.000	
Barium	No					0.404	0.019	0.008	
Beryllium	Yes					0.001	0.000	0.000	
Cadmium	Yes					0.101	0.005	0.002	
Chromium	Yes					0.129	0.006	0.002	
Cobalt	Yes					0.008	0.000	0.000	

Table 9A-1-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Annual HAP Emissions (lb/yr)									
Quantity @ ACP-1		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Pollutant	**HAP?**	**Solar Taurus 60 Turbine**	**Solar Taurus 70 Turbine**	**Solar Mars 100 Turbine**	**Solar Titan 130 Turbine**	**Boiler < 100 MMBtu**	**Boiler < 100 MMBtu**	**Boiler < 100 MMBtu**	**1500 KW Caterpillar Egen**
		7700	**10915**	**15900**	**20500**	**10.7**	**0.5**	**0.2**	**2098**
		hp	**hp**	**hp**	**hp**	**MMBTU/hr**	**MMBTU/hr**	**MMBTU/hr**	**hp**
Copper	No					0.078	0.004	0.001	
Manganese	Yes					0.035	0.002	0.001	
Mercury	Yes					0.024	0.001	0.000	
Molybdenum	No					0.101	0.005	0.002	
Nickel	Yes					0.193	0.009	0.004	
Selenium	Yes					0.002	0.000	0.000	
Vanadium	No					0.211	0.010	0.004	
Zinc	No					2.665	0.125	0.050	
Lead	Yes					0.046	0.002	0.001	
Total HAPs		819.314	1050.586	1570.758	1923.863				
Total HAP/unit (lb/yr)		**819**	**1051**	**1571**	**1924**	**174**	**8.11**	**3.24**	**43**
Total HAP/unit (TPY)		**0.410**	**0.525**	**0.785**	**0.962**	**0.087**	**0.004**	**0.002**	**0.021**

Hazardous Air Pollutant

Notes:
(1) Emissions above are on a per unit basis
(2) Calculations for the Caterpillar emergency generator assume 100 hours of operation; all other calculations assume 8,760 hours of operation
(3) Heat rates for Solar Turbines taken from Solar Datasheets
(4) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table 9A-1-6 Combustion Source HAP Emission Factors
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Pollutant	HAP?	Emission Factors					
		Solar Taurus 60 Turbine	Solar Taurus 70 Turbine	Solar Mars 100 Turbine	Solar Titan 130 Turbine	Boiler < 100 MMBtu	1500 KW Caterpillar Egen
		lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMscf	lb/hp-hr
1,1,2,2-Tetrachloroethane	Yes						1.7E-07
1,1,2-Trichloroethane	Yes						1.3E-07
1,1-Dichloroethane	Yes						9.9E-08
1,2,3-Trimethylbenzene	No						9.0E-08
1,2,4-Trimethylbenzene	No						2.8E-07
1,2-Dichloroethane	Yes						1.1E-07
1,2-Dichloropropane	Yes						1.1E-07
1,3,5-Trimethylbenzene	No						4.6E-08
1,3-Butadiene	Yes						2.1E-06
1,3-Dichloropropene	Yes						1.1E-07
2,2,4-Trimethylpentane	Yes						2.2E-06
2-Methylnaphthalene	No					2.4E-05	5.4E-08
3-Methylchloranthrene	No					1.8E-06	
7,12-Dimethylbenz(a)anthracene	No					1.6E-05	
Acenaphthene	No					1.8E-06	3.4E-09
Acenaphthylene	No					1.8E-06	8.1E-09
Acetaldehyde	Yes						2.0E-05
Acrolein	Yes						2.0E-05
Anthracene	No					2.4E-06	1.8E-09
Benz(a)anthracene	No					1.8E-06	8.5E-10
Benzene	Yes					2.1E-03	4.9E-06
Benzo(a)pyrene	No					1.2E-06	1.4E-11
Benzo(b)fluoranthene	No					1.8E-06	2.2E-11
Benzo(e)pyrene	No						6.0E-11
Benzo(g,h,i)perylene	No					1.2E-06	6.3E-11
Benzo(k)fluoranthene	No					1.8E-06	1.1E-11
Biphenyl	Yes						1.0E-08
Butane	No					2.1E+00	1.2E-05
Butyr/Isobutyraldehyde	No						1.1E-06
Carbon Tetrachloride	Yes						1.5E-07
Chlorobenzene	Yes						1.1E-07
Chloroethane	Yes						
Chloroform	Yes						1.2E-07
Chrysene	No					1.8E-06	1.7E-09
Cyclohexane	No						7.8E-07
Cyclopentane	No						2.4E-07
Dibenzo(a,h)anthracene	No					1.2E-06	
Dichlorobenzene	Yes					1.2E-03	
Ethane	No					3.1E+00	1.8E-04
Ethylbenzene	Yes						2.7E-07
Ethylene Dibromide	Yes						1.9E-07
Fluoranthene	No					3.0E-06	9.2E-10
Fluorene	No					2.8E-06	4.3E-09
Formaldehyde	Yes	2.9E-03	2.9E-03	2.9E-03	2.9E-03	7.5E-02	1.4E-04
Hexane (or n-Hexane)	Yes					1.8E+00	1.1E-06
Indeno(1,2,3-c,d)pyrene	No					1.8E-06	2.5E-11
Isobutane	No						9.5E-06
Methanol	Yes						6.3E-06
Methylcyclohexane	No						8.6E-07
Methylene Chloride	Yes						3.7E-07
n-Nonane	No						7.8E-08
n-Octane	No						1.9E-07
Naphthalene	Yes					6.1E-04	2.5E-07
PAH	Yes						3.4E-07
Pentane (or n-Pentane)	No					2.6E+00	3.9E-06
Perylene	No						1.3E-11
Phenanthrene	No					1.7E-05	9.0E-09
Phenol	Yes						1.1E-07
Propane	No					1.6E+00	7.3E-05
Propylene Oxide	Yes						
Pyrene	No					5.0E-06	1.5E-09

Table 9A-1-6 Combustion Source HAP Emission Factors
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Pollutant	HAP?	Emission Factors					
		Solar Taurus 60 Turbine	Solar Taurus 70 Turbine	Solar Mars 100 Turbine	Solar Titan 130 Turbine	Boiler < 100 MMBtu	1500 KW Caterpillar Egen
		lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMscf	lb/hp-hr
Styrene	Yes						1.4E-07
Tetrachloroethane	No						
Toluene	Yes					3.4E-03	2.5E-06
Vinyl Chloride+A32	Yes						6.3E-08
Xylene	Yes						6.8E-07
Arsenic	Yes					2.0E-04	
Barium	No					4.4E-03	
Beryllium	Yes					1.2E-05	
Cadmium	Yes					1.1E-03	
Chromium	Yes					1.4E-03	
Cobalt	Yes					8.4E-05	
Copper	No					8.5E-04	
Manganese	Yes					3.8E-04	
Mercury	Yes					2.6E-04	
Molybdenum	No					1.1E-03	
Nickel	Yes					2.1E-03	
Selenium	Yes					2.4E-05	
Vanadium	No					2.3E-03	
Zinc	No					2.9E-02	
Lead	Yes					5.0E-04	
Total Haps		3.1E-03	3.1E-03	3.1E-03	3.1E-03		

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for natural gas boilers from AP-42 Tables 1.4-2, 1.4-3, and 1.4-4
(3) Emission factors for 2 SLB natural gas engines and Caterpillar natural gas emergency generators taken from AP-42 Table 3.2-1
(4) Emission factors for Solar natural gas turbines and Caterpillar emergency generators converted using 1 KWh = 3412 Btu and 1 kw = 1.341 hp
(5) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL 168

Table 9A-1-7 Potential Emissions From Fugitive Leaks
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Fugitive Emissions (FUG)

Source Designation:	FUG-02

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr	CH_4 Weight Fraction[1]	Fug Emission Rate tpy
Solar Turbine	Gas	2.67E-02	0.934	250

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	952	4.28	18.8	0.026	0.492	0.0271	0.509	0.895	16.8	1.48E-03	2.78E-02
Compressors	Gas	5.71E+01	4	228	1001	0.026	26.2	0.0271	27.1	0.895	895	1.48E-03	1.48E+00
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04	3	6.00E-04	2.63E-03	0.026	6.89E-05	0.0271	7.13E-05	0.895	2.35E-03	1.48E-03	3.89E-06
Flanges	Gas	3.90E-04	658	0.257	1.124	0.026	0.029	0.0271	0.030	0.895	1.006	1.48E-03	1.66E-03
Open-ended lines	Gas	2.00E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.000	1.48E-03	0.00E+00
			Total	233	1021	-	26.8	-	27.7	-	913	-	1.51E+00

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.
3. Source count for fugitive emissions includes equipment from ACP-1, ACP Kincheloe M&R station, and SHP CNX M&R Station.
4. SHP CNX M&R Station source counts based on Long Run M&R Station equipment counts.

Sample Calculations:

Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count

Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table 9A-1-8 Tank Emissions
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Source Designation:	TK-1, TK-2, TK-3

Tank Parameters

Source	Type of Tank	Contents	Capacity	Throughput	Tank Diam.	Tank Length	Paint Color	Paint Condition
			(gal)	gal/yr	ft	ft		
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	2,000	10,000	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	1.03E-06	4.50E-06	2.98E-06	1.31E-05	4.01E-06	1.76E-05

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.
3. Losses (Emissions) from TK-3 8,000-gallon Ammonia tank assumed to be insignficant.

Table 9A-1-9 Project Potential Emissions
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Titan 130 Turbine	CT-01	15.0	27.8	1.43	2.58	4.4	4.4	4.4	10.80	90,196	7.40	2.27	91,059	10.2	0.962
Solar Mars 100 Turbine	CT-02	12.3	20.7	1.14	2.12	3.60	3.60	3.60	8.90	74,385	6.00	1.87	75,094	8.12	0.785
Solar Taurus 70 Turbine	CT-03	8.35	13.08	0.775	1.43	2.42	2.42	2.42	5.99	50,035	4.00	1.26	50,511	5.77	0.525
Solar Taurus 60 Turbine	CT-04	6.28	8.46	0.561	1.08	1.83	1.83	1.83	4.53	37,843	2.96	0.954	38,201	4.29	0.410
Caterpillar G3516C Egen	EG-01	0.116	0.45	0.123	0.000	0.028	0.028	0.028	0.007	103	1.03	0.00	129	0.00	0.021
Boiler	WH-01	2.30	3.86	0.253	0.028	0.087	0.087	0.087	0.262	5,514	0.106	0.101	5,546	0.00	0.087
Fugitive Leaks - Blowdowns	FUG-01	-	-	24.73	-	-	-	-	-	25.59	844	-	21,124	-	1.396
Fugitive Leaks - Piping	FUG-02	-	-	26.8	-	-	-	-	-	27.7	913	-	22,856	-	1.51
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	1.76E-05	-	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**44.4**	**74.4**	**56.1**	**7.24**	**12.3**	**12.3**	**12.3**	**30.5**	**258,130**	**1,779**	**6.46**	**304,519**	**28.4**	**5.70**

Table 9A-2-1 Project Equipment List
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Emission Point ID	Source	Manufacturer	Model/Type	Rated Capacity
CT-01	Compressor Turbine	Solar Turbines	Mars 100-16000S	15,900 hp
CT-02	Compressor Turbine	Solar Turbines	Taurus 70-10802S	10,915 hp
CT-03	Compressor Turbine	Solar Turbines	Taurus 60-7800S	7,700 hp
CT-04	Compressor Turbine	Solar Turbines	Centaur 50-6200LS	6,200 hp
WH-01	Boiler	TBD	TBD	9.5 MMBtu/hr
LH-01	Line Heater	ETI	WB HTR	17 MMBtu/hr
LH-02	Line Heater	ETI	WB HTR	17 MMBtu/hr
LH-03	Line Heater	ETI	WB HTR	17 MMBtu/hr
LH-04	Line Heater	ETI	WB HTR	17 MMBtu/hr
MT-01	Microturbine	Capstone	C200	200 kW
MT-02	Microturbine	Capstone	C200	200 kW
MT-03	Microturbine	Capstone	C200	200 kW
MT-04	Microturbine	Capstone	C200	200 kW
MT-05	Microturbine	Capstone	C200	200 kW
MT-06	Microturbine	Capstone	C200	200 kW
MT-07	Microturbine	Capstone	C200	200 kW
MT-08	Microturbine	Capstone	C200	200 kW
MT-09	Microturbine	Capstone	C200	200 kW
MT-10	Microturbine	Capstone	C200	200 kW
FUG-01	Fugitive Leaks - Blowdowns	-	-	-
FUG-02	Fugitive Leaks - Piping	-	-	-
TK-1	Accumulator Tank	-	-	2,500 gal
TK-2	Hydrocarbon (Waste Oil) Tank	--	--	2,000 gal
TK-3	Ammonia Tank	--	--	8,000 gal

Table 9A-2-2 Potential Emissions From Combustion Sources
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr	8,760

Microturbine Operational Hours:

Normal Hours of Operation:	8,760

Boiler/Heater Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Mars 100 Turbine	15,900	hp	Natural Gas	21.9	35.5	1.97	2.12	3.60	3.60	3.60	8.90	74,298	5.37	1.87	74,991	8.12	0.785
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.9	23.8	1.36	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	5.77	0.525
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	11.2	18.0	1.01	1.08	1.83	1.83	1.83	4.53	37,813	2.73	0.954	38,165	4.29	0.410
Solar Centaur 50L Turbine	6,200	hp	Natural Gas	9.25	14.8	0.834	0.894	1.51	1.51	1.51	3.74	31,295	2.26	0.788	31,587	3.58	0.352
Boiler	9.5	MMBtu/hr	Natural Gas	2.04	3.43	0.224	0.024	0.078	0.078	0.078	0.233	4,895	0.094	0.090	4924.38	0.00	0.077
M&R Heater 1 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812.06	0.00	0.138
M&R Heater 2 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812.06	0.00	0.138
M&R Heater 3 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812.06	0.00	0.138
M&R Heater 4 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812.06	0.00	0.138
MicroTurbine 1 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 2 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 3 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 4 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 5 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 6 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 7 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 8 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 9 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
MicroTurbine 10 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336.38	0.00	0.003
Total (tons/yr)				**67**	**117**	**8.07**	**5.83**	**9.9**	**9.9**	**9.9**	**25.19**	**246,636**	**15.6**	**5.70**	**248,725**	**21.8**	**2.73**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Selective Catalytic Reduction	44%	-	-
Oxidation Catalyst	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Mars 100 Turbine	15900	hp	Natural Gas	12.1	7.1	0.99	2.12	3.60	3.60	3.60	8.90	74,298	5.37	1.87	74,991	8.12	0.785
Solar Taurus 70 Turbine	10915	hp	Natural Gas	8.25	4.8	0.680	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	5.77	0.525
Solar Taurus 60 Turbine	7700	hp	Natural Gas	6.23	3.6	0.505	1.08	1.83	1.83	1.83	4.53	37,813	2.73	0.954	38,165	4.29	0.410
Solar Centaur 50L Turbine	6200	hp	Natural Gas	5.14	3.0	0.417	0.894	1.51	1.51	1.51	3.74	31,295	2.26	0.788	31,587	3.58	0.352
Boiler	9.5	MMBtu/hr	Natural Gas	2.04	3.43	0.224	0.024	0.078	0.078	0.078	0.233	4,895	0.094	0.090	4,924	0.00	0.077
M&R Heater 1 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
M&R Heater 2 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
M&R Heater 3 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
M&R Heater 4 (Woods Corner)	17	MMBtu/hr	Natural Gas	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
MicroTurbine 1 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 2 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 3 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 4 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 5 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 6 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 7 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 8 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 9 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
MicroTurbine 10 (Woods Corner)	200	KW	Natural Gas	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
Total (tons/yr)				**41.1**	**43.8**	**5.48**	**5.83**	**9.9**	**9.9**	**9.9**	**25.2**	**246,636**	**15.6**	**5.70**	**248,725**	**21.8**	**2.731**

Notes:
(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) MicroTurbine emissions are calculated by the following formula: Power Rating * Run Hours * EF / 1000 / 2000
Power Rating = Engine kW rating (kW)
EF = Emission Factor from either manufacturer's data or AP-42 (lb/MWh)
2000 = the amount of lbs in a ton
1000 = the amount of kW in a MW
(3) Boiler/Heater emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF) for Boilers; Heaters use manufacturer EF where available.
Power Rating = Boiler/Heater Heat Capacity (MMBtu/hr)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
(4) Turbines are equipped with Selective Catalytic Reduction (SCR) and oxidation catalyst for control of NOx (44%), CO (80%), and VOC (50%)
(5) Boiler assumed to have low-NOx burners
(6) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(7) See Emissions Factors table for Emissions Factors for each operating scenario.
(8) Each start-up/shut-down event assumed to last 10 minutes

Table 9A-2-3 Event Based Potential Emissions From Combustion Sources
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Mars 100 Turbine	15,900	hp	Natural Gas	100	0.070	6.18	0.071	41.5	0.284	48.6
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.040	3.66	0.042	25.95	0.168	30.2
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	100	0.035	3.22	0.037	20.50	0.148	24.20
Solar Centaur 50L Turbine	6,200	hp	Natural Gas	100	0.040	3.46	0.040	23.45	0.160	27.45
Total (tons/yr)					**0.185**	**16.50**	**0.190**	**111.4**	**0.760**	**130.4**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Mars 100 Turbine	15,900	hp	Natural Gas	100	0.085	7.46	0.085	46.0	0.340	54.5
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.055	4.67	0.053	28.8	0.212	34.1
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	100	0.020	1.650	0.019	10.20	0.076	12.10
Solar Centaur 50L Turbine	6,200	hp	Natural Gas	100	0.020	1.770	0.020	10.85	0.080	12.85
Total (tons/yr)					**0.180**	**15.55**	**0.177**	**95.8**	**0.708**	**113.5**
Total SUSD Emissions (tons/yr)					**0.365**	**32.1**	**0.367**	**207**	**1.468**	**244**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Mars 100 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Taurus 70 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Taurus 60 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Centaur 50L Turbine	100	2.216	2.293	75.634	1,893	0.125
Total (tons/yr)		**8.866**	**9.173**	**303**	**7,573**	**0.500**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Mars 100 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Taurus 70 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Taurus 60 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Centaur 50L Turbine	100	3.675	3.80	125.39	3,139	0.207
Total (tons/yr)		**14.698**	**15.21**	**502**	**12,555**	**0.830**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
ACP-2	1	1.167	1.21	39.8	996	0.066
Total (tons/yr)		**1.167**	**1.21**	**39.8**	**996**	**0.066**
Total Blowdown Emissions (tons/yr)		**24.73**	**25.6**	**844**	**21,124**	**1.396**

Table 9A-2-4 Combustion Source Criteria Pollutant Emission Factors
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Solar Turbine Normal Operation Emission Factors (lb/hr)															
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**	**NH3**
Solar Centaur 50L Turbine	Natural Gas	lb/hr	1.98	3.30	0.190	0.20	0.35	0.35	0.35	0.85	7145	0.52	0.18	7212	0.818
Solar Taurus 60 Turbine	Natural Gas	lb/hr	2.40	4.00	0.230	0.25	0.42	0.42	0.42	1.03	8633	0.62	0.22	8713	0.979
Solar Taurus 70 Turbine	Natural Gas	lb/hr	3.18	5.30	0.310	0.33	0.55	0.55	0.55	1.37	11411	0.83	0.29	11517	1.317
Solar Mars 100 Turbine	Natural Gas	lb/hr	4.68	7.90	0.450	0.48	0.82	0.82	0.82	2.03	16963	1.23	0.43	17121	1.854
Solar Titan 130 Turbine	Natural Gas	lb/hr	5.70	9.60	0.550	0.59	1.00	1.00	1.00	2.46	20565	1.49	0.52	20757	2.33

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) NH3 emission rates based on a 10 ppm ammonia slip from the SCR based on manufacturer information
(5) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(6) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Centaur 50L Turbine	Natural Gas	lb/hr	26.4	19.8	0.380	15.4	1,320	7.60
Solar Taurus 60 Turbine	Natural Gas	lb/hr	32.0	24.0	0.460	18.7	1,600	9.20
Solar Taurus 70 Turbine	Natural Gas	lb/hr	42.4	31.8	0.620	24.7	2,120	12.4
Solar Mars 100 Turbine	Natural Gas	lb/hr	62.4	47.4	0.900	36.4	3,160	18.0

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown Efs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Centaur 50L Turbine	Natural Gas	lb/event	0.8	69.1	0.8	469	3.2	549	0.4	35.4	0.4	217	1.6	257
Solar Taurus 60 Turbine	Natural Gas	lb/event	0.7	64.3	0.7	410	3.0	484	0.4	33.0	0.4	204	1.5	242
Solar Taurus 70 Turbine	Natural Gas	lb/event	0.8	73.1	0.8	519	3.4	603	1.1	93.4	1.1	575	4.2	681
Solar Mars 100 Turbine	Natural Gas	lb/event	1.4	123.5	1.4	829	5.7	971	1.7	149.2	1.7	920	6.8	1090

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Engine and Boiler Emission Factors															
Equipment Type	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**	**NH3**
Boiler < 100 MMBtu	Natural Gas	lb/MMscf	50	84	5.5	0.6	1.9	1.9	1.9	5.7	120000	2.3	2.2	120713	0.00
M&R Line Heater	Natural Gas	lb/MMscf	11.22	37.74	6.12	0.6	1.44	1.44	1.44	5.7	120000	2.3	2.2	120713	0.00
Capstone Microturbine	Natural Gas	lb/MWh	0.460	1.250	0.100	0.012	0.006	0.006	0.006	0.016	1520	0.100	0.010	1526	0.00

Notes
(1) NOx, CO, VOC, and PMF-10 Emission Factors for Boilers < 100 MMBtu from ETI Combustion Analysis June 2015
(2) All other emission factors for natural gas boilers taken from AP-42 Tables 1.4-1 & 1.4-2
(3) NOx, CO, VOC, CO2, and CH4 emission factors for Capstone Microturbine taken from Capstone Manufacturer data
(4) SO2, PMF, PMF-10, PMF-2.5, PMC, and N2O Emission factors for Capstone Turbines taken from AP-42 Table 3.1-2a and converted using 1 KWh = 3412 Btu
(5) NOx, CO, VOC, and PMF emission factors for Line Heaters from Manufacturer's data and convered to lb/MMscf using 1020 MMBtu/MMscf
(6) SO2, PMC, CO2, CH4, and N2O emission factors for Line Heaters from AP-42 Tables 1.4-1 & 1.4-2
(7) Assume PMF=PMF-10=PMF-2.5
(8) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(9) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR 98]

Table 9A-2-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Annual HAP Emissions (lb/yr)										
Quantity @ ACP-2		1	1	1	1	1	1	1	4	10
Pollutant	HAP?	Solar Centaur 50L Turbine	Solar Taurus 60 Turbine	Solar Taurus 70 Turbine	Solar Mars 100 Turbine	Boiler < 100 MMBtu	Boiler < 100 MMBtu	Boiler < 100 MMBtu	M&R Line Heater	Capstone Microturbine
		6200	7700	10915	15900	9.5	0.5	0.2	17	200
		hp	hp	hp	hp	MMBTU/hr	MMBTU/hr	MMBTU/hr	MMBTU/hr	kW
		8500	7965	7205	7395					
		Btu/hp-hr	Btu/hp-hr	Btu/hp-hr	Btu/hp-hr					
1,1,2,2-Tetrachloroethane	Yes									
1,1,2-Trichloroethane	Yes									
1,1-Dichloroethane	Yes									
1,2,3-Trimethylbenzene	No									
1,2,4-Trimethylbenzene	No									
1,2-Dichloroethane	Yes									
1,2-Dichloropropane	Yes									
1,3,5-Trimethylbenzene	No									
1,3-Butadiene	Yes									0.003
1,3-Dichloropropene	Yes									
2,2,4-Trimethylpentane	Yes									
2-Methylnaphthalene	No					0.002	0.000	0.000	0.004	
3-Methylchloranthrene	No					0.000	0.000	0.000	0.000	
7,12-Dimethylbenz(a)anthracene	No					0.001	0.000	0.000	0.002	
Acenaphthene	No					0.000	0.000	0.000	0.000	
Acenaphthylene	No					0.000	0.000	0.000	0.000	
Acetaldehyde	Yes									0.239
Acrolein	Yes									0.038
Anthracene	No					0.000	0.000	0.000	0.000	
Benz(a)anthracene	No					0.000	0.000	0.000	0.000	
Benzene	Yes					0.171	0.009	0.004	0.307	0.072
Benzo(a)pyrene	No					0.000	0.000	0.000	0.000	
Benzo(b)fluoranthene	No					0.000	0.000	0.000	0.000	
Benzo(e)pyrene	No									
Benzo(g,h,i)perylene	No					0.000	0.000	0.000	0.000	
Benzo(k)fluoranthene	No					0.000	0.000	0.000	0.000	
Biphenyl	Yes									
Butane	No					171.335	9.018	3.607	306.600	
Butyr/Isobutyraldehyde	No									
Carbon Tetrachloride	Yes									
Chlorobenzene	Yes									
Chloroethane	Yes									
Chloroform	Yes									
Chrysene	No					0.000	0.000	0.000	0.000	
Cyclohexane	No									
Cyclopentane	No									
Dibenzo(a,h)anthracene	No					0.000	0.000	0.000	0.000	
Dichlorobenzene	Yes					0.098	0.005	0.002	0.175	
Ethane	No					252.924	13.312	5.325	452.600	
Ethylbenzene	Yes									0.191
Ethylene Dibromide	Yes									
Fluoranthene	No					0.000	0.000	0.000	0.000	
Fluorene	No					0.000	0.000	0.000	0.000	
Formaldehyde	Yes	664.779	773.647	992.029	1483.207	6.119	0.322	0.129	10.950	4.244
Hexane (or n-Hexane)	Yes					146.859	7.729	3.092	262.800	
Indeno(1,2,3-c,d)pyrene	No					0.000	0.000	0.000	0.000	
Isobutane	No									
Methanol	Yes									
Methylcyclohexane	No									
Methylene Chloride	Yes									
n-Nonane	No									
n-Octane	No									
Naphthalene	Yes					0.050	0.003	0.001	0.089	0.008
PAH	Yes									0.013
Pentane (or n-Pentane)	No					212.129	11.165	4.466	379.600	
Perylene	No									
Phenanthrene	No					0.001	0.000	0.000	0.002	
Phenol	Yes									
Propane	No					130.541	6.871	2.748	233.600	
Propylene Oxide	Yes									0.173
Pyrene	No					0.000	0.000	0.000	0.001	
Styrene	Yes									
Tetrachloroethane	No									
Toluene	Yes					0.277	0.015	0.006	0.496	0.777
Vinyl Chloride	Yes									
Xylene	Yes									0.383
Arsenic	Yes					0.016	0.001	0.000	0.029	
Barium	No					0.359	0.019	0.008	0.642	
Beryllium	Yes					0.001	0.000	0.000	0.002	
Cadmium	Yes					0.090	0.005	0.002	0.161	
Chromium	Yes					0.114	0.006	0.002	0.204	
Cobalt	Yes					0.007	0.000	0.000	0.012	
Copper	No					0.069	0.004	0.001	0.124	
Manganese	Yes					0.031	0.002	0.001	0.055	
Mercury	Yes					0.021	0.001	0.000	0.038	
Molybdenum	No					0.090	0.005	0.002	0.161	
Nickel	Yes					0.171	0.009	0.004	0.307	
Selenium	Yes					0.002	0.000	0.000	0.004	
Vanadium	No					0.188	0.010	0.004	0.336	

Table 9A-2-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Annual HAP Emissions (lb/yr)										
Quantity @ ACP-2		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**4**	**10**
Pollutant	**HAP?**	**Solar Centaur 50L Turbine**	**Solar Taurus 60 Turbine**	**Solar Taurus 70 Turbine**	**Solar Mars 100 Turbine**	**Boiler < 100 MMBtu**	**Boiler < 100 MMBtu**	**Boiler < 100 MMBtu**	**M&R Line Heater**	**Capstone Microturbine**
		6200	**7700**	**10915**	**15900**	**9.5**	**0.5**	**0.2**	**17**	**200**
		hp	**hp**	**hp**	**hp**	**MMBTU/hr**	**MMBTU/hr**	**MMBTU/hr**	**MMBTU/hr**	**kW**
Zinc	No					2.366	0.125	0.050	4.234	
Lead	Yes					0.041	0.002	0.001	0.073	
Total HAPs		704.019	819.314	1050.586	1570.758					
Total HAP/unit (lb/yr)		**704**	**819**	**1051**	**1571**	**154**	**8.11**	**3.24**	**276**	**6.141**
Total HAP/unit (TPY)		**0.352**	**0.410**	**0.525**	**0.785**	**0.077**	**0.004**	**0.002**	**0.138**	**0.003**

Hazardous Air Pollutant

Notes:
(1) Emissions above are on a per unit basis
(2) Heat rates for Solar Turbines taken from Solar Datasheets
(3) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table 9A-2-6 Combustion Source HAP Emission Factors
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Pollutant	HAP?	Emission Factors					
		Solar Centaur 50L Turbine	Solar Taurus 60 Turbine	Solar Taurus 70 Turbine	Solar Mars 100 Turbine	Boiler/Line Heater < 100 MMBtu	Capstone Microturbine
		lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMscf	lb/kW-hr
1,1,2,2-Tetrachloroethane	Yes						
1,1,2-Trichloroethane	Yes						
1,1-Dichloroethane	Yes						
1,2,3-Trimethylbenzene	No						
1,2,4-Trimethylbenzene	No						
1,2-Dichloroethane	Yes						
1,2-Dichloropropane	Yes						
1,3,5-Trimethylbenzene	No						
1,3-Butadiene	Yes						1.5E-09
1,3-Dichloropropene	Yes						
2,2,4-Trimethylpentane	Yes						
2-Methylnaphthalene	No					2.4E-05	
3-Methylchloranthrene	No					1.8E-06	
7,12-Dimethylbenz(a)anthracene	No					1.6E-05	
Acenaphthene	No					1.8E-06	
Acenaphthylene	No					1.8E-06	
Acetaldehyde	Yes						1.4E-07
Acrolein	Yes						2.2E-08
Anthracene	No					2.4E-06	
Benz(a)anthracene	No					1.8E-06	
Benzene	Yes					2.1E-03	4.1E-08
Benzo(a)pyrene	No					1.2E-06	
Benzo(b)fluoranthene	No					1.8E-06	
Benzo(e)pyrene	No						
Benzo(g,h,i)perylene	No					1.2E-06	
Benzo(k)fluoranthene	No					1.8E-06	
Biphenyl	Yes						
Butane	No					2.1E+00	
Butyr/Isobutyraldehyde	No						
Carbon Tetrachloride	Yes						
Chlorobenzene	Yes						
Chloroethane	Yes						
Chloroform	Yes						
Chrysene	No					1.8E-06	
Cyclohexane	No						
Cyclopentane	No						
Dibenzo(a,h)anthracene	No					1.2E-06	
Dichlorobenzene	Yes					1.2E-03	
Ethane	No					3.1E+00	
Ethylbenzene	Yes						1.1E-07
Ethylene Dibromide	Yes						
Fluoranthene	No					3.0E-06	
Fluorene	No					2.8E-06	
Formaldehyde	Yes	2.9E-03	2.9E-03	2.9E-03	2.9E-03	7.5E-02	2.4E-06
Hexane (or n-Hexane)	Yes					1.8E+00	
Indeno(1,2,3-c,d)pyrene	No					1.8E-06	
Isobutane	No						
Methanol	Yes						
Methylcyclohexane	No						
Methylene Chloride	Yes						
n-Nonane	No						
n-Octane	No						
Naphthalene	Yes					6.1E-04	4.4E-09
PAH	Yes						7.5E-09
Pentane (or n-Pentane)	No					2.6E+00	
Perylene	No						
Phenanthrene	No					1.7E-05	
Phenol	Yes						
Propane	No					1.6E+00	
Propylene Oxide	Yes						9.9E-08
Pyrene	No					5.0E-06	
Styrene	Yes						
Tetrachloroethane	No						
Toluene	Yes					3.4E-03	4.4E-07
Vinyl Chloride+A32	Yes						

Table 9A-2-6 Combustion Source HAP Emission Factors
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Pollutant	HAP?	Emission Factors					
		Solar Centaur 50L Turbine	Solar Taurus 60 Turbine	Solar Taurus 70 Turbine	Solar Mars 100 Turbine	Boiler/Line Heater < 100 MMBtu	Capstone Microturbine
		lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMscf	lb/kW-hr
Xylene	Yes						2.2E-07
Arsenic	Yes					2.0E-04	
Barium	No					4.4E-03	
Beryllium	Yes					1.2E-05	
Cadmium	Yes					1.1E-03	
Chromium	Yes					1.4E-03	
Cobalt	Yes					8.4E-05	
Copper	No					8.5E-04	
Manganese	Yes					3.8E-04	
Mercury	Yes					2.6E-04	
Molybdenum	No					1.1E-03	
Nickel	Yes					2.1E-03	
Selenium	Yes					2.4E-05	
Vanadium	No					2.3E-03	
Zinc	No					2.9E-02	
Lead	Yes					5.0E-04	
Total Haps		3.1E-03	3.1E-03	3.1E-03	3.1E-03		

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for natural gas boilers from AP-42 Tables 1.4-2, 1.4-3, and 1.4-4
(3) Emission factors for Solar natural gas turbines and Caterpillar natural gas emergency generators converted using 1 KWh = 3412 Btu and 1 kw = 1.341 hp
(4) Emission factors for Capstone natural gas turbines converted using 1 KWh = 3412 Btu
(5) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL 168

Table 9A-2-7 Potential Emissions From Fugitive Leaks
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Fugitive Emissions (FUG)

Source Designation:	FUG-02

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr	CH_4 Weight Fraction[1]	Fug Emission Rate tpy
Solar Turbine	Gas	2.67E-02	0.934	250

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	755	3.40	14.9	0.026	0.390	0.0271	0.404	0.895	13.3	1.48E-03	2.20E-02
Compressors	Gas	5.71E+01	4	228	1001	0.026	26.2	0.0271	27.1	0.895	895	1.48E-03	1.48E+00
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04	4	8.00E-04	3.50E-03	0.026	9.19E-05	0.0271	9.50E-05	0.895	0.00	1.48E-03	5.19E-06
Flanges	Gas	3.90E-04	509	0.199	0.869	0.026	0.023	0.0271	0.024	0.895	0.778	1.48E-03	1.29E-03
Open-ended lines	Gas	2.00E-03		0.000	0.000	0.026	0.00	0.0271	0.000	0.895	0.000	1.48E-03	0.00E+00
			Total	232.084	1016.529	-	26.7	-	27.6	-	909	-	1.50E+00

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.
3. Source count for fugitive emissions includes equipment from ACP-2 and the Woods Corner M&R station.

Sample Calculations:

Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count

Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table 9A-2-8 Tank Emissions
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Source Designation:	TK-1, TK-2, TK-3

Tank Parameters

Source	Type of Tank	Contents	Capacity	Throughput	Tank Diam.	Tank Length	Paint Color	Paint Condition
			(gal)	gal/yr	ft	ft		
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	2,000	10,000	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	1.03E-06	4.50E-06	2.98E-06	1.31E-05	4.01E-06	1.76E-05

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.
3. Losses (Emissions) from TK-3 8,000-gallon Ammonia tank assumed to be insignficant.

Table 9A-2-9 Project Potential Emissions
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Mars 100 Turbine	CT-01	12.3	20.7	1.14	2.12	3.60	3.60	3.60	8.90	74,385	6.00	1.87	75,094	8.12	0.785
Solar Taurus 70 Turbine	CT-02	8.35	13.08	0.775	1.43	2.42	2.42	2.42	5.99	50,035	4.00	1.26	50,511	5.77	0.525
Solar Taurus 60 Turbine	CT-03	6.28	8.46	0.561	1.08	1.83	1.83	1.83	4.53	37,843	2.96	0.954	38,201	4.29	0.410
Solar Centaur 50L Turbine	CT-04	5.20	8.19	0.477	0.894	1.51	1.51	1.51	3.74	31,329	2.50	0.788	31,627	3.58	0.352
Boiler	WH-01	2.04	3.43	0.224	0.024	0.078	0.078	0.078	0.233	4,895	0.094	0.090	4924	0.00	0.077
M&R Heater 1 (Woods Corner)	LH-01	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812	0.00	0.138
M&R Heater 2 (Woods Corner)	LH-02	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812	0.00	0.138
M&R Heater 3 (Woods Corner)	LH-03	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812	0.00	0.138
M&R Heater 4 (Woods Corner)	LH-04	0.819	2.76	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8812	0.00	0.138
MicroTurbine 1 (Woods Corner)	MT-01	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 2 (Woods Corner)	MT-02	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 3 (Woods Corner)	MT-03	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 4 (Woods Corner)	MT-04	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 5 (Woods Corner)	MT-05	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 6 (Woods Corner)	MT-06	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 7 (Woods Corner)	MT-07	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 8 (Woods Corner)	MT-08	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 9 (Woods Corner)	MT-09	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
MicroTurbine 10 (Woods Corner)	MT-10	0.403	1.10	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1336	0.00	0.00
Fugitive Leaks - Blowdowns	FUG-01	-	-	24.73	-	-	-	-	-	25.59	844		21124	-	1.396
Fugitive Leaks - Piping	FUG-02	-	-	26.7	-	-	-	-	-	27.6	909	-	22764	-	1.50
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	1.76E-05	-	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**41.5**	**75.8**	**57.6**	**5.83**	**9.9**	**9.9**	**9.9**	**25.2**	**246,897**	**1,770**	**5.70**	**292,856**	**21.8**	**5.63**

Table 9A-3-1 Project Equipment List
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Emission Point ID	Source	Manufacturer	Model/Type	Rated Capacity
CT-01	Compressor Turbine	Solar Turbines	Taurus 70-10802S	10,915 hp
CT-02	Compressor Turbine	Solar Turbines	Centaur 50-6200LS	6,200 hp
CT-03	Compressor Turbine	Solar Turbines	Centaur 40-4700S	4,700 hp
EG-01	Emergency Generator	Caterpillar	G3516	1,416 hp
WH-01	Boiler	TBD	TBD	6.3 MMBtu/hr
FUG-01	Fugitive Leaks - Blowdowns	-	-	-
FUG-02	Fugitive Leaks - Piping	-	-	-
TK-1	Accumulator Tank	-	-	2,500 gal
TK-2	Hydrocarbon (Waste Oil) Tank	--	--	1,500 gal
TK-3	Ammonia Tank	--	--	8,000 gal

Table 9A-3-2 Potential Emissions From Combustion Sources
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F)	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr):	8,760

Emergency Generator Operational Hours:

Normal Hours of Operation:	100

Boiler/Heater Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.9	23.8	1.36	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	5.77	0.525
Solar Centaur 50L Turbine	6,200	hp	Natural Gas	9.2	14.8	0.834	0.894	1.51	1.51	1.51	3.74	31,295	2.26	0.788	31,587	3.58	0.352
Solar Centaur 40 Turbine	4,700	hp	Natural Gas	22.0	25.6	0.702	0.760	1.29	1.29	1.29	3.18	26,718	1.92	0.671	26,966	3.02	0.286
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.00	0.014
Boiler	6.3	MMBtu/hr	Natural Gas	1.35	2.27	0.149	0.016	0.051	0.05	0.051	0.154	3246.35	0.062	0.060	3266	0.00	0.051
Total (tons/yr)				**47.7**	**66.8**	**3.08**	**3.10**	**5.29**	**5.29**	**5.29**	**13.07**	**111,317**	**8.15**	**2.78**	**112,350**	**12.4**	**1.23**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Selective Catalytic Reduction (Centaur 40)	80%	-	-
Selective Catalytic Reduction (All Others)	44%	-	-
Oxidation Catalyst (Centaur 40)	-	90%	50%
Oxidation Catalyst (All Others)	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Taurus 70 Turbine	10915	hp	Natural Gas	8.25	4.76	0.680	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	5.77	0.525
Solar Centaur 50L Turbine	6200	hp	Natural Gas	5.14	2.96	0.417	0.894	1.51	1.51	1.51	3.74	31,295	2.26	0.788	31,587	3.58	0.352
Solar Centaur 40 Turbine	4700	hp	Natural Gas	4.39	2.56	0.351	0.760	1.29	1.29	1.29	3.18	26,718	1.92	0.671	26,966	3.02	0.286
Caterpillar G3516 Egen	1416	hp	Natural Gas	0.312	0.295	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.00	0.014
Boiler	6.3	MMBtu/hr	Natural Gas	1.35	2.27	0.149	0.016	0.051	0.051	0.051	0.154	3,246	0.062	0.060	3,266	0.00	0.051
Total (tons/yr)				**19.4**	**12.8**	**1.63**	**3.10**	**5.29**	**5.29**	**5.29**	**13.1**	**111,317**	**8.15**	**2.78**	**112,350**	**12.4**	**1.23**

Notes:

(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) Emergency Generator emissions are calculated by the following formula: Power Rating * Run Hours * EF / 2000
Power Rating = Engine hp rating (hp)
EF = Emission Factor from either manufacturer's data or AP-42 (lb/hp-hr)
2000 = the amount of lbs in a ton
(3) Boiler/Heater emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF)
Power Rating = Boiler/Heater Heat Capacity (MMBtu/hr)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
(4) Turbines are equipped with Selective Catalytic Reduction (SCR) and oxidation catalyst for control of NOx (44%), CO (80%), and VOC (50%), unless otherwise stated
(5) Taurus Centaur 40 oxidation catalyst has a control of 90% for CO and 80% for Nox
(6) Emergency generator engine hp taken from manufacturer data
(7) Boiler assumed to have low-NOx burners
(8) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(9) See Emissions Factors table for Emissions Factors for each operating scenario
(10) Each start-up/shut-down event assumed to last 10 minutes

Table 9A-3-3 Event Based Potential Emissions From Combustion Sources
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.040	3.66	0.042	25.95	0.168	30.2
Solar Centaur 50L Turbine	6,200	hp	Natural Gas	100	0.040	3.46	0.040	23.45	0.160	27.45
Solar Centaur 40 Turbine	4,700	hp	Natural Gas	100	0.035	3.22	0.037	19.60	0.148	23.30
Total (tons/yr)					**0.115**	**10.3**	**0.119**	**69.0**	**0.476**	**80.9**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.055	4.67	0.053	28.8	0.212	34.1
Solar Centaur 50L Turbine	6,200	hp	Natural Gas	100	0.020	1.770	0.020	10.85	0.080	12.85
Solar Centaur 40 Turbine	4,700	hp	Natural Gas	100	0.015	1.510	0.017	9.05	0.068	10.75
Total (tons/yr)					**0.090**	**7.95**	**0.090**	**48.7**	**0.360**	**57.7**
Total SUSD Emissions (tons/yr)					**0.205**	**18.3**	**0.209**	**118**	**0.836**	**139**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Taurus 70 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Centaur 50L Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Centaur 40 Turbine	100	2.216	2.293	75.634	1,893	0.125
Total (tons/yr)		**6.649**	**6.880**	**227**	**5,679**	**0.375**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Taurus 70 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Centaur 50L Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Centaur 40 Turbine	100	3.675	3.80	125.39	3,139	0.207
Total (tons/yr)		**11.024**	**11.41**	**376**	**9,416**	**0.622**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
ACP-3	1	1.167	1.21	39.8	996	0.066
Total (tons/yr)		**1.167**	**1.21**	**39.8**	**996**	**0.066**
Total Blowdown Emissions (tons/yr)		**18.8**	**19.5**	**643**	**16,092**	**1.06**

Table 9A-3-4 Combustion Source Criteria Pollutant Emission Factors
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Solar Turbine Normal Operation Emission Factors (lb/hr)															
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**	**NH3**
Solar Centaur 40 Turbine	Natural Gas	lb/hr	4.70	5.70	0.160	0.17	0.29	0.29	0.29	0.73	6100	0.44	0.15	6157	0.690
Solar Centaur 50L Turbine	Natural Gas	lb/hr	1.98	3.30	0.190	0.20	0.35	0.35	0.35	0.85	7145	0.52	0.18	7212	0.818
Solar Taurus 70 Turbine	Natural Gas	lb/hr	3.18	5.30	0.310	0.33	0.55	0.55	0.55	1.37	11411	0.83	0.29	11517	1.317

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) NH3 emission rates based on a 10 ppm ammonia slip from the SCR based on manufacturer information
(5) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(6) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Centaur 40 Turbine	Natural Gas	lb/hr	62.7	34.2	0.320	36.6	2,280	6.40
Solar Centaur 50L Turbine	Natural Gas	lb/hr	26.4	19.8	0.380	15.4	1,320	7.60
Solar Taurus 70 Turbine	Natural Gas	lb/hr	42.4	31.8	0.620	24.7	2,120	12.4

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown EFs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Centaur 40 Turbine	Natural Gas	lb/event	0.7	64.4	0.7	392	3.0	466	0.3	30.2	0.3	181	1.4	215
Solar Centaur 50L Turbine	Natural Gas	lb/event	0.8	69.1	0.8	469	3.2	549	0.4	35.4	0.4	217	1.6	257
Solar Taurus 70 Turbine	Natural Gas	lb/event	0.8	73.1	0.8	519	3.4	603	1.1	93.4	1.1	575	4.2	681

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Engine and Boiler Emission Factors															
Equipment Type	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**	**NH3**
Boiler < 100 MMBtu	Natural Gas	lb/MMscf	50	84	5.5	0.6	1.9	1.9	1.9	5.7	120000	2.3	2.2	120713	0.00
Engine 2 SLB	Natural Gas	lb/MMBtu	3.17	0.386	0.12	0.000588	0.0384	0.0384	0.0384	0.00991	110	1.45	0	146	0.00
1000 KW Caterpillar Egen	Natural Gas	lb/hp-hr	0.004408	0.004166	0.000529	4.62E-06	0.0003018	0.00030179	0.000302	7.79E-05	1.0998	0.0041	0	1	0.00

Notes
(1) NOx, CO, VOC, and PMF-10 Emission Factors for Boilers < 100 MMBtu from ETI Combustion Analysis June 2015
(2) All other emission factors for natural gas boilers taken from AP-42 Tables 1.4-1 & 1.4-2
(3) Emission Factors for 2 SLB engine taken from AP-42 Table 3.2-1
(4) NOx, CO, VOC, CO2, and CH4 emission factors for Caterpillar Egens taken from Caterpillar Manufacturer data
(5) SO2, PMF, PMF-10, PMF-2.5, PMC, and N2O Emission factors for Caterpillar Egens taken from AP-42 Table 3.2-1 and converted using manufacturer fuel data
(6) Assume PMF=PMF-10=PMF-2.5
(7) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(8) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR 98]

Table 9A-3-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Annual HAP Emissions (lb/yr)								
Quantity @ ACP-3		1	1	1	1	1	1	1
Pollutant	HAP?	Solar Centaur 40 Turbine	Solar Centaur 50L Turbine	Solar Taurus 70 Turbine	Boiler < 100 MMBtu	Boiler < 100 MMBtu	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		4700	6200	10915	6.3	0.5	0.2	1416
		hp	hp	hp	MMBTU/hr	MMBTU/hr	MMBTU/hr	hp
		9125	8500	7205				
		Btu/hp-hr	Btu/hp-hr	Btu/hp-hr				
1,1,2,2-Tetrachloroethane	Yes							0.024
1,1,2-Trichloroethane	Yes							0.019
1,1-Dichloroethane	Yes							0.014
1,2,3-Trimethylbenzene	No							0.013
1,2,4-Trimethylbenzene	No							0.040
1,2-Dichloroethane	Yes							0.015
1,2-Dichloropropane	Yes							0.016
1,3,5-Trimethylbenzene	No							0.006
1,3-Butadiene	Yes							0.295
1,3-Dichloropropene	Yes							0.016
2,2,4-Trimethylpentane	Yes							0.305
2-Methylnaphthalene	No				0.001	0.000	0.000	0.008
3-Methylchloranthrene	No				0.000	0.000	0.000	
7,12-Dimethylbenz(a)anthracene	No				0.001	0.000	0.000	
Acenaphthene	No				0.000	0.000	0.000	0.000
Acenaphthylene	No				0.000	0.000	0.000	0.001
Acetaldehyde	Yes							2.796
Acrolein	Yes							2.803
Anthracene	No				0.000	0.000	0.000	0.000
Benz(a)anthracene	No				0.000	0.000	0.000	0.000
Benzene	Yes				0.114	0.009	0.004	0.699
Benzo(a)pyrene	No				0.000	0.000	0.000	0.000
Benzo(b)fluoranthene	No				0.000	0.000	0.000	0.000
Benzo(e)pyrene	No							0.000
Benzo(g,h,i)perylene	No				0.000	0.000	0.000	0.000
Benzo(k)fluoranthene	No				0.000	0.000	0.000	0.000
Biphenyl	Yes							0.001
Butane	No				113.622	9.018	3.607	1.711
Butyr/Isobutyraldehyde	No							0.157
Carbon Tetrachloride	Yes							0.022
Chlorobenzene	Yes							0.016
Chloroethane	Yes							
Chloroform	Yes							0.017
Chrysene	No				0.000	0.000	0.000	0.000
Cyclohexane	No							0.111
Cyclopentane	No							0.034
Dibenzo(a,h)anthracene	No				0.000	0.000	0.000	
Dichlorobenzene	Yes				0.065	0.005	0.002	
Ethane	No				167.728	13.312	5.325	25.544
Ethylbenzene	Yes							0.039
Ethylene Dibromide	Yes							0.026
Fluoranthene	No				0.000	0.000	0.000	0.000
Fluorene	No				0.000	0.000	0.000	0.001
Formaldehyde	Yes	541.000	664.779	992.029	4.058	0.322	0.129	19.888
Hexane (or n-Hexane)	Yes				97.391	7.729	3.092	0.160
Indeno(1,2,3-c,d)pyrene	No				0.000	0.000	0.000	0.000
Isobutane	No							1.351
Methanol	Yes							0.894
Methylcyclohexane	No							0.122
Methylene Chloride	Yes							0.053
n-Nonane	No							0.011
n-Octane	No							0.027
Naphthalene	Yes				0.033	0.003	0.001	0.035
PAH	Yes							0.048
Pentane (or n-Pentane)	No				140.675	11.165	4.466	0.551
Perylene	No							0.000
Phenanthrene	No				0.001	0.000	0.000	0.001
Phenol	Yes							0.015
Propane	No				86.569	6.871	2.748	10.340
Propylene Oxide	Yes							
Pyrene	No				0.000	0.000	0.000	0.000
Styrene	Yes							0.020
Tetrachloroethane	No							
Toluene	Yes				0.184	0.015	0.006	0.347

Table 9A-3-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Annual HAP Emissions (lb/yr)								
Quantity @ ACP-3		**1**	**1**	**1**	**1**	**1**	**1**	**1**
Pollutant	**HAP?**	**Solar Centaur 40 Turbine**	**Solar Centaur 50L Turbine**	**Solar Taurus 70 Turbine**	**Boiler < 100 MMBtu**	**Boiler < 100 MMBtu**	**Boiler < 100 MMBtu**	**1000 KW Caterpillar Egen**
		4700	**6200**	**10915**	**6.3**	**0.5**	**0.2**	**1416**
		hp	**hp**	**hp**	**MMBTU/hr**	**MMBTU/hr**	**MMBTU/hr**	**hp**
Vinyl Chloride	Yes							0.009
Xylene	Yes							0.097
Arsenic	Yes				0.011	0.001	0.000	
Barium	No				0.238	0.019	0.008	
Beryllium	Yes				0.001	0.000	0.000	
Cadmium	Yes				0.060	0.005	0.002	
Chromium	Yes				0.076	0.006	0.002	
Cobalt	Yes				0.005	0.000	0.000	
Copper	No				0.046	0.004	0.001	
Manganese	Yes				0.021	0.002	0.001	
Mercury	Yes				0.014	0.001	0.000	
Molybdenum	No				0.060	0.005	0.002	
Nickel	Yes				0.114	0.009	0.004	
Selenium	Yes				0.001	0.000	0.000	
Vanadium	No				0.124	0.010	0.004	
Zinc	No				1.569	0.125	0.050	
Lead	Yes				0.027	0.002	0.001	
Total HAPs		572.934	704.019	1050.586				
Total HAP/unit (lb/yr)		**572.934**	**704.019**	**1050.586**	**102**	**8.11**	**3.24**	**29**
Total HAP/unit (TPY)		**0.286**	**0.352**	**0.525**	**0.051**	**0.004**	**0.002**	**0.014**

Hazardous Air Pollutant

Notes:
(1) Emissions above are on a per unit basis
(2) Calculations for the Caterpillar emergency generator assume 100 hours of operation; all other calculations assume 8,760 hours of operation
(3) Heat rates for Solar Turbines taken from Solar Datasheets
(4) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table 9A-3-6 Combustion Source HAP Emission Factors
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Pollutant	HAP?	Emission Factors				
		Solar Centaur 40 Turbine	Solar Centaur 50L Turbine	Solar Taurus 70 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMscf	lb/hp-hr
1,1,2,2-Tetrachloroethane	Yes					1.7E-07
1,1,2-Trichloroethane	Yes					1.3E-07
1,1-Dichloroethane	Yes					9.9E-08
1,2,3-Trimethylbenzene	No					9.0E-08
1,2,4-Trimethylbenzene	No					2.8E-07
1,2-Dichloroethane	Yes					1.1E-07
1,2-Dichloropropane	Yes					1.1E-07
1,3,5-Trimethylbenzene	No					4.6E-08
1,3-Butadiene	Yes					2.1E-06
1,3-Dichloropropene	Yes					1.1E-07
2,2,4-Trimethylpentane	Yes					2.2E-06
2-Methylnaphthalene	No				2.4E-05	5.4E-08
3-Methylchloranthrene	No				1.8E-06	
7,12-Dimethylbenz(a)anthracene	No				1.6E-05	
Acenaphthene	No				1.8E-06	3.4E-09
Acenaphthylene	No				1.8E-06	8.1E-09
Acetaldehyde	Yes					2.0E-05
Acrolein	Yes					2.0E-05
Anthracene	No				2.4E-06	1.8E-09
Benz(a)anthracene	No				1.8E-06	8.5E-10
Benzene	Yes				2.1E-03	4.9E-06
Benzo(a)pyrene	No				1.2E-06	1.4E-11
Benzo(b)fluoranthene	No				1.8E-06	2.2E-11
Benzo(e)pyrene	No					6.0E-11
Benzo(g,h,i)perylene	No				1.2E-06	6.3E-11
Benzo(k)fluoranthene	No				1.8E-06	1.1E-11
Biphenyl	Yes					1.0E-08
Butane	No				2.1E+00	1.2E-05
Butyr/Isobutyraldehyde	No					1.1E-06
Carbon Tetrachloride	Yes					1.5E-07
Chlorobenzene	Yes					1.1E-07
Chloroethane	Yes					
Chloroform	Yes					1.2E-07
Chrysene	No				1.8E-06	1.7E-09
Cyclohexane	No					7.8E-07
Cyclopentane	No					2.4E-07
Dibenzo(a,h)anthracene	No				1.2E-06	
Dichlorobenzene	Yes				1.2E-03	
Ethane	No				3.1E+00	1.8E-04
Ethylbenzene	Yes					2.7E-07
Ethylene Dibromide	Yes					1.9E-07
Fluoranthene	No				3.0E-06	9.2E-10
Fluorene	No				2.8E-06	4.3E-09
Formaldehyde	Yes	2.9E-03	2.9E-03	2.9E-03	7.5E-02	1.4E-04
Hexane (or n-Hexane)	Yes				1.8E+00	1.1E-06
Indeno(1,2,3-c,d)pyrene	No				1.8E-06	2.5E-11
Isobutane	No					9.5E-06
Methanol	Yes					6.3E-06
Methylcyclohexane	No					8.6E-07
Methylene Chloride	Yes					3.7E-07
n-Nonane	No					7.8E-08
n-Octane	No					1.9E-07
Naphthalene	Yes				6.1E-04	2.5E-07
PAH	Yes					3.4E-07
Pentane (or n-Pentane)	No				2.6E+00	3.9E-06
Perylene	No					1.3E-11
Phenanthrene	No				1.7E-05	9.0E-09
Phenol	Yes					1.1E-07
Propane	No				1.6E+00	7.3E-05
Propylene Oxide	Yes					
Pyrene	No				5.0E-06	1.5E-09
Styrene	Yes					1.4E-07
Tetrachloroethane	No					
Toluene	Yes				3.4E-03	2.5E-06
Vinyl Chloride+A32	Yes					6.3E-08
Xylene	Yes					6.8E-07
Arsenic	Yes				2.0E-04	
Barium	No				4.4E-03	
Beryllium	Yes				1.2E-05	

Table 9A-3-6 Combustion Source HAP Emission Factors
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Pollutant	HAP?	Emission Factors				
		Solar Centaur 40 Turbine	Solar Centaur 50L Turbine	Solar Taurus 70 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMBtu	lb/MMBtu	lb/MMscf	lb/hp-hr
Cadmium	Yes				1.1E-03	
Chromium	Yes				1.4E-03	
Cobalt	Yes				8.4E-05	
Copper	No				8.5E-04	
Manganese	Yes				3.8E-04	
Mercury	Yes				2.6E-04	
Molybdenum	No				1.1E-03	
Nickel	Yes				2.1E-03	
Selenium	Yes				2.4E-05	
Vanadium	No				2.3E-03	
Zinc	No				2.9E-02	
Lead	Yes				5.0E-04	
Total HAPs		3.1E-03	3.1E-03	3.1E-03		

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for natural gas boilers from AP-42 Tables 1.4-2, 1.4-3, and 1.4-4
(3) Emission factors for 2 SLB natural gas engines and Caterpillar natural gas emergency generators taken from AP-42 Table 3.2-1
(4) Emission factors for Solar natural gas turbines and Caterpillar natural gas emergency generators converted using 1 KWh = 3412 Btu and 1 kw = 1.341 hp
(5) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL 168

Table 9A-3-7 Potential Emissions From Fugitive Leaks
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Fugitive Emissions (FUG)

Source Designation:	FUG-02

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr	CH_4 Weight Fraction[1]	Fug Emission Rate tpy
Solar Turbine	Gas	2.67E-02	0.934	250.2

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	646	2.91	12.7	0.026	0.334	0.0271	0.345	0.895	11.4	1.48E-03	1.88E-02
Compressors	Gas	5.71E+01	3	171	751	0.026	19.7	0.0271	20.4	0.895	672	1.48E-03	1.11E+00
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00	0.0271	0.00	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00	0.0271	0.00	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04	1	2.00E-04	8.76E-04	0.026	2.30E-05	0.0271	2.38E-05	0.895	7.84E-04	1.48E-03	1.30E-06
Flanges	Gas	3.90E-04	340	0.133	0.581	0.026	0.015	0.0271	0.016	0.895	0.520	1.48E-03	8.59E-04
Open-ended lines	Gas	2.00E-03		0.00	0.00	0.026	0.00	0.0271	0.00	0.895	0.00	1.48E-03	0.00E+00
			Total	174	764	-	20.0	-	20.7	-	683.419	-	1.13E+00

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.

Sample Calculations:

Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count

Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table 9A-3-8 Tank Emissions
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Source Designation:	TK-1, TK-2, TK-3

Tank Parameters

Source	Type of Tank	Contents	Capacity	Throughput	Tank Diam.	Tank Length	Paint Color	Paint Condition
			(gal)	gal/yr	ft	ft		
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	1,500	7,500	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	7.76E-07	3.40E-06	2.24E-06	9.80E-06	3.01E-06	1.32E-05

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.
3. Losses (Emissions) from TK-3 8,000-gallon Ammonia tank assumed to be insignficant.

Table 9A-3-9 Project Potential Emissions
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Taurus 70 Turbine	CT-01	8.35	13.1	0.775	1.43	2.42	2.42	2.42	5.99	50035	4.00	1.26	50511	5.77	0.525
Solar Centaur 50L Turbine	CT-02	5.20	8.2	0.477	0.894	1.51	1.51	1.51	3.74	31329	2.50	0.788	31627	3.58	0.352
Solar Centaur 40 Turbine	CT-03	4.4	7.3	0.405	0.760	1.29	1.29	1.29	3.18	26747	2.14	0.671	27000	3.02	0.286
Caterpillar G3516 Egen	EG-01	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.01	78	0.29	0.00	85	0.00	0.014
Boiler	WH-01	1.35	2.27	0.149	0.016	0.051	0.051	0.051	0.154	3246	0.062	0.060	3266	0.00	0.051
Fugitive Leaks - Blowdowns	FUG-01	-	-	18.84	-	-	-	-	-	19.49	643		16,092	-	1.063
Fugitive Leaks - Piping	FUG-02	-	-	20.0	-	-	-	-	-	20.7	683	-	17,106	-	1.13
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	1.32E-05	-	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**19.7**	**31.1**	**41.1**	**3.10**	**5.29**	**5.29**	**5.29**	**13.1**	**111,475**	**1,335**	**2.78**	**145,686**	**12.4**	**3.42**

Table 9A-3-9 Project Potential Emissions
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				Ammonia (tpy)	HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
Solar Taurus 70 Turbine	CT-01	8.35	13.1	0.775	1.43	2.42	2.42	2.42	5.99	50035	4.00	1.26	50511	5.77	0.525
Solar Centaur 50L Turbine	CT-02	5.20	8.2	0.477	0.894	1.51	1.51	1.51	3.74	31329	2.50	0.788	31627	3.58	0.352
Solar Centaur 40 Turbine	CT-03	4.4	7.3	0.405	0.760	1.29	1.29	1.29	3.18	26747	2.14	0.671	27000	3.02	0.286
Caterpillar G3516 Egen	EG-01	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.01	78	0.29	0.00	85	0.00	0.014
Boiler	WH-01	1.35	2.27	0.149	0.016	0.051	0.051	0.051	0.154	3246	0.062	0.060	3266	0.00	0.051
Hot Water Heater	WH-02	0.215	0.180	0.012	0.001	0.004	0.004	0.004	0.012	258	0.005	0.005	259	0.00	0.004
Space Heater	SH-01	0.086	0.072	0.005	0.001	0.002	0.002	0.002	0.005	103	0.002	0.002	104	0.00	0.002
Fugitive Leaks - Blowdowns	FUG-01	-	-	18.84	-	-	-	-	-	19.49	643		16,092	-	1.063
Fugitive Leaks - Piping	FUG-02	-	-	20.0	-	-	-	-	-	20.7	683	-	17,106	-	1.13
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	1.32E-05	-	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**20.0**	**31.4**	**41.1**	**3.10**	**5.3**	**5.3**	**5.3**	**13.1**	**111,836**	**1,335**	**2.79**	**146,049**	**12.4**	**3.43**

Table 9A-4-1 Project Potential Emissions
Brunswick M&R Station - Brunswick County, Virginia
Atlantic Coast Pipeline

Equipment	Fuel	Power Rating	Units	Hours	Criteria Pollutants (tons/yr)								GHG Emissions (tons/yr)				Ammonia (tpy)	HAP (tpy)
					NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
M&R Heater 1	Natural Gas	16.0	MMBtu/hr	8760	0.77	2.6	0.420	0.041	0.099	0.099	0.099	0.392	8,245	0.158	0.151	8,294	0.00	0.130
M&R Heater 2	Natural Gas	16.0	MMBtu/hr	8760	0.77	2.6	0.420	0.041	0.099	0.099	0.099	0.392	8,245	0.158	0.151	8,294	0.00	0.130
M&R Heater 3	Natural Gas	16.0	MMBtu/hr	8760	0.77	2.6	0.420	0.041	0.099	0.099	0.099	0.392	8,245	0.158	0.151	8,294	0.00	0.130
Hydrocarbon (Waste Oil) Tank	Waste Oil	-	-	-	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-	-
Fugitive Leaks - Piping	-	-	-	-	-	-	0.058	-	-	-	-	-	0.107	3.45	-	86.4	-	0.007
Total (tons/yr)					**2.31**	**7.78**	**1.32**	**0.124**	**0.297**	**0.297**	**0.297**	**1.17**	**24,734**	**3.93**	**0.45**	**24,968**	**0.00**	**0.40**

Notes:
(1) Emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF) or manufacturer provided value
Power Rating = Heat Capacity (MMBtu/hr)
Hours = Potential run hours for the year (8760)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
2000 = amount of lbs in a ton

Table 9A-4-2 Project Potential Emissions
Greensville M&R Station - Greensville County, Virginia
Atlantic Coast Pipeline

Equipment	Fuel	Power Rating	Units	Hours	Criteria Pollutants (tons/yr)								GHG Emissions (tons/yr)				Ammonia (tpy)	HAP (tpy)
					NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
M&R Heater 1	Natural Gas	17.0	MMBtu/hr	8760	0.82	2.8	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
M&R Heater 2	Natural Gas	17.0	MMBtu/hr	8760	0.82	2.8	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
M&R Heater 3	Natural Gas	17.0	MMBtu/hr	8760	0.82	2.8	0.447	0.044	0.105	0.105	0.105	0.416	8,760	0.168	0.161	8,812	0.00	0.138
Hydrocarbon (Waste Oil) Tan	Waste Oil	-	-	-	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-	-
Fugitive Leaks - Piping	-	-	-	-	-	-	0.058	-	-	-	-	-	0.107	3.45	-	86	-	0.007
Total (tons/yr)					**2.46**	**8.27**	**1.40**	**0.131**	**0.315**	**0.315**	**0.315**	**1.25**	**26,280**	**3.96**	**0.482**	**26,523**	**0.00**	**0.42**

Notes:
(1) Emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF) or manufacturer provided value
Power Rating = Heat Capacity (MMBtu/hr)
Hours = Potential run hours for the year (8760)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
2000 = amount of lbs in a ton

Table 9A-4-3 Project Potential Emissions
Long Run M&R Station - Randolph County, West Virginia
Atlantic Coast Pipeline

Equipment	Fuel	Power Rating	Units	Hours	Criteria Pollutants (tons/yr)								GHG Emissions (tons/yr)				Ammonia (tpy)	HAP (tpy)
					NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	NH3	Total HAP
M&R Heater 1 (see below)	Natural Gas	9.8	MMBtu/hr	8760	0.47	1.6	0.258	0.025	0.061	0.061	0.061	0.240	5,050	0.097	0.093	5,080	0.00	0.079
M&R Heater 2 (see below)	Natural Gas	9.8	MMBtu/hr	8760	0.47	1.6	0.258	0.025	0.061	0.061	0.061	0.240	5,050	0.097	0.093	5,080	0.00	0.079
M&R Heater 3 (see below)	Natural Gas	9.8	MMBtu/hr	8760	0.47	1.6	0.258	0.025	0.061	0.061	0.061	0.240	5,050	0.097	0.093	5,080	0.00	0.079
Capstone MicroTurbine 1	Natural Gas	200.0	KW	8760	0.403	1.095	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
Capstone MicroTurbine 2	Natural Gas	200.0	KW	8760	0.403	1.095	0.088	0.010	0.006	0.006	0.006	0.014	1,332	0.088	0.009	1,336	0.00	0.003
Hydrocarbon (Waste Oil) Tank	Waste Oil	-	-	-	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-	-
Fugitive Leaks - Piping	-	-	-	-	-	-	0.063	-	-	-	-	-	0.116	3.45	-	86	-	0.007
Total (tons/yr)					**2.22**	**6.95**	**1.01**	**0.096**	**0.193**	**0.193**	**0.193**	**0.748**	**17,813**	**3.92**	**0.296**	**17,999**	**0.00**	**0.250**

Notes:
(1) Emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF) or manufacturer provided value
Power Rating = Heat Capacity (MMBtu/hr)
Hours = Potential run hours for the year (8760)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
2000 = amount of lbs in a ton
(2) Emissions for MicroTurbine calculated by the following formula: EF * Power Rating * Run hours / 2000
EF = Manufacturer or AP-42 emission factor (lb/MWh)
Power Rating = Turbine power rating (KW)

Table 9A-4-4 Project Potential Emissions
Additional M&R Stations
Atlantic Coast Pipeline

Locations	VOC	GHG Emissions (tons/yr)				Total HAP
		CO2	CH4	N2O	CO2e	
Elizabeth River Fugitives	0.044	0.082	2.64	-	66	0.005
Fayetteville Fugitives	0.044	0.081	2.62	-	66	0.005
Smithfield Fugitives	0.062	0.113	3.67	-	92	0.007
Pembroke Fugitives	0.060	0.111	3.59	-	90	0.007
Total (tons/yr)	**0.210**	**0.387**	**12.5**	**0.00**	**313**	**0.025**

Notes
(1) Information for fugitive emissions taken from engineering design component counts
(2) Kincheloe M&R station fugitive emissions have been included as part of the fugitive emissions for ACP-1
(3) Woods Corner M&R station has been included as part of the emissions for ACP-2

Table 9A-5-1 Project Equipment List
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Emission Point ID	Source	Manufacturer	Model/Type	Rated Capacity
CT-01	Compressor Turbine	Solar Turbines	Titan 130-20502S	20,500 hp
CT-02	Compressor Turbine	Solar Turbines	Titan 130-20502S	20,500 hp
EG-01	Emergency Generator	Caterpillar	G3516	1,416 hp
WH-01	Boiler	TBD	TBD	7.2 MMBtu/hr
FUG-01	Fugitive Leaks - Blowdowns	-	-	-
FUG-02	Fugitive Leaks - Piping	-	-	-
TK-1	Accumulator Tank	-	-	2,500 gal
TK-2	Hydrocarbon (Waste Oil) Tank	--	--	1,000 gal

Table 9A-5-2 Potential Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F)	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr)	8,760

Generator Operational Parameters:

Normal Hours of Operation:	100

Boiler Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Titan 130 Turbine	20,500	hp	Natural Gas	26.6	43.1	2.41	2.58	4.4	4.4	4.4	10.80	90,075	6.52	2.27	90,915	0.962
Solar Titan 130 Turbine	20,500	hp	Natural Gas	26.6	43.1	2.41	2.58	4.4	4.4	4.4	10.80	90,075	6.52	2.27	90,915	0.962
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.312	0.29	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.058
Boiler	7.2	MMBtu/hr	Natural Gas	1.55	2.60	0.170	0.019	0.059	0.059	0.059	0.176	3,710	0.071	0.068	3,732	0.014
Total (tons/yr)				**55.1**	**89.1**	**5.03**	**5.17**	**8.8**	**8.8**	**8.8**	**21.77**	**183,937**	**13.4**	**4.62**	**185,648**	**1.997**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Oxidation Catalyst	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Titan 130 Turbine	20,500	hp	Natural Gas	26.6	8.6	1.21	2.58	4.4	4.4	4.4	10.80	90,075	6.52	2.27	90,915	0.96
Solar Titan 130 Turbine	20,500	hp	Natural Gas	26.6	8.6	1.21	2.58	4.4	4.4	4.4	10.80	90,075	6.52	2.27	90,915	0.96
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.06
Boiler	7.2	MMBtu/hr	Natural Gas	1.55	2.60	0.170	0.019	0.059	0.059	0.059	0.176	3,710	0.071	0.068	3,732	0.014
Total (tons/yr)				**55.1**	**20.1**	**2.62**	**5.17**	**8.8**	**8.8**	**8.8**	**21.77**	**183,937**	**13.4**	**4.62**	**185,648**	**1.997**

Notes:
(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) Emergency Generator emissions are calculated by the following formula: Power Rating * Run Hours * EF / 2000
Power Rating = Engine hp rating (hp)
EF = Emission Factor from either manufacturer's data or AP-42 (lb/hp-hr)
2000 = the amount of lbs in a ton
(3) Boiler emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF)
Power Rating = Boiler Heat Capacity (MMBtu/hr)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
(4) Turbines are equipped with oxidation catalyst for control of CO (80%) and VOC (50%)
(5) Emergency generator engine hp taken from manufacturer data
(6) Boiler assumed to have low-NOx burners
(7) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(8) See Emissions Factors table for Emissions Factors for each operating scenario.
(9) Each start-up/shut-down event assumed to last 10 minutes

Table 9A-5-3 Event Based Potential Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Titan 130 Turbine	20,500	hp	Natural Gas	100	0.095	8.85	0.101	58.1	0.404	68.150
Solar Titan 130 Turbine	20,500	hp	Natural Gas	100	0.095	8.85	0.101	58.1	0.404	68.150
Total (tons/yr)					**0.190**	**17.69**	**0.202**	**116.1**	**0.808**	**136.3**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Titan 130 Turbine	20,500	hp	Natural Gas	100	0.120	10.38	0.119	63.6	0.476	75.5
Solar Titan 130 Turbine	20,500	hp	Natural Gas	100	0.120	10.38	0.119	63.6	0.476	75.5
Total (tons/yr)					**0.240**	**20.76**	**0.238**	**127**	**0.952**	**151.0**
Total SUSD Emissions (tons/yr)					**0.430**	**38.5**	**0.440**	**243.3**	**1.760**	**287**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Titan 130 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Titan 130 Turbine	100	2.216	2.293	75.634	1,893	0.125
Total (tons/yr)		**4.433**	**4.586**	**151**	**3,786**	**0.250**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Titan 130 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Titan 130 Turbine	100	3.675	3.80	125.39	3,139	0.207
Total (tons/yr)		**7.349**	**7.60**	**251**	**6,277**	**0.415**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
SHP-M	1	1.167	1.21	39.8	996	0.066
Total (tons/yr)		**1.167**	**1.21**	**39.8**	**996**	**0.066**
Total Blowdown Emissions (tons/yr)		**12.95**	**13.40**	**442**	**11,060**	**0.731**

Table 9A-5-4 Combustion Source Criteria Pollutant Emission Factors
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Solar Turbine Normal Operation Emission Factors (lb/hr)														
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Solar Titan 130 Turbine	Natural Gas	lb/hr	5.70	9.60	0.550	0.59	1.00	1.00	1.00	2.46	20565	1.49	0.52	20757

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(5) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Titan 130 Turbine	Natural Gas	lb/hr	76.0	57.6	1.10	44.33	3,840	22.0

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown Efs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Titan 130 Turbine	Natural Gas	lb/event	1.9	176.9	2.0	1161	8.1	1363	2.4	207.6	2.4	1272	9.5	1510

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Engine and Boiler Emission Factors														
Equipment Type	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Boiler < 100 MMBtu	Natural Gas	lb/MMscf	50	84	5.5	0.6	1.9	1.9	1.9	5.7	120000	2.3	2.2	120713
Engine 2 SLB	Natural Gas	lb/MMBtu	3.17	0.386	0.12	0.000588	0.0384	0.0384	0.0384	0.00991	110	1.45	0	146
1000 KW Caterpillar Egen	Natural Gas	lb/hp-hr	0.004408	0.004166	0.000529	4.62E-06	0.0003018	0.00030179	0.000302	7.79E-05	1.0998	0.0041	0	1

Notes
(1) NOx, CO, VOC, and PMF-10 Emission Factors for Boilers < 100 MMBtu from ETI Combustion Analysis June 2015
(2) All other emission factors for natural gas boilers taken from AP-42 Tables 1.4-1 & 1.4-2
(3) Emission Factors for 2 SLB engine taken from AP-42 Table 3.2-1
(4) NOx, CO, VOC, CO2, and CH4 emission factors for Caterpillar Egens taken from Caterpillar Manufacturer data
(5) SO2, PMF, PMF-10, PMF-2.5, PMC, and N2O Emission factors for Caterpillar Egens taken from AP-42 Table 3.2-1 and converted using manufacturer fuel data
(6) Assume PMF=PMF-10=PMF-2.5
(7) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(8) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR 98]

Table 9A-5-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Annual HAP Emissions (lb/yr)				
Quantity @ SHP-Mockingbird		2	1	1
Pollutant	HAP?	Solar Titan 130 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		20500	7.2	1416
		hp	MMBTU/hr	hp
		7025		
		Btu/hp-hr		
1,1,2,2-Tetrachloroethane	Yes			0.024
1,1,2-Trichloroethane	Yes			0.019
1,1-Dichloroethane	Yes			0.014
1,2,3-Trimethylbenzene	No			0.013
1,2,4-Trimethylbenzene	No			0.040
1,2-Dichloroethane	Yes			0.015
1,2-Dichloropropane	Yes			0.016
1,3,5-Trimethylbenzene	No			0.006
1,3-Butadiene	Yes			0.295
1,3-Dichloropropene	Yes			0.016
2,2,4-Trimethylpentane	Yes			0.305
2-Methylnaphthalene	No		0.001	0.008
3-Methylchloranthrene	No		0.000	
7,12-Dimethylbenz(a)anthracene	No		0.001	
Acenaphthene	No		0.000	0.000
Acenaphthylene	No		0.000	0.001
Acetaldehyde	Yes			2.796
Acrolein	Yes			2.803
Anthracene	No		0.000	0.000
Benz(a)anthracene	No		0.000	0.000
Benzene	Yes		0.130	0.699
Benzo(a)pyrene	No		0.000	0.000
Benzo(b)fluoranthene	No		0.000	0.000
Benzo(e)pyrene	No			0.000
Benzo(g,h,i)perylene	No		0.000	0.000
Benzo(k)fluoranthene	No		0.000	0.000
Biphenyl	Yes			0.001
Butane	No		129.854	1.711
Butyr/Isobutyraldehyde	No			0.157
Carbon Tetrachloride	Yes			0.022
Chlorobenzene	Yes			0.016
Chloroethane	Yes			
Chloroform	Yes			0.017
Chrysene	No		0.000	0.000
Cyclohexane	No			0.111
Cyclopentane	No			0.034
Dibenzo(a,h)anthracene	No		0.000	
Dichlorobenzene	Yes		0.074	
Ethane	No		191.689	25.544
Ethylbenzene	Yes			0.039
Ethylene Dibromide	Yes			0.026
Fluoranthene	No		0.000	0.000
Fluorene	No		0.000	0.001
Formaldehyde	Yes	1816.631	4.638	19.888
Hexane (or n-Hexane)	Yes		111.304	0.160
Indeno(1,2,3-c,d)pyrene	No		0.000	0.000
Isobutane	No			1.351
Methanol	Yes			0.894
Methylcyclohexane	No			0.122
Methylene Chloride	Yes			0.053
n-Nonane	No			0.011
n-Octane	No			0.027
Naphthalene	Yes		0.038	0.035
PAH	Yes			0.048
Pentane (or n-Pentane)	No		160.772	0.551
Perylene	No			0.000
Phenanthrene	No		0.001	0.001
Phenol	Yes			0.015

Table 9A-5-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Annual HAP Emissions (lb/yr)				
Quantity @ SHP-Mockingbird		**2**	**1**	**1**
Pollutant	**HAP?**	**Solar Titan 130 Turbine**	**Boiler < 100 MMBtu**	**1000 KW Caterpillar Egen**
		20500	**7.2**	**1416**
		hp	**MMBTU/hr**	**hp**
Propane	No		98.936	10.340
Propylene Oxide	Yes			
Pyrene	No		0.000	0.000
Styrene	Yes			0.020
Tetrachloroethane	No			
Toluene	Yes		0.210	0.347
Vinyl Chloride	Yes			0.009
Xylene	Yes			0.097
Arsenic	Yes		0.012	
Barium	No		0.272	
Beryllium	Yes		0.001	
Cadmium	Yes		0.068	
Chromium	Yes		0.087	
Cobalt	Yes		0.005	
Copper	No		0.053	
Manganese	Yes		0.023	
Mercury	Yes		0.016	
Molybdenum	No		0.068	
Nickel	Yes		0.130	
Selenium	Yes		0.001	
Vanadium	No		0.142	
Zinc	No		1.793	
Lead	Yes		0.031	
Total HAPs		1923.863		
Total HAP/unit (lb/yr)		**1924**	**117**	**29**
Total HAP/unit (TPY)		**0.962**	**0.058**	**0.014**

Hazardous Air Pollutant

(1) Emissions above are on a per unit basis
(2) Calculations for the Caterpillar emergency generator assume 100 hours of operation; all other calculations assume 8,760 hours of operation
(3) Heat rates for Solar Turbines taken from Solar Datasheets
(4) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table 9A-5-6 Combustion Source HAP Emission Factors
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Pollutant	HAP?	Emission Factors		
		Solar Titan 130 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMscf	lb/hp-hr
1,1,2,2-Tetrachloroethane	Yes			1.7E-07
1,1,2-Trichloroethane	Yes			1.3E-07
1,1-Dichloroethane	Yes			9.9E-08
1,2,3-Trimethylbenzene	No			9.0E-08
1,2,4-Trimethylbenzene	No			2.8E-07
1,2-Dichloroethane	Yes			1.1E-07
1,2-Dichloropropane	Yes			1.1E-07
1,3,5-Trimethylbenzene	No			4.6E-08
1,3-Butadiene	Yes			2.1E-06
1,3-Dichloropropene	Yes			1.1E-07
2,2,4-Trimethylpentane	Yes			2.2E-06
2-Methylnaphthalene	No		2.4E-05	5.4E-08
3-Methylchloranthrene	No		1.8E-06	
7,12-Dimethylbenz(a)anthracene	No		1.6E-05	
Acenaphthene	No		1.8E-06	3.4E-09
Acenaphthylene	No		1.8E-06	8.1E-09
Acetaldehyde	Yes			2.0E-05
Acrolein	Yes			2.0E-05
Anthracene	No		2.4E-06	1.8E-09
Benz(a)anthracene	No		1.8E-06	8.5E-10
Benzene	Yes		2.1E-03	4.9E-06
Benzo(a)pyrene	No		1.2E-06	1.4E-11
Benzo(b)fluoranthene	No		1.8E-06	2.2E-11
Benzo(e)pyrene	No			6.0E-11
Benzo(g,h,i)perylene	No		1.2E-06	6.3E-11
Benzo(k)fluoranthene	No		1.8E-06	1.1E-11
Biphenyl	Yes			1.0E-08
Butane	No		2.1E+00	1.2E-05
Butyr/Isobutyraldehyde	No			1.1E-06
Carbon Tetrachloride	Yes			1.5E-07
Chlorobenzene	Yes			1.1E-07
Chloroethane	Yes			
Chloroform	Yes			1.2E-07
Chrysene	No		1.8E-06	1.7E-09
Cyclohexane	No			7.8E-07
Cyclopentane	No			2.4E-07
Dibenzo(a,h)anthracene	No		1.2E-06	
Dichlorobenzene	Yes		1.2E-03	
Ethane	No		3.1E+00	1.8E-04
Ethylbenzene	Yes			2.7E-07
Ethylene Dibromide	Yes			1.9E-07
Fluoranthene	No		3.0E-06	9.2E-10
Fluorene	No		2.8E-06	4.3E-09
Formaldehyde	Yes	2.9E-03	7.5E-02	1.4E-04
Hexane (or n-Hexane)	Yes		1.8E+00	1.1E-06
Indeno(1,2,3-c,d)pyrene	No		1.8E-06	2.5E-11
Isobutane	No			9.5E-06
Methanol	Yes			6.3E-06
Methylcyclohexane	No			8.6E-07
Methylene Chloride	Yes			3.7E-07
n-Nonane	No			7.8E-08

Table 9A-5-6 Combustion Source HAP Emission Factors
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Pollutant	HAP?	Emission Factors		
		Solar Titan 130 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMscf	lb/hp-hr
n-Octane	No			1.9E-07
Naphthalene	Yes		6.1E-04	2.5E-07
PAH	Yes			3.4E-07
Pentane (or n-Pentane)	No		2.6E+00	3.9E-06
Perylene	No			1.3E-11
Phenanthrene	No		1.7E-05	9.0E-09
Phenol	Yes			1.1E-07
Propane	No		1.6E+00	7.3E-05
Propylene Oxide	Yes			
Pyrene	No		5.0E-06	1.5E-09
Styrene	Yes			1.4E-07
Tetrachloroethane	No			
Toluene	Yes		3.4E-03	2.5E-06
Vinyl Chloride+A32	Yes			6.3E-08
Xylene	Yes			6.8E-07
Arsenic	Yes		2.0E-04	
Barium	No		4.4E-03	
Beryllium	Yes		1.2E-05	
Cadmium	Yes		1.1E-03	
Chromium	Yes		1.4E-03	
Cobalt	Yes		8.4E-05	
Copper	No		8.5E-04	
Manganese	Yes		3.8E-04	
Mercury	Yes		2.6E-04	
Molybdenum	No		1.1E-03	
Nickel	Yes		2.1E-03	
Selenium	Yes		2.4E-05	
Vanadium	No		2.3E-03	
Zinc	No		2.9E-02	
Lead	Yes		5.0E-04	
Total Haps		3.1E-03		

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for natural gas boilers from AP-42 Tables 1.4-2, 1.4-3, and 1.4-4
(3) Emission factors for 2 SLB natural gas engines and Caterpillar natural gas emergency generators
(4) Emission factors for Solar natural gas turbines and Caterpillar natural gas emergency generators c
(5) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL

Table 9A-5-7 Potential Emissions From Fugitive Leaks
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Fugitive Emissions (FUG)

Source Designation:

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr	CH_4 Weight Fraction[1]	Fug Emission Rate tpy
Solar Turbine	Gas	2.67E-02	0.934	250

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	782	3.52	15.4	0.026	0.404	0.0271	0.418	0.895	13.8	1.48E-03	2.28E-02
Compressors	Gas	5.71E+01	2	114	500	0.026	13.12	0.0271	13.6	0.895	448	1.48E-03	7.41E-01
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04	1	2.00E-04	8.76E-04	0.026	2.30E-05	0.0271	2.38E-05	0.895	7.84E-04	1.48E-03	1.30E-06
Flanges	Gas	3.90E-04	437	0.170	0.746	0.026	0.020	0.0271	0.020	0.895	0.668	1.48E-03	1.10E-03
Open-ended lines	Gas	2.00E-03		0.000	0.000	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
			Total	118	517	-	13.54	-	14.0	-	462	-	7.64E-01

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.

Sample Calculations:

Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count

Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table 9A-5-8 Tank Emissions
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Source Designation:	TK-1, TK-2

Tank Parameters

Source	Type of Tank	Contents	Capacity	Throughput	Tank Diam.	Tank Length	Paint Color	Paint Condition
			(gal)	gal/yr	ft	ft		
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	1,000	5,000	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	5.14E-07	2.25E-06	1.48E-06	6.50E-06	2.00E-06	8.75E-06

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.

Table 9A-5-9 Project Potential Emissions
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Titan 130 Turbine	CT-01	26.8	27.8	1.43	2.58	4.4	4.4	4.4	10.80	90,196	7.40	2.27	91,059	0.962
Solar Titan 130 Turbine	CT-02	26.8	27.8	1.43	2.58	4.4	4.4	4.4	10.80	90,196	7.40	2.27	91,059	0.962
Caterpillar G3516 Egen	EG-01	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85.1	0.058
Boiler	WH-01	1.55	2.60	0.170	0.019	0.059	0.059	0.059	0.176	3,710	0.071	0.068	3,732	0.014
Fugitive Leaks - Blowdowns	FUG-01	-	-	12.95	-	-	-	-	-	13.40	442		11,060	0.731
Fugitive Leaks - Piping	FUG-02	-	-	13.54	-	-	-	-	-	14.0	462	-	11,567	0.764
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	8.750E-06	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**55.5**	**58.6**	**29.9**	**5.17**	**8.8**	**8.8**	**8.8**	**21.8**	**184,208**	**919**	**4.62**	**208,563**	**3.49**

Table 9A-6-1 Project Equipment List
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Emission Point ID	Source	Manufacturer	Model/Type	Rated Capacity
CT-01	Compressor Turbine	Solar Turbines	Taurus 70-10802S	10,915 hp
CT-02	Compressor Turbine	Solar Turbines	Taurus 70-10802S	10,915 hp
EG-01	Emergency Generator	Caterpillar	G3516	1,416 hp
WH-01	Boiler	TBD	TBD	6.5 MMBtu/hr
FUG-01	Fugitive Leaks - Blowdowns	-	-	-
FUG-02	Fugitive Leaks - Piping	-	-	-
TK-1	Accumulator Tank	-	-	2,500 gal
TK-2	Hydrocarbon (Waste Oil) Tank	--	--	1,000 gal

Table 9A-6-2 Potential Emissions From Combustion Sources
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F)	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr)	8,760

Generator Operational Parameters:

Normal Hours of Operation:	100

Boiler Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.9	23.8	1.36	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	0.525
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.9	23.8	1.36	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	0.525
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.053
Boiler	6.5	MMBtu/hr	Natural Gas	1.40	2.34	0.154	0.017	0.053	0.053	0.053	0.159	3,349	0.064	0.061	3,369	0.014
Total (tons/yr)				**31.4**	**50.2**	**2.91**	**2.88**	**4.9**	**4.9**	**4.9**	**12.14**	**103,388**	**7.59**	**2.58**	**104,347**	**1.118**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Oxidation Catalyst	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.86	4.76	0.680	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	0.525
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	14.86	4.76	0.680	1.43	2.42	2.42	2.42	5.99	49,980	3.62	1.26	50,446	0.525
Caterpillar G3516 Egen	1,416	hp	Natural Gas	0.31	0.29	0.037	0.000	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.053
Boiler	7.2	MMBtu/hr	Natural Gas	1.40	2.34	0.154	0.017	0.053	0.053	0.053	0.159	3,349	0.064	0.061	3,369	0.014
Total (tons/yr)				**31.4**	**12.2**	**1.55**	**2.88**	**4.9**	**4.9**	**4.9**	**12.14**	**103,388**	**7.59**	**2.58**	**104,347**	**1.118**

Notes:
(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) Emergency Generator emissions are calculated by the following formula: Power Rating * Run Hours * EF / 2000
Power Rating = Engine hp rating (hp)
EF = Emission Factor from either manufacturer's data or AP-42 (lb/hp-hr)
2000 = the amount of lbs in a ton
(3) Boiler emissions calculated by the following formula: EF * Power Rating * Run Hours / HHV / 2000
EF = AP-42 Emission Factor (lb/MMSCF)
Power Rating = Boiler Heat Capacity (MMBtu/hr)
HHV = Natural Gas High Heating Value (1020 MMBtu/MMSCF)
(4) Turbines are equipped with oxidation catalyst for control of CO (80%) and VOC (50%)
(5) Emergency generator engine hp taken from manufacturer data
(6) Boiler assumed to have low-NOx burners
(7) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(8) See Emissions Factors table for Emissions Factors for each operating scenario.
(9) Each start-up/shut-down event assumed to last 10 minutes

Table 9A-6-3 Event Based Potential Emissions From Combustion Sources
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.040	3.655	0.042	25.950	0.168	30.150
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.040	3.655	0.042	25.950	0.168	30.150
Total (tons/yr)					**0.080**	**7.310**	**0.084**	**51.9**	**0.336**	**60.3**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.055	4.670	0.053	28.750	0.212	34.050
Solar Taurus 70 Turbine	10,915	hp	Natural Gas	100	0.055	4.670	0.053	28.750	0.212	34.050
Total (tons/yr)					**0.110**	**9.340**	**0.106**	**57.5**	**0.424**	**68.1**

Total SUSD Emissions (tons/yr)	**0.190**	**16.650**	**0.190**	**109**	**0.760**	**128**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Taurus 70 Turbine	100	2.216	2.293	75.634	1,893	0.125
Solar Taurus 70 Turbine	100	2.216	2.293	75.634	1,893	0.125
Total (tons/yr)		**4.433**	**4.586**	**151**	**3,786**	**0.250**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Taurus 70 Turbine	100	3.675	3.80	125.39	3,139	0.207
Solar Taurus 70 Turbine	100	3.675	3.80	125.39	3,139	0.207
Total (tons/yr)		**7.349**	**7.60**	**251**	**6,277**	**0.415**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
SHP-J	1	1.167	1.21	39.8	996	0.066
Total (tons/yr)		**1.167**	**1.21**	**39.8**	**996**	**0.066**

Total Blowdown Emissions (tons/yr)	**12.95**	**13.40**	**442**	**11,060**	**0.731**

Table 9A-6-4 Combustion Source Criteria Pollutant Emission Factors
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Solar Turbine Normal Operation Emission Factors (lb/hr)														
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Solar Taurus 70 Turbine	Natural Gas	lb/hr	3.18	5.30	0.310	0.33	0.55	0.55	0.55	1.37	11411	0.83	0.29	11517

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(5) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Taurus 70 Turbine	Natural Gas	lb/hr	42.4	31.8	0.620	24.7	2,120	12.4

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown Efs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Taurus 70 Turbine	Natural Gas	lb/event	0.8	73.1	0.8	519	3.4	603	1.1	93.4	1.1	575	4.2	681

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Engine and Boiler Emission Factors														
Equipment Type	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Boiler < 100 MMBtu	Natural Gas	lb/MMscf	50	84	5.5	0.6	1.9	1.9	1.9	5.7	120000	2.3	2.2	120713
Engine 2 SLB	Natural Gas	lb/MMBtu	3.17	0.386	0.12	0.000588	0.0384	0.0384	0.0384	0.00991	110	1.45	0	146
1000 KW Caterpillar Egen	Natural Gas	lb/hp-hr	0.004408	0.004166	0.000529	4.62E-06	0.0003018	0.00030179	0.000302	7.79E-05	1.0998	0.0041	0	1

Notes
(1) NOx, CO, VOC, and PMF-10 Emission Factors for Boilers < 100 MMBtu from ETI Combustion Analysis June 2015
(2) All other emission factors for natural gas boilers taken from AP-42 Tables 1.4-1 & 1.4-2
(3) Emission Factors for 2 SLB engine taken from AP-42 Table 3.2-1
(4) NOx, CO, VOC, CO2, and CH4 emission factors for Caterpillar Egens taken from Caterpillar Manufacturer data
(5) SO2, PMF, PMF-10, PMF-2.5, PMC, and N2O Emission factors for Caterpillar Egens taken from AP-42 Table 3.2-1 and converted using manufacturer fuel data
(6) Assume PMF=PMF-10=PMF-2.5
(7) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(8) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR 98]

Table 9A-6-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Annual HAP Emissions (lb/yr)				
Quantity @ SHP-JB Tonkin		2	1	1
Pollutant	HAP?	Solar Taurus 70 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		10915	6.5	1416
		hp	MMBTU/hr	hp
		7205		
		Btu/hp-hr		
1,1,2,2-Tetrachloroethane	Yes			0.024
1,1,2-Trichloroethane	Yes			0.019
1,1-Dichloroethane	Yes			0.014
1,2,3-Trimethylbenzene	No			0.013
1,2,4-Trimethylbenzene	No			0.040
1,2-Dichloroethane	Yes			0.015
1,2-Dichloropropane	Yes			0.016
1,3,5-Trimethylbenzene	No			0.006
1,3-Butadiene	Yes			0.295
1,3-Dichloropropene	Yes			0.016
2,2,4-Trimethylpentane	Yes			0.305
2-Methylnaphthalene	No		0.001	0.008
3-Methylchloranthrene	No		0.000	
7,12-Dimethylbenz(a)anthracene	No		0.001	
Acenaphthene	No		0.000	0.000
Acenaphthylene	No		0.000	0.001
Acetaldehyde	Yes			2.796
Acrolein	Yes			2.803
Anthracene	No		0.000	0.000
Benz(a)anthracene	No		0.000	0.000
Benzene	Yes		0.117	0.699
Benzo(a)pyrene	No		0.000	0.000
Benzo(b)fluoranthene	No		0.000	0.000
Benzo(e)pyrene	No			0.000
Benzo(g,h,i)perylene	No		0.000	0.000
Benzo(k)fluoranthene	No		0.000	0.000
Biphenyl	Yes			0.001
Butane	No		117.229	1.711
Butyr/Isobutyraldehyde	No			0.157
Carbon Tetrachloride	Yes			0.022
Chlorobenzene	Yes			0.016
Chloroethane	Yes			
Chloroform	Yes			0.017
Chrysene	No		0.000	0.000
Cyclohexane	No			0.111
Cyclopentane	No			0.034
Dibenzo(a,h)anthracene	No		0.000	
Dichlorobenzene	Yes		0.067	
Ethane	No		173.053	25.544
Ethylbenzene	Yes			0.039
Ethylene Dibromide	Yes			0.026
Fluoranthene	No		0.000	0.000
Fluorene	No		0.000	0.001
Formaldehyde	Yes	992.029	4.187	19.888
Hexane (or n-Hexane)	Yes		100.482	0.160
Indeno(1,2,3-c,d)pyrene	No		0.000	0.000
Isobutane	No			1.351
Methanol	Yes			0.894
Methylcyclohexane	No			0.122
Methylene Chloride	Yes			0.053
n-Nonane	No			0.011
n-Octane	No			0.027
Naphthalene	Yes		0.034	0.035
PAH	Yes			0.048
Pentane (or n-Pentane)	No		145.141	0.551
Perylene	No			0.000
Phenanthrene	No		0.001	0.001
Phenol	Yes			0.015
Propane	No		89.318	10.340
Propylene Oxide	Yes			

Table 9A-6-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Annual HAP Emissions (lb/yr)				
Quantity @ SHP-JB Tonkin		**2**	**1**	**1**
Pollutant	**HAP?**	**Solar Taurus 70 Turbine**	**Boiler < 100 MMBtu**	**1000 KW Caterpillar Egen**
		10915	**6.5**	**1416**
		hp	**MMBTU/hr**	**hp**
Pyrene	No		0.000	0.000
Styrene	Yes			0.020
Tetrachloroethane	No			
Toluene	Yes		0.190	0.347
Vinyl Chloride	Yes			0.009
Xylene	Yes			0.097
Arsenic	Yes		0.011	
Barium	No		0.246	
Beryllium	Yes		0.001	
Cadmium	Yes		0.061	
Chromium	Yes		0.078	
Cobalt	Yes		0.005	
Copper	No		0.047	
Manganese	Yes		0.021	
Mercury	Yes		0.015	
Molybdenum	No		0.061	
Nickel	Yes		0.117	
Selenium	Yes		0.001	
Vanadium	No		0.128	
Zinc	No		1.619	
Lead	Yes		0.028	
Total HAPs		1050.586		
Total HAP/unit (lb/yr)		**1051**	**105**	**29**
Total HAP/unit (TPY)		**0.525**	**0.053**	**0.014**

Hazardous Air Pollutant

(1) Emissions above are on a per unit basis
(2) Calculations for the Caterpillar emergency generator assume 100 hours of operation; all other calculations assume 8,760 hours of operation
(3) Heat rates for Solar Turbines taken from Solar Datasheets
(4) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table 9A-6-6 Combustion Source HAP Emission Factors
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Pollutant	HAP?	Emission Factors		
		Solar Taurus 70 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMscf	lb/hp-hr
1,1,2,2-Tetrachloroethane	Yes			1.7E-07
1,1,2-Trichloroethane	Yes			1.3E-07
1,1-Dichloroethane	Yes			9.9E-08
1,2,3-Trimethylbenzene	No			9.0E-08
1,2,4-Trimethylbenzene	No			2.8E-07
1,2-Dichloroethane	Yes			1.1E-07
1,2-Dichloropropane	Yes			1.1E-07
1,3,5-Trimethylbenzene	No			4.6E-08
1,3-Butadiene	Yes			2.1E-06
1,3-Dichloropropene	Yes			1.1E-07
2,2,4-Trimethylpentane	Yes			2.2E-06
2-Methylnaphthalene	No		2.4E-05	5.4E-08
3-Methylchloranthrene	No		1.8E-06	
7,12-Dimethylbenz(a)anthracene	No		1.6E-05	
Acenaphthene	No		1.8E-06	3.4E-09
Acenaphthylene	No		1.8E-06	8.1E-09
Acetaldehyde	Yes			2.0E-05
Acrolein	Yes			2.0E-05
Anthracene	No		2.4E-06	1.8E-09
Benz(a)anthracene	No		1.8E-06	8.5E-10
Benzene	Yes		2.1E-03	4.9E-06
Benzo(a)pyrene	No		1.2E-06	1.4E-11
Benzo(b)fluoranthene	No		1.8E-06	2.2E-11
Benzo(e)pyrene	No			6.0E-11
Benzo(g,h,i)perylene	No		1.2E-06	6.3E-11
Benzo(k)fluoranthene	No		1.8E-06	1.1E-11
Biphenyl	Yes			1.0E-08
Butane	No		2.1E+00	1.2E-05
Butyr/Isobutyraldehyde	No			1.1E-06
Carbon Tetrachloride	Yes			1.5E-07
Chlorobenzene	Yes			1.1E-07
Chloroethane	Yes			
Chloroform	Yes			1.2E-07
Chrysene	No		1.8E-06	1.7E-09
Cyclohexane	No			7.8E-07
Cyclopentane	No			2.4E-07
Dibenzo(a,h)anthracene	No		1.2E-06	
Dichlorobenzene	Yes		1.2E-03	
Ethane	No		3.1E+00	1.8E-04
Ethylbenzene	Yes			2.7E-07
Ethylene Dibromide	Yes			1.9E-07
Fluoranthene	No		3.0E-06	9.2E-10
Fluorene	No		2.8E-06	4.3E-09
Formaldehyde	Yes	2.9E-03	7.5E-02	1.4E-04
Hexane (or n-Hexane)	Yes		1.8E+00	1.1E-06
Indeno(1,2,3-c,d)pyrene	No		1.8E-06	2.5E-11
Isobutane	No			9.5E-06
Methanol	Yes			6.3E-06
Methylcyclohexane	No			8.6E-07
Methylene Chloride	Yes			3.7E-07
n-Nonane	No			7.8E-08
n-Octane	No			1.9E-07
Naphthalene	Yes		6.1E-04	2.5E-07
PAH	Yes			3.4E-07
Pentane (or n-Pentane)	No		2.6E+00	3.9E-06
Perylene	No			1.3E-11
Phenanthrene	No		1.7E-05	9.0E-09
Phenol	Yes			1.1E-07
Propane	No		1.6E+00	7.3E-05
Propylene Oxide	Yes			
Pyrene	No		5.0E-06	1.5E-09
Styrene	Yes			1.4E-07
Tetrachloroethane	No			
Toluene	Yes		3.4E-03	2.5E-06

Table 9A-6-6 Combustion Source HAP Emission Factors
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Pollutant	HAP?	Emission Factors		
		Solar Taurus 70 Turbine	Boiler < 100 MMBtu	1000 KW Caterpillar Egen
		lb/MMBtu	lb/MMscf	lb/hp-hr
Vinyl Chloride+A32	Yes			6.3E-08
Xylene	Yes			6.8E-07
Arsenic	Yes		2.0E-04	
Barium	No		4.4E-03	
Beryllium	Yes		1.2E-05	
Cadmium	Yes		1.1E-03	
Chromium	Yes		1.4E-03	
Cobalt	Yes		8.4E-05	
Copper	No		8.5E-04	
Manganese	Yes		3.8E-04	
Mercury	Yes		2.6E-04	
Molybdenum	No		1.1E-03	
Nickel	Yes		2.1E-03	
Selenium	Yes		2.4E-05	
Vanadium	No		2.3E-03	
Zinc	No		2.9E-02	
Lead	Yes		5.0E-04	
Total HAPs		3.1E-03		

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for natural gas boilers from AP-42 Tables 1.4-2, 1.4-3, and 1.4-4
(3) Emission factors for 2 SLB natural gas engines and Caterpillar natural gas emergency generators taken from AP-42 Table 3.2-1
(4) Emission factors for Solar natural gas turbines and Caterpillar natural gas emergency generators converted using 1 KWh = 3412 Btu and 1 kw = 1.341 hp
(5) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL 168

Table 9A-6-7 Potential Emissions From Fugitive Leaks
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Fugitive Emissions (FUG)

Source Designation:

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr	CH_4 Weight Fraction[1]	Fug Emission Rate tpy
Solar Turbine	Gas	2.67E-02	0.934	250

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	743	3.34	14.6	0.026	0.384	0.0271	0.397	0.895	13.1	1.48E-03	2.17E-02
Compressors	Gas	5.71E+01	2	114	500	0.026	13.12	0.0271	13.6	0.895	448	1.48E-03	7.41E-01
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04	1	2.00E-04	8.76E-04	0.026	2.30E-05	0.0271	2.38E-05	0.895	7.84E-04	1.48E-03	1.30E-06
Flanges	Gas	3.90E-04	401	0.156	0.685	0.026	0.018	0.0271	0.019	0.895	0.613	1.48E-03	1.01E-03
Open-ended lines	Gas	2.00E-03		0.000	0.000	0.026	0.00	0.0271	0.000	0.895	0.000	1.48E-03	0.00E+00
			Total	118	516	-	13.52	-	14.0	-	461	-	7.63E-01

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.

Sample Calculations:

Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count

Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table 9A-6-8 Tank Emissions
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Source Designation:	TK-1, TK-2

Tank Parameters

Source	Type of Tank	Contents	Capacity	Throughput	Tank Diam.	Tank Length	Paint Color	Paint Condition
			(gal)	gal/yr	ft	ft		
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	1,000	5,000	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	5.14E-07	2.25E-06	1.48E-06	6.50E-06	2.00E-06	8.75E-06

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.

Table 9A-6-9 Project Potential Emissions
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Taurus 70 Turbine	CT-01	15.0	13.08	0.775	1.43	2.42	2.42	2.42	5.99	50,035	4.00	1.26	50,511	0.525
Solar Taurus 70 Turbine	CT-02	15.0	13.08	0.775	1.43	2.42	2.42	2.42	5.99	50,035	4.00	1.26	50,511	0.525
Caterpillar G3516 Egen	EG-01	0.31	0.29	0.037	0.0003	0.021	0.021	0.021	0.006	78	0.29	0.00	85	0.053
Boiler	WH-01	1.40	2.34	0.154	0.017	0.053	0.053	0.053	0.159	3,349	0.064	0.061	3,369	0.014
Fugitive Leaks - Blowdowns	FUG-01	-	-	12.95	-	-	-	-	-	13.40	442		11,060	0.731
Fugitive Leaks - Piping	FUG-02	-	-	13.52	-	-	-	-	-	14	461	-	11,549	0.763
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**31.6**	**28.8**	**28.6**	**2.88**	**4.9**	**4.9**	**4.9**	**12.1**	**103,524**	**912**	**2.58**	**127,084**	**2.61**

Table 9A-7-1 Project Equipment List
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Emission Point ID	Source	Manufacturer	Model/Type	Rated Capacity
CT-01	Compressor Turbine	Solar Turbines	Taurus 60-7800S	7,700 hp
FUG-01	Fugitive Leaks - Blowdowns	-	-	-
FUG-02	Fugitive Leaks - Piping	-	-	-
TK-1	Accumulator Tank	-	-	2,500 gal
TK-2	Hydrocarbon (Waste Oil) Tank	--	--	1,000 gal

Table 9A-7-2 Potential Emissions From Combustion Sources
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Turbine Operational Parameters:

Normal Hours of Operation:	8,677
Hours at Low Load (<50%)	0
Hours of Low Temp. (< 0 deg. F)	50
Hours of Start-up/Shut-down	33.3
Total Hours of Operation (hr/yr)	8,760

Generator Operational Parameters:

Normal Hours of Operation:	100

Boiler Operational Parameters:

Normal Hours of Operation:	8,760

Pre-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	11.2	18.0	1.01	1.08	1.83	1.83	1.83	4.53	37,813	2.73	0.954	38,165	0.410
Total (tons/yr)				**11.2**	**18.0**	**1.01**	**1.08**	**1.83**	**1.83**	**1.83**	**4.53**	**37,813**	**2.73**	**0.954**	**38,165**	**0.410**

Turbine Control Efficiencies

Control Technology	NOx	CO	VOC
Oxidation Catalyst	-	80%	50%

Post-Control Potential to Emit

Combustion Sources	Power Rating	Units	Fuel	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
				NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	11.21	3.59	0.505	1.08	1.83	1.83	1.83	4.53	37,813	2.73	0.954	38,165	0.410
Total (tons/yr)				**11.21**	**3.59**	**0.505**	**1.08**	**1.83**	**1.83**	**1.83**	**4.53**	**37,813**	**2.73**	**0.954**	**38,165**	**0.410**

Notes:
(1) Turbine emissions are calculated by the following formula: ER * Run Hours / 2000 * (1 - Control Efficiency)
ER = Emission Rate for particular equipment and pollutant (lbs/hr)
2000 = the amount of lbs in a ton
(2) Turbines are equipped with oxidation catalyst for control of CO (80%) and VOC (50%)
(3) See the "HAP Emissions" worksheet for a more detailed breakdown of HAP emissions
(4) See Emissions Factors table for Emissions Factors for each operating scenario.
(5) Each start-up/shut-down event assumed to last 10 minutes

Table 9A-7-3 Event Based Potential Emissions From Combustion Sources
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Start-up Emissions

Combustion Sources	Power Rating	Units	Fuel	Start-up Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	100	0.035	3.215	0.037	20.50	0.148	24.20
Total (tons/yr)					**0.035**	**3.215**	**0.037**	**20.50**	**0.148**	**24.20**

Shutdown Emissions

Combustion Sources	Power Rating	Units	Fuel	Shutdown Events	Criteria Pollutants (tpy)			GHG Emissions (tpy)		
					NOx	CO	VOC	CO2	CH4	CO2e
Solar Taurus 60 Turbine	7,700	hp	Natural Gas	100	0.020	1.650	0.019	10.20	0.076	12.10
Total (tons/yr)					**0.020**	**1.65**	**0.019**	**10.2**	**0.076**	**12.1**
Total SUSD Emissions (tons/yr)					**0.055**	**4.87**	**0.056**	**30.7**	**0.224**	**36.3**

Compressor Blowdown Emissions

Source Designation:	FUG-01

Blowdown Start-up Events

Blowdown from Start-up	38000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Start-up Blowdown	1691	lb/event

Blowdown Shutdown Events

Blowdown from Shutdown	63000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Shutdown Blowdown	2803	lb/event

Gas Composition

Pollutant	Molecular Weight (lb/lb-mol)	Molar (Volume) Fraction (mol%)	Wt. Fraction[1] (wt. %)
Total Stream Molecular Weight	16.89		
Non-VOC			
Carbon Dioxide	44.01	1.041%	**2.71%**
Nitrogen	28.01	0.994%	**1.65%**
Methane	16.04	94.21%	**89.47%**
Ethane	30.07	2.923%	**5.20%**
VOC			
Propane	44.10	0.546%	**1.43%**
n-Butane	58.12	0.084%	**0.29%**
IsoButane	58.12	0.079%	**0.27%**
n-Pentane	72.15	0.022%	**0.09%**
IsoPentane	72.15	0.024%	**0.10%**
n-Hexane	78.11	0.032%	**0.15%**
n-Heptane	100.21	0.049%	**0.29%**
Total VOC Fraction			**2.62%**
Total HAP Fraction			**0.15%**

Blowdown from Startup Events

Combustion Sources	Start-up Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Taurus 60 Turbine	100	2.216	2.293	75.6	1,893	0.125
Total (tons/yr)		**2.216**	**2.293**	**75.6**	**1,893**	**0.125**

Blowdown from Shutdown Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
Solar Taurus 60 Turbine	100	3.675	3.80	125.4	3,139	0.207
Total (tons/yr)		**3.675**	**3.80**	**125.4**	**3,139**	**0.207**

Site-Wide Blowdown Events

Site-Wide Blowdown	2,000,000	scf/event
Volumetric flow rate	385	scf-lbmol
Methane Molecular Weight	16	lb-lbmol
Methane Percent Weight	93%	%
Site-Wide Blowdown	88,990	lb/event

Blowdown from Site Wide Events

Combustion Sources	Startup Events	VOC	GHG Emissions (tpy)			HAPs
			CO2	CH4	CO2e	
SHP-C	1	1.167	1.21	39.8	996	0.066
Total (tons/yr)		**1.167**	**1.21**	**39.8**	**996**	**0.066**
Total Blowdown Emissions (tons/yr)		**7.06**	**7.30**	**240.8**	**6,028**	**0.398**

Table 9A-7-4 Combustion Source Criteria Pollutant Emission Factors
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Solar Turbine Normal Operation Emission Factors (lb/hr)														
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**SO2**	**PMF**	**PMF-10**	**PMF-2.5**	**PMC**	**CO2**	**CH4**	**N2O**	**CO2e**
Solar Taurus 60 Turbine	Natural Gas	lb/hr	2.40	4.00	0.230	0.25	0.42	0.42	0.42	1.03	8633	0.62	0.22	8713

Notes
(1) Pre-Control Emission Rates for NOx, CO, VOC, PMF, PMC, and CO2 taken from Solar Turbine Data at 100% load and 0 degrees F
(2) Emission Factors for SO2, CH4, N2O taken from AP-42 in (lbs/MMBtu) and multiplied by turbine fuel throughput by Solar Turbine at 100% load and 0 degree F to get Emission Rates
(3) Assume PMF=PMF-10=PMF-2.5; Filterable and Condensable based on Solar Turbine Emission Factor and ratio of AP-42 Table 3.1 factors
(4) CO2e emission rate calculated by multiplying each GHG (CO2, CH4, N2O) by its Global Warming Potential (GWP) and adding them together
(5) CO2 GWP = 1; CH4 GWP = 25; N2O GWP = 298 [40 CFR Part 98]

Solar Turbine Alternate Operation Emission Factors (lb/hr)								
			< 0 degrees F			**Solar Turbine Low Load F**		
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**
Solar Taurus 60 Turbine	Natural Gas	lb/hr	32.0	24.0	0.460	18.7	1,600	9.20

Notes
(1) Pre-Control low temperature Emission Rates for NOx, CO, VOC. Conservatively assume 120 ppm NOx, 150 ppm CO, and 5 ppm VOC (10% of UHC) per Table 2 of Solar PIL 167
(2) Pre-Control low load Emission Rates for NOx, CO, VOC. Conservatively assume 70 ppm NOx, 10,000 ppm CO, and 100 ppm VOC (10% of UHC) per Table 4 of Solar PIL 167

Solar Turbine Start-up and Shutdown Emission Factors (lb/event)														
			Start-up EFs						**Shutdown Efs**					
Equipment Name	**Fuel**	**Units**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**	**NOx**	**CO**	**VOC**	**CO2**	**CH4**	**CO2e**
Solar Taurus 60 Turbine	Natural Gas	lb/event	0.7	64.3	0.7	410	3.0	484	0.4	33.0	0.4	204	1.5	242

Notes
(1) Start-up and Shutdown Emissions based on Solar Turbines Incorporated Product Information Letter 170: Emission Estimates at Start-up, Shutdown, and Commissioning for SoLoNOx Combustion Products (13 June 2012). Emission Estimates do not include SO2, PM, N2O, or any HAPs.
(2) VOCs assumed to be 20% of UHC and CH4 assumed to be 80% of UHC.
(3) CO2e emission rate calculated by multiplying each GHG (CO2, CH4) by its Global Warming Potential (GWP) and adding them together
(4) CO2 GWP = 1; CH4 GWP = 25; [40 CFR Part 98]

Table 9A-7-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Annual HAP Emissions (lb/yr)		
Quantity @ SHP-Crayne		1
Pollutant	HAP?	Solar Taurus 60 Turbine
		7700
		hp
		7965
		Btu/hp-hr
1,1,2,2-Tetrachloroethane	Yes	
1,1,2-Trichloroethane	Yes	
1,1-Dichloroethane	Yes	
1,2,3-Trimethylbenzene	No	
1,2,4-Trimethylbenzene	No	
1,2-Dichloroethane	Yes	
1,2-Dichloropropane	Yes	
1,3,5-Trimethylbenzene	No	
1,3-Butadiene	Yes	
1,3-Dichloropropene	Yes	
2,2,4-Trimethylpentane	Yes	
2-Methylnaphthalene	No	
3-Methylchloranthrene	No	
7,12-Dimethylbenz(a)anthracene	No	
Acenaphthene	No	
Acenaphthylene	No	
Acetaldehyde	Yes	
Acrolein	Yes	
Anthracene	No	
Benz(a)anthracene	No	
Benzene	Yes	
Benzo(a)pyrene	No	
Benzo(b)fluoranthene	No	
Benzo(e)pyrene	No	
Benzo(g,h,i)perylene	No	
Benzo(k)fluoranthene	No	
Biphenyl	Yes	
Butane	No	
Butyr/Isobutyraldehyde	No	
Carbon Tetrachloride	Yes	
Chlorobenzene	Yes	
Chloroethane	Yes	
Chloroform	Yes	
Chrysene	No	
Cyclohexane	No	
Cyclopentane	No	
Dibenzo(a,h)anthracene	No	
Dichlorobenzene	Yes	
Ethane	No	
Ethylbenzene	Yes	
Ethylene Dibromide	Yes	
Fluoranthene	No	
Fluorene	No	
Formaldehyde	Yes	773.647
Hexane (or n-Hexane)	Yes	
Indeno(1,2,3-c,d)pyrene	No	
Isobutane	No	
Methanol	Yes	
Methylcyclohexane	No	
Methylene Chloride	Yes	
n-Nonane	No	

Table 9A-7-5 Hazardous Air Pollutant (HAP) Emissions From Combustion Sources
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Annual HAP Emissions (lb/yr)		
Quantity @ SHP-Crayne		**1**
Pollutant	**HAP?**	**Solar Taurus 60 Turbine**
		7700
		hp
n-Octane	No	
Naphthalene	Yes	
PAH	Yes	
Pentane (or n-Pentane)	No	
Perylene	No	
Phenanthrene	No	
Phenol	Yes	
Propane	No	
Propylene Oxide	Yes	
Pyrene	No	
Styrene	Yes	
Tetrachloroethane	No	
Toluene	Yes	
Vinyl Chloride	Yes	
Xylene	Yes	
Arsenic	Yes	
Barium	No	
Beryllium	Yes	
Cadmium	Yes	
Chromium	Yes	
Cobalt	Yes	
Copper	No	
Manganese	Yes	
Mercury	Yes	
Molybdenum	No	
Nickel	Yes	
Selenium	Yes	
Vanadium	No	
Zinc	No	
Lead	Yes	
Total HAPs		819.314
Total HAP/unit (lb/yr)		**819**
Total HAP/unit (TPY)		**0.410**

Hazardous Air Pollutant

Notes:
(1) Emissions above are on a per unit basis
(2) Heat rates for Solar Turbines taken from Solar Datasheets
(3) Solar turbines have a 50% HAP control efficiency due to the Oxidation Catalyst

Table 9A-7-6 Combustion Source HAP Emission Factors
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Pollutant	HAP?	Emission Factors
		Solar Taurus 60 Turbine
		lb/MMBtu
1,1,2,2-Tetrachloroethane	Yes	
1,1,2-Trichloroethane	Yes	
1,1-Dichloroethane	Yes	
1,2,3-Trimethylbenzene	No	
1,2,4-Trimethylbenzene	No	
1,2-Dichloroethane	Yes	
1,2-Dichloropropane	Yes	
1,3,5-Trimethylbenzene	No	
1,3-Butadiene	Yes	
1,3-Dichloropropene	Yes	
2,2,4-Trimethylpentane	Yes	
2-Methylnaphthalene	No	
3-Methylchloranthrene	No	
7,12-Dimethylbenz(a)anthracene	No	
Acenaphthene	No	
Acenaphthylene	No	
Acetaldehyde	Yes	
Acrolein	Yes	
Anthracene	No	
Benz(a)anthracene	No	
Benzene	Yes	
Benzo(a)pyrene	No	
Benzo(b)fluoranthene	No	
Benzo(e)pyrene	No	
Benzo(g,h,i)perylene	No	
Benzo(k)fluoranthene	No	
Biphenyl	Yes	
Butane	No	
Butyr/Isobutyraldehyde	No	
Carbon Tetrachloride	Yes	
Chlorobenzene	Yes	
Chloroethane	Yes	
Chloroform	Yes	
Chrysene	No	
Cyclohexane	No	
Cyclopentane	No	
Dibenzo(a,h)anthracene	No	
Dichlorobenzene	Yes	
Ethane	No	
Ethylbenzene	Yes	
Ethylene Dibromide	Yes	
Fluoranthene	No	
Fluorene	No	
Formaldehyde	Yes	2.9E-03
Hexane (or n-Hexane)	Yes	
Indeno(1,2,3-c,d)pyrene	No	
Isobutane	No	
Methanol	Yes	
Methylcyclohexane	No	
Methylene Chloride	Yes	
n-Nonane	No	
n-Octane	No	
Naphthalene	Yes	
PAH	Yes	
Pentane (or n-Pentane)	No	
Perylene	No	
Phenanthrene	No	
Phenol	Yes	
Propane	No	
Propylene Oxide	Yes	
Pyrene	No	
Styrene	Yes	
Tetrachloroethane	No	
Toluene	Yes	
Vinyl Chloride+A32	Yes	
Xylene	Yes	
Arsenic	Yes	

Table 9A-7-6 Combustion Source HAP Emission Factors
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Pollutant	HAP?	Emission Factors
		Solar Taurus 60 Turbine
		lb/MMBtu
Barium	No	
Beryllium	Yes	
Cadmium	Yes	
Chromium	Yes	
Cobalt	Yes	
Copper	No	
Manganese	Yes	
Mercury	Yes	
Molybdenum	No	
Nickel	Yes	
Selenium	Yes	
Vanadium	No	
Zinc	No	
Lead	Yes	
Total HAPs		3.1E-03

Hazardous Air Pollutant

Notes:
(1) Emission factors for Solar and Capstone natural gas turbines from AP-42 Table 3.1-3
(2) Emission factors for Solar natural gas turbines and Caterpillar natural gas emergency generators converted using 1 KWh = 3412 Btu and 1 kw = 1.341 hp
(3) Emission Factors (lb/MMBtu) for Formaldehyde and Total HAPs for Solar Turbines from Solar PIL 168

Table 9A-7-7 Potential Emissions From Fugitive Leaks
SHP Crayne Compressor Station - Pennsylvania
Supply Header Project

Fugitive Emissions (FUG)

Source Designation:	FUG-02

Operational Parameters:

Annual Hours of Operation (hr/yr):	8,760

Compressor Fugitive Emissions Rate

Equipment	Service	CH4 Emission Factor[1] ton/comp-hr	CH_4 Weight Fraction[1]	Fug Emission Rate tpy
Solar Turbine	Gas	2.67E-02	0.934	250.2

1. Default methane basis and emission factor taken from Table 6-6 of Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, API, August 2009.
2. Sample calculations: Hours of operation (hr/yr) * EF (ton / compressor -hr) / Methane Fraction

Pipeline Natural Gas Fugitive Emissions

Equipment	Service	Emission Factor[1] lb/hr/source	Source Count[2]	Total HC Potential Emissions lb/hr	Total HC Potential Emissions tpy	VOC Weight Fraction	VOC Emissions tpy	CO_2 Weight Fraction	CO_2 Emissions tpy	CH_4 Weight Fraction	CH_4 Emissions tpy	HAP Weight Fraction	HAP Emissions tpy
Valves	Gas	4.50E-03	63	0.284	1.242	0.026	3.26E-02	0.0271	0.034	0.895	1.111	1.48E-03	1.84E-03
Compressors	Gas	5.71E+01	1	57.122	250.19	0.026	6.56E+00	0.0271	6.787	0.895	223.84	1.48E-03	3.70E-01
Pump Seals	Gas	2.40E-03		0.00	0.00	0.026	0.00E+00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Others (compressors and others)	Gas	8.80E-03		0.00	0.00	0.026	0.00E+00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Connectors	Gas	2.00E-04		0.00	0.00	0.026	0.00E+00	0.0271	0.000	0.895	0.00	1.48E-03	0.00E+00
Flanges	Gas	3.90E-04	51	0.02	0.09	0.026	2.28E-03	0.0271	0.002	0.895	0.08	1.48E-03	1.29E-04
Open-ended lines	Gas	2.00E-03		0.000	0.000	0.026	0.00E+00	0.0271	0.000	0.895	0.000	1.48E-03	0.00E+00
			Total	57.425	251.523	-	6.59E+00	-	6.823	-	225.025	-	3.72E-01

1. EPA Protocol for Equipment Leaks Emissions Estimate (EPA-453/R-95-017) Table 2-4: Oil and Gas Production Operations Emission Factors.
2. Component count based on Basic Systems Engineering Estimate.

Sample Calculations:

Potential Emissions (lb/hr) = Emission Factor (lb/hr/source) * Source Count

Potential Emissions (tons/yr) = $(lb/hr)_{Potential}$ × Hours of Operation (hr/yr) × (1 ton/2,000 lb).

Table 9A-7-8 Tank Emissions
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Source Designation:	TK-1, TK-2

Tank Parameters

Source	Type of Tank	Contents	Capacity	Throughput	Tank Diam.	Tank Length	Paint Color	Paint Condition
			(gal)	gal/yr	ft	ft		
TK-1	Horizontal, fixed	Produced Fluids	2,500	12,500	4.61	20	Light Grey	Good
TK-2	Horizontal, fixed	Lube Oil	1,000	5,000	4.12	10	Light Grey	Good

Total Emissions

Source	VOC Emissions							
	Flashing Losses		Working Losses		Breathing Losses		Total Losses	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
TK-1[1]	--	--	--	--	--	--	0.080	0.350
TK-2[2]	NA	NA	5.14E-07	2.25E-06	1.48E-06	6.50E-06	2.00E-06	8.75E-06

1. Losses were calculated for TK-1 using E&P Tanks Software. See attached for output.
2. Losses were calculated for TK-2 using EPA's TANKS 4.09d software with default breather vent settings.

Table 9A-7-9 Project Potential Emissions
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Combustion Sources	ID	Criteria Pollutants (tpy)								GHG Emissions (tpy)				HAP (tpy)
		NOx	CO	VOC	SO2	PMF	PMF-10	PMF-2.5	PMC	CO2	CH4	N2O	CO2e	Total HAP
Solar Taurus 60 Turbine	CT-01	11.3	8.5	0.561	1.08	1.83	1.83	1.83	4.53	37,843	2.96	0.954	38,201	0.410
Fugitive Leaks - Blowdowns	FUG-01	-	-	7.06	-	-	-	-	-	7.30	240.8		6,028	0.398
Fugitive Leaks - Piping	FUG-02	-	-	6.59	-	-	-	-	-	6.82	225	-	5,632	0.372
Accumulator Tank	TK-1	-	-	0.350	-	-	-	-	-	-	-	-	-	-
Hydrocarbon (Waste Oil) Tank	TK-2	-	-	8.75E-06	-	-	-	-	-	-	-	-	-	-
Total (tons/yr)		**11.3**	**8.46**	**14.6**	**1.08**	**1.83**	**1.83**	**1.83**	**4.53**	**37,857**	**469**	**0.954**	**49,862**	**1.18**

Table 9A-8-1 Project Potential Emissions

SHP Burch Ridge Compressor Station - Marshall County, West Virginia

Supply Header Project

Locations	VOC	GHG Emissions (tons/yr)				NH3	Total HAP
		CO2	CH4	N2O	CO2e		
Fugitive Leaks - Piping	0.012	0.023	0.741	-	18.5	-	0.001
Total (tons/yr)	**0.012**	**0.023**	**0.741**	**0.00**	**18.5**	**0.00**	**0.001**

Notes

(1) Burch Ridge is an existing compressor station with no additional sources

(2) Only fugitive emissions from modifications to the pipeline onsite are considered

Table 9A-9-1 Potential Construction Emissions from Off-Road Engine Combustion
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)										Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Marts Compressor Station			Kincheloe M&R			CNX M&R			Project														
			Number	Months at Project	% Utilization	Number	Months at Project	% Utilization	Months at Project	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																										
150 ton Crawler Crane	Cranes	263	1	3	50%	0	0	0%	0	0	0%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	69.21	0.02	0.05	0.22	0.01	0.01
100 Ton Hydraulic Crane	Cranes	225	1	6	25%	0	0	0%	0	0	0%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	59.21	0.02	0.04	0.19	0.01	0.01
50 Ton Hydraulic Crane	Cranes	185	1	10	75%	1	2	50%	1	2	50%	2850.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	308.33	0.10	0.22	0.97	0.04	0.04
Earthwork / Concrete Equipment																										
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	3	14	50%	1	6	50%	1	6	50%	8100.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.01	1116.02	0.91	3.15	6.16	0.59	0.57
Loaders	Tractors/Loaders/Backhoes	200	1	10	50%	0	0	0%	0	0	0%	1500.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	206.67	0.17	0.58	1.14	0.11	0.11
Graders	Graders	200	1	4	25%	0	0	0%	0	0	0%	300.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	35.47	0.01	0.03	0.08	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	8	50%	0	0	0%	0	0	0%	1200.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	283.78	0.08	0.41	1.02	0.06	0.06
Dozer - D-6	Crawler Tractor/Dozers	300	1	8	50%	0	0	0%	0	0	0%	1200.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	212.84	0.06	0.17	0.51	0.03	0.03
Compactor	Surfacing Equipment	200	1	14	50%	1	6	50%	1	6	50%	3900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	461.02	0.17	0.64	1.89	0.12	0.11
Dump Trucks	Off-highway Trucks	400	2	10	40%	1	4	40%	1	4	40%	3360.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	794.66	0.21	0.55	1.57	0.08	0.08
Concrete Pump	Pumps	125	1	10	20%	1	1	10%	1	1	10%	660.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	48.20	0.03	0.11	0.35	0.02	0.02
Vehicles																										
ATVs	Tractors/Loaders/Backhoes	20	4	18	10%	1	10	5%	1	10	5%	2460.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	37.65	0.03	0.17	0.25	0.02	0.02
Pick-up Trucks	Off-highway Trucks	300	4	18	10%	1	10	5%	1	10	5%	2460.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	436.37	0.11	0.13	0.52	0.02	0.02
Flatbed Trucks (2 ton)	Off-highway Trucks	400	4	12	5%	0	0	0%	0	0	0%	720.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	170.29	0.04	0.12	0.34	0.02	0.02
2000 Gallon Water Truck	Off-highway Trucks	400	1	12	5%	0	0	0%	0	0	0%	180.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	42.57	0.01	0.03	0.08	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	18	1%	0	0	0%	0	0	0%	54.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	12.77	0.00	0.01	0.03	0.00	0.00
Forklifts / Manlifts																										
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	10	25%	1	4	5%	1	4	5%	2370.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	280.20	0.09	0.32	0.95	0.06	0.06
Manlifts	Aerial Lift	95	6	10	60%	1	4	25%	1	4	25%	11400.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.01	827.20	1.18	6.33	5.64	0.89	0.87
Air Compressors																										
160-185 CFM Portable	Air Compressors	150	1	6	50%	0	0	0%	0	0	0%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																										
Welding Machines (300 - 400 AMP)	Welders	35	10	12	95%	4	6	95%	4	6	95%	47880.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.01	1280.96	1.51	6.63	8.72	1.06	1.03
Water Pump	Pumps	8	2	10	5%	1	5	5%	1	5	5%	450.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	2.33	0.00	0.02	0.02	0.00	0.00
Generator	Generator Sets	13	3	14	90%	1	5	90%	1	5	90%	14040.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	118.40	0.12	0.54	0.99	0.08	0.08
Lighting Towers (portable)	Generator Sets	7	2	6	20%	0	0	0%	0	0	0%	720.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	3.27	0.00	0.03	0.03	0.00	0.00
Total Estimated Project Emissions (Tons/Project)																				**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
																				0.04	**6,886.34**	**4.92**	**20.35**	**31.99**	**3.26**	**3.16**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-9-2 Potential Construction Emissions from On-Road Engine Combustion
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	60	40	2400
Company Commute Trucks	Light Commercial Truck	1	30	30
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	140	140
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	14	40	560
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	50	150

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.51	12.41	0.68	0.04	0.02	0.01	724.46
Company Commute Trucks	0.01	0.13	0.01	0.00	0.00	0.00	34.92
Delivery Trucks (Warehouse)	0.04	0.12	0.09	0.01	0.01	0.00	185.19
Contractor Commute Trucks	0.22	2.52	0.19	0.01	0.00	0.00	651.87
Delivery Trucks (Local)	0.04	0.13	0.10	0.01	0.01	0.00	198.42
TOTAL EMISSIONS	0.82	15.32	1.07	0.06	0.04	0.02	1,794.85

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-9-3 Potential Construction Emissions from Unpaved Road Fugitives

ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	105.9
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	13.94	4.86	0.49

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.27	2.19	0.22
Controlled	lb/hr	3.76	1.31	0.13
Uncontrolled	tons	18.82	6.56	0.66
Controlled	**tons**	**11.29**	**3.94**	**0.39**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Weston, WV 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-4 Potential Construction Emissions from Paved Road Fugitives

ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	60	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	14	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.73
Precip > 0.01 in (p)[1]	days/yr	105.9
Truck Schedule	VMT/day	3,280
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0679	0.0136	0.0033
E_{ext}	lb/VMT	0.0630	0.0126	0.0031

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	222.74	44.55	10.93

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	206.58	41.32	10.14
Total Emissions	**tons**	**61.97**	**12.39**	**3.04**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Weston, WV 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-5 Potential Construction Emissions from Material Handling
ACP Compressor Station 1 - Lewis County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	6.19
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	77.4
Precip > 0.01 in (p)[3]	days	105.9
Land Affected During Construction	acre	20.0
Depth of Land Excavated[4]	feet	13.5
Volume of Ground Material Moved[5]	cubic yd	871,200
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	976,491
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	726.0
Daily Pile Height and Radius[8]	yd	8.85
Daily Pile Surface Area[8]	acre	2.157

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00274	0.00129	0.00020
Fugitive Wind Erosion Factor	lb/day	208.63	104.32	15.65

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**1.34**	**0.63**	**0.10**
Total Fugitive Wind Emissions	**tons**	**62.59**	**31.29**	**4.69**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Clarksburg/Benedum Field Weather Station data, average from 1972-2000

[2] Elkins/Randolph Field Weather Station data, frequency wind greater than calm, 1961-1990

[3] Weston, WV 30-year average of days > 0.1 inch precipitation (1981-2010)

[4] Based on maximum depth of pipeline trench

[5] Volume doubled because material is removed and replaced; see GE&F calculations

[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space

[7] Construction schedule assumed to be 20 months, 30 days/month

[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)

[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)

[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)

[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent

[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent

[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-6 Potential Construction Emissions from Off-Road Engine Combustion
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)							Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Buckingham Compressor Station			Woods Corner M&R			Project														
			Number	Months at Project	% Utilization	Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																							
150 ton Crawler Crane	Cranes	263	1	3	50%	0	0	0%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	69.21	0.02	0.05	0.22	0.01	0.01
100 Ton Hydraulic Crane	Cranes	225	1	6	25%	0	0	0%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	59.21	0.02	0.04	0.19	0.01	0.01
50 Ton Hydraulic Crane	Cranes	185	1	10	75%	1	2	50%	2550.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	275.88	0.09	0.19	0.87	0.04	0.04
Earthwork / Concrete Equipment																							
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	3	14	50%	1	6	50%	7200.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.01	992.01	0.80	2.80	5.47	0.53	0.51
Loaders	Tractors/Loaders/Backhoes	200	1	10	50%	0	0	0%	1500.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	206.67	0.17	0.58	1.14	0.11	0.11
Graders	Graders	200	1	4	25%	0	0	0%	300.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	35.47	0.01	0.03	0.08	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	4	50%	0	0	0%	600.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	141.89	0.04	0.21	0.51	0.03	0.03
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	0	0	0%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	14	50%	1	6	50%	3000.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	354.63	0.13	0.49	1.45	0.09	0.09
Dump Trucks	Off-highway Trucks	400	2	10	40%	1	4	40%	2880.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	681.14	0.18	0.47	1.35	0.07	0.07
Concrete Pump	Pumps	125	1	10	20%	1	1	10%	630.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	46.01	0.03	0.10	0.34	0.02	0.02
Vehicles																							
ATVs	Tractors/Loaders/Backhoes	20	4	18	10%	1	10	5%	2310.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	35.35	0.03	0.16	0.23	0.02	0.02
Pick-up Trucks	Off-highway Trucks	300	4	18	10%	1	10	5%	2310.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	409.76	0.10	0.12	0.48	0.02	0.01
Flatbed Trucks (2 ton)	Off-highway Trucks	400	4	12	5%	0	0	0%	720.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	170.29	0.04	0.12	0.34	0.02	0.02
2000 Gallon Water Truck	Off-highway Trucks	400	1	12	5%	0	0	0%	180.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	42.57	0.01	0.03	0.08	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	18	1%	0	0	0%	54.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	12.77	0.00	0.01	0.03	0.00	0.00
Forklifts / Manlifts																							
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	10	25%	1	4	5%	2310.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	273.10	0.09	0.31	0.93	0.06	0.06
Manlifts	Aerial Lift	95	6	10	60%	1	4	25%	11100.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	805.43	1.15	6.16	5.49	0.87	0.84
Air Compressors																							
160-185 CFM Portable	Air Compressors	150	1	6	50%	0	0	0%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																							
Welding Machines (300 - 400 AMP)	Welders	35	10	12	95%	4	6	95%	41040.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.01	1097.97	1.29	5.68	7.48	0.91	0.88
Water Pump	Pumps	8	2	10	5%	1	5	5%	375.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	1.95	0.00	0.01	0.02	0.00	0.00
Generator	Generator Sets	13	3	14	90%	1	5	90%	12690.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	107.01	0.11	0.49	0.90	0.07	0.07
Lighting Towers (portable)	Generator Sets	7	2	6	20%	0	0	0%	720.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	3.27	0.00	0.03	0.03	0.00	0.00
Total Estimated Project Emissions (Tons/Project)																	**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
																	0.03	**6,006.94**	**4.40**	**18.26**	**28.20**	**2.92**	**2.83**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-9-7 Potential Construction Emissions from On-Road Engine Combustion
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	60	50	3000
Company Commute Trucks	Light Commercial Truck	1	50	50
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	160	160
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	14	50	700
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	50	150

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.63	15.52	0.85	0.05	0.02	0.01	905.58
Company Commute Trucks	0.02	0.22	0.02	0.00	0.00	0.00	58.20
Delivery Trucks (Warehouse)	0.04	0.14	0.11	0.01	0.01	0.00	211.64
Contractor Commute Trucks	0.28	3.15	0.23	0.01	0.01	0.00	814.83
Delivery Trucks (Local)	0.04	0.13	0.10	0.01	0.01	0.00	198.42
TOTAL EMISSIONS	1.01	19.16	1.31	0.08	0.04	0.02	2,188.67

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-9-8 Potential Construction Emissions from Unpaved Road Fugitives
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	74.6
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.63	5.45	0.54

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	7.03	2.45	0.25
Controlled	lb/hr	4.22	1.47	0.15
Uncontrolled	tons	21.10	7.36	0.74
Controlled	**tons**	**12.66**	**4.41**	**0.44**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] Buckingham, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-9 Potential Construction Emissions from Paved Road Fugitives
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	60	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	14	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.73
Precip > 0.01 in (p)[1]	days/yr	74.6
Truck Schedule	VMT/day	4,060
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0679	0.0136	0.0033
E_{ext}	lb/VMT	0.0644	0.0129	0.0032

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	275.71	55.14	13.53

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	261.62	52.32	12.84
Total Emissions	**tons**	**78.49**	**15.70**	**3.85**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Buckingham, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-10 Potential Construction Emissions from Material Handling
ACP Compressor Station 2 - Buckingham County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	7.78
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	90.3
Precip > 0.01 in (p)[3]	days	74.6
Land Affected During Construction	acre	20.0
Depth of Land Excavated[4]	feet	13.5
Volume of Ground Material Moved[5]	cubic yd	871,200
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	976,491
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	726.0
Daily Pile Height and Radius[8]	yd	8.85
Daily Pile Surface Area[8]	acre	2.157

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00368	0.00174	0.00026
Fugitive Wind Erosion Factor	lb/day	272.81	136.40	20.46

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**1.80**	**0.85**	**0.13**
Total Fugitive Wind Emissions	**tons**	**81.84**	**40.92**	**6.14**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Lynchburg/P. Glenn Weather Station data, average from 1948-2000
[2] Lynchburg/P. Glenn Weather Station data, frequency wind greater than calm, 1961-1990
[3] Buckingham, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 20 months, 30 days/month
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-11 Potential Construction Emissions from Off-Road Engine Combustion
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Northampton Compressor Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	1	3	50%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	69.21	0.02	0.05	0.22	0.01	0.01
100 Ton Hydraulic Crane	Cranes	225	1	6	25%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	59.21	0.02	0.04	0.19	0.01	0.01
50 Ton Hydraulic Crane	Cranes	185	1	10	75%	2250.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	243.42	0.08	0.17	0.77	0.03	0.03
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	3	14	50%	6300.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.01	868.01	0.70	2.45	4.79	0.46	0.45
Loaders	Tractors/Loaders/Backhoes	200	1	10	50%	1500.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	206.67	0.17	0.58	1.14	0.11	0.11
Graders	Graders	200	1	4	25%	300.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	35.47	0.01	0.03	0.08	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	4	50%	600.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	141.89	0.04	0.21	0.51	0.03	0.03
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	14	50%	2100.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	248.24	0.09	0.34	1.02	0.06	0.06
Dump Trucks	Off-highway Trucks	400	2	10	40%	2400.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	567.62	0.15	0.39	1.12	0.06	0.06
Concrete Pump	Pumps	125	1	10	20%	600.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	43.82	0.03	0.10	0.32	0.02	0.02
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	18	10%	2160.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	33.05	0.03	0.15	0.22	0.02	0.02
Pick-up Trucks	Off-highway Trucks	300	4	18	10%	2160.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	383.15	0.10	0.12	0.45	0.01	0.01
Flatbed Trucks (2 ton)	Off-highway Trucks	400	4	12	5%	720.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	170.29	0.04	0.12	0.34	0.02	0.02
2000 Gallon Water Truck	Off-highway Trucks	400	1	12	5%	180.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	42.57	0.01	0.03	0.08	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	18	1%	54.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	12.77	0.00	0.01	0.03	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	10	25%	2250.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	266.01	0.09	0.31	0.91	0.06	0.06
Manlifts	Aerial Lift	95	6	10	60%	10800.00	0.0043	692.905	0.99	5.30	4.72	0.75	0.72	0.00	783.66	1.12	5.99	5.34	0.84	0.82
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	10	12	95%	34200.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.01	914.97	1.08	4.74	6.23	0.76	0.73
Water Pump	Pumps	8	2	10	5%	300.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	1.56	0.00	0.01	0.01	0.00	0.00
Generator	Generator Sets	13	3	14	90%	11340.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	95.63	0.10	0.44	0.80	0.07	0.06
Lighting Towers (portable)	Generator Sets	7	2	6	20%	720.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	3.27	0.00	0.03	0.03	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.03	**5,375.84**	**3.94**	**16.46**	**25.17**	**2.62**	**2.54**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-9-12 Potential Construction Emissions from On-Road Engine Combustion
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	60	20	1200
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	170	170
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	14	20	280
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.25	6.21	0.34	0.02	0.01	0.01	362.23
Company Commute Trucks	0.01	0.09	0.01	0.00	0.00	0.00	23.28
Delivery Trucks (Warehouse)	0.04	0.15	0.11	0.01	0.01	0.00	224.87
Contractor Commute Trucks	0.11	1.26	0.09	0.00	0.00	0.00	325.93
Delivery Trucks (Local)	0.03	0.10	0.08	0.01	0.01	0.00	158.73
TOTAL EMISSIONS	0.45	7.81	0.63	0.04	0.02	0.01	1,095.05

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-9-13 Potential Construction Emissions from Unpaved Road Fugitives
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	77.1
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.49	5.40	0.54

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.97	2.43	0.24
Controlled	lb/hr	4.18	1.46	0.15
Uncontrolled	tons	20.92	7.29	0.73
Controlled	**tons**	**12.55**	**4.38**	**0.44**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] Jackson, NC 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-14 Potential Construction Emissions from Paved Road Fugitives
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	60	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	14	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.73
Precip > 0.01 in (p)[1]	days/yr	77.1
Truck Schedule	VMT/day	1,790
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0679	0.0136	0.0033
E_{ext}	lb/VMT	0.0643	0.0129	0.0032

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	121.56	24.31	5.97

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	115.14	23.03	5.65
Total Emissions	**tons**	**34.54**	**6.91**	**1.70**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Jackson, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-9-15 Potential Construction Emissions from Material Handling
ACP Compressor Station 3 - Northampton County, North Carolina
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	10.93
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	96.4
Precip > 0.01 in (p)[3]	days	77.1
Land Affected During Construction	acre	20.0
Depth of Land Excavated[4]	feet	13.5
Volume of Ground Material Moved[5]	cubic yd	871,200
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	976,491
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	726.0
Daily Pile Height and Radius[8]	yd	8.85
Daily Pile Surface Area[8]	acre	2.157

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00573	0.00271	0.00041
Fugitive Wind Erosion Factor	lb/day	288.73	144.36	21.65

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**2.80**	**1.32**	**0.20**
Total Fugitive Wind Emissions	**tons**	**86.62**	**43.31**	**6.50**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Norfolk International Airport Weather Station data, average from 1948-2000
[2] Norfolk International Airport Weather Station data, frequency wind greater than calm, 1961-1990
[3] Jackson, NC 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 20 months, 30 days/month
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-1 Potential Construction Emissions from Off-Road Engine Combustion
Brunswick M&R Station - Brunswick County, Virginia
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Brunswick M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-2 Potential Construction Emissions from On-Road Engine Combustion
Brunswick M&R Station - Brunswick County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	25	625
Company Commute Trucks	Light Commercial Truck	1	25	25
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	110	110
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	25	100
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	50	150

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.09	2.10	0.12	0.01	0.00	0.00	122.63
Company Commute Trucks	0.01	0.07	0.01	0.00	0.00	0.00	18.92
Delivery Trucks (Warehouse)	0.02	0.06	0.05	0.00	0.00	0.00	94.58
Contractor Commute Trucks	0.03	0.29	0.02	0.00	0.00	0.00	75.66
Delivery Trucks (Local)	0.03	0.08	0.06	0.00	0.00	0.00	128.97
TOTAL EMISSIONS	0.16	2.61	0.25	0.02	0.01	0.00	440.76

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-3 Potential Construction Emissions from Unpaved Road Fugitives

Brunswick M&R Station - Brunswick County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	72.1
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.76	5.50	0.55

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	7.09	2.47	0.25
Controlled	lb/hr	4.26	1.48	0.15
Uncontrolled	tons	13.83	4.82	0.48
Controlled	**tons**	**8.30**	**2.89**	**0.29**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-4 Potential Construction Emissions from Paved Road Fugitives

Brunswick M&R Station - Brunswick County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	72.1
Truck Schedule	VMT/day	1,010
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0754	0.0151	0.0037

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	80.11	16.02	3.93

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	76.15	15.23	3.74
Total Emissions	**tons**	**14.85**	**2.97**	**0.73**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-5 Potential Construction Emissions from Material Handling
Brunswick M&R Station - Brunswick County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	8.07
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	92.7
Precip > 0.01 in (p)[3]	days	72.1
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	8.0
Volume of Ground Material Moved[5]	cubic yd	129,067
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	144,665
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	165.5
Daily Pile Height and Radius[8]	yd	5.41
Daily Pile Surface Area[8]	acre	0.805

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00386	0.00183	0.00028
Fugitive Wind Erosion Factor	lb/day	105.40	52.70	7.90

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.28**	**0.13**	**0.02**
Total Fugitive Wind Emissions	**tons**	**20.55**	**10.28**	**1.54**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Richmond/Byrd Field Weather Station data, average from 1942-2000
[2] Richmond/Byrd Field Weather Station data, frequency wind greater than calm, 1961-1990
[3] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-6 Potential Construction Emissions from Off-Road Engine Combustion
Elizabeth River M&R Station - City of Chesapeake, VA
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Elizabeth River M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-7 Potential Construction Emissions from On-Road Engine Combustion
Elizabeth River M&R Station - City of Chesapeake, VA
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	20	500
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	350	350
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	20	80
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.07	1.68	0.09	0.01	0.00	0.00	98.10
Company Commute Trucks	0.01	0.06	0.00	0.00	0.00	0.00	15.13
Delivery Trucks (Warehouse)	0.06	0.20	0.15	0.01	0.01	0.00	300.93
Contractor Commute Trucks	0.02	0.23	0.02	0.00	0.00	0.00	60.53
Delivery Trucks (Local)	0.02	0.07	0.05	0.00	0.00	0.00	103.18
TOTAL EMISSIONS	0.18	2.24	0.32	0.02	0.02	0.00	577.88

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-8 Potential Construction Emissions from Unpaved Road Fugitives
Elizabeth River M&R Station - City of Chesapeake, VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	87.9
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	14.91	5.20	0.52

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.71	2.34	0.23
Controlled	lb/hr	4.03	1.40	0.14
Uncontrolled	tons	13.09	4.56	0.46
Controlled	**tons**	**7.85**	**2.74**	**0.27**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Wallaceton Lake Drummond, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-9 Potential Construction Emissions from Paved Road Fugitives
Elizabeth River M&R Station - City of Chesapeake, VA
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	87.9
Truck Schedule	VMT/day	1,070
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0745	0.0149	0.0037

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	84.87	16.97	4.17

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	79.76	15.95	3.92
Total Emissions	**tons**	**15.55**	**3.11**	**0.76**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Wallaceton Lake Drummond, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-10 Potential Construction Emissions from Material Handling
Elizabeth River M&R Station - City of Chesapeake, VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	10.93
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	96.4
Precip > 0.01 in (p)[3]	days	87.9
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	8.0
Volume of Ground Material Moved[5]	cubic yd	129,067
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	144,665
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	165.5
Daily Pile Height and Radius[8]	yd	5.41
Daily Pile Surface Area[8]	acre	0.805

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00573	0.00271	0.00041
Fugitive Wind Erosion Factor	lb/day	103.69	51.85	7.78

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.41**	**0.20**	**0.03**
Total Fugitive Wind Emissions	**tons**	**20.22**	**10.11**	**1.52**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Norfolk International Airport Weather Station data, average from 1948-2000
[2] Norfolk International Airport Weather Station data, frequency wind greater than calm, 1961-1990
[3] Wallaceton Lake Drummond, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-11 Potential Construction Emissions from Off-Road Engine Combustion
Fayetteville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Fayetteville M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-12 Potential Construction Emissions from On-Road Engine Combustion
Fayetteville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	20	500
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	260	260
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	20	80
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	30	90

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.07	1.68	0.09	0.01	0.00	0.00	98.10
Company Commute Trucks	0.01	0.06	0.00	0.00	0.00	0.00	15.13
Delivery Trucks (Warehouse)	0.04	0.15	0.11	0.01	0.01	0.00	223.55
Contractor Commute Trucks	0.02	0.23	0.02	0.00	0.00	0.00	60.53
Delivery Trucks (Local)	0.02	0.05	0.04	0.00	0.00	0.00	77.38
TOTAL EMISSIONS	0.15	2.17	0.26	0.02	0.01	0.00	474.70

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-13 Potential Construction Emissions from Unpaved Road Fugitives

Fayetteville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	77.9
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.45	5.39	0.54

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.95	2.42	0.24
Controlled	lb/hr	4.17	1.45	0.15
Uncontrolled	tons	13.56	4.73	0.47
Controlled	**tons**	**8.13**	**2.84**	**0.28**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Smithfield, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-14 Potential Construction Emissions from Paved Road Fugitives

Fayetteville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	77.9
Truck Schedule	VMT/day	950
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0751	0.0150	0.0037

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	75.35	15.07	3.70

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	71.33	14.27	3.50
Total Emissions	**tons**	**13.91**	**2.78**	**0.68**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Smithfield, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-15 Potential Construction Emissions from Material Handling
Fayetteville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	5.90
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.7
Precip > 0.01 in (p)[3]	days	77.9
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	145,200
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	162,749
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	186.2
Daily Pile Height and Radius[8]	yd	5.62
Daily Pile Surface Area[8]	acre	0.871

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00257	0.00122	0.00018
Fugitive Wind Erosion Factor	lb/day	110.54	55.27	8.29

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.21**	**0.10**	**0.01**
Total Fugitive Wind Emissions	**tons**	**21.56**	**10.78**	**1.62**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Seymour-Johnson Air Force Base Weather Station data, average from 1943-2000
[2] Raleigh Weather Station data, frequency wind greater than calm, 1961-1990
[3] Smithfield, NC 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-16 Potential Construction Emissions from Off-Road Engine Combustion
Greensville M&R Station - Greensville County, Virginia
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Greensville M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-17 Potential Construction Emissions from On-Road Engine Combustion
Greensville M&R Station - Greensville County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	25	625
Company Commute Trucks	Light Commercial Truck	1	25	25
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	110	110
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	25	100
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	50	150

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.09	2.10	0.12	0.01	0.00	0.00	122.63
Company Commute Trucks	0.01	0.07	0.01	0.00	0.00	0.00	18.92
Delivery Trucks (Warehouse)	0.02	0.06	0.05	0.00	0.00	0.00	94.58
Contractor Commute Trucks	0.03	0.29	0.02	0.00	0.00	0.00	75.66
Delivery Trucks (Local)	0.03	0.08	0.06	0.00	0.00	0.00	128.97
TOTAL EMISSIONS	0.16	2.61	0.25	0.02	0.01	0.00	440.76

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-18 Potential Construction Emissions from Unpaved Road Fugitives

Greensville M&R Station - Greensville County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	74.8
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.62	5.45	0.54

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	7.03	2.45	0.25
Controlled	lb/hr	4.22	1.47	0.15
Uncontrolled	tons	13.70	4.78	0.48
Controlled	**tons**	**8.22**	**2.87**	**0.29**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] Emporia 1 WNW, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-19 Potential Construction Emissions from Paved Road Fugitives

Greensville M&R Station - Greensville County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	74.8
Truck Schedule	VMT/day	1,010
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0753	0.0151	0.0037

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	80.11	16.02	3.93

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	76.01	15.20	3.73
Total Emissions	**tons**	**14.82**	**2.96**	**0.73**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Emporia 1 WNW, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-20 Potential Construction Emissions from Material Handling
Greensville M&R Station - Greensville County, Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	8.07
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	92.7
Precip > 0.01 in (p)[3]	days	74.8
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	8.0
Volume of Ground Material Moved[5]	cubic yd	129,067
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	144,665
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	165.5
Daily Pile Height and Radius[8]	yd	5.41
Daily Pile Surface Area[8]	acre	0.805

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00386	0.00183	0.00028
Fugitive Wind Erosion Factor	lb/day	104.42	52.21	7.83

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.28**	**0.13**	**0.02**
Total Fugitive Wind Emissions	**tons**	**20.36**	**10.18**	**1.53**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Richmond/Byrd Field Weather Station data, average from 1942-2000
[2] Richmond/Byrd Field Weather Station data, frequency wind greater than calm, 1961-1990
[3] Emporia 1 WNW, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-21 Potential Construction Emissions from Off-Road Engine Combustion
Long Run M&R Station - Randolph County, West Virginia
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Long Run M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-22 Potential Construction Emissions from On-Road Engine Combustion
Long Run M&R Station - Randolph County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	65	1625
Company Commute Trucks	Light Commercial Truck	1	65	65
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	150	150
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	65	260
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	65	195

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.22	5.46	0.30	0.02	0.01	0.00	318.84
Company Commute Trucks	0.02	0.19	0.01	0.00	0.00	0.00	49.18
Delivery Trucks (Warehouse)	0.03	0.08	0.06	0.00	0.00	0.00	128.97
Contractor Commute Trucks	0.07	0.76	0.06	0.00	0.00	0.00	196.72
Delivery Trucks (Local)	0.03	0.11	0.08	0.01	0.01	0.00	167.66
TOTAL EMISSIONS	0.37	6.61	0.52	0.03	0.02	0.01	861.38

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-23 Potential Construction Emissions from Unpaved Road Fugitives

Long Run M&R Station - Randolph County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	112.5
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	13.59	4.74	0.47

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.11	2.13	0.21
Controlled	lb/hr	3.67	1.28	0.13
Uncontrolled	tons	11.92	4.16	0.42
Controlled	**tons**	**7.15**	**2.49**	**0.25**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] Glady 1 N, WV 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-24 Potential Construction Emissions from Paved Road Fugitives

Long Run M&R Station - Randolph County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	112.5
Truck Schedule	VMT/day	2,295
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0732	0.0146	0.0036

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	182.03	36.41	8.94

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	168.01	33.60	8.25
Total Emissions	**tons**	**32.76**	**6.55**	**1.61**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Glady 1 N, WV 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-25 Potential Construction Emissions from Material Handling
Long Run M&R Station - Randolph County, West Virginia
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	6.80
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	77.4
Precip > 0.01 in (p)[3]	days	112.5
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	13.5
Volume of Ground Material Moved[5]	cubic yd	217,800
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	244,123
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	279.2
Daily Pile Height and Radius[8]	yd	6.44
Daily Pile Surface Area[8]	acre	1.141

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00309	0.00146	0.00022
Fugitive Wind Erosion Factor	lb/day	107.53	53.76	8.06

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.38**	**0.18**	**0.03**
Total Fugitive Wind Emissions	**tons**	**20.97**	**10.48**	**1.57**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Elkins/Randolph Field Weather Station data, average from 1948-2000
[2] Elkins/Randolph Field Weather Station data, frequency wind greater than calm, 1961-1990
[3] Glady 1 N, WV 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-26 Potential Construction Emissions from Off-Road Engine Combustion
Pembroke M&R Station - Robeson County, NC
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Pembroke M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-27 Potential Construction Emissions from On-Road Engine Combustion
Pembroke M&R Station - Robeson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	25	625
Company Commute Trucks	Light Commercial Truck	1	25	25
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	340	340
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	25	100
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.09	2.10	0.12	0.01	0.00	0.00	122.63
Company Commute Trucks	0.01	0.07	0.01	0.00	0.00	0.00	18.92
Delivery Trucks (Warehouse)	0.06	0.19	0.15	0.01	0.01	0.00	292.33
Contractor Commute Trucks	0.03	0.29	0.02	0.00	0.00	0.00	75.66
Delivery Trucks (Local)	0.02	0.07	0.05	0.00	0.00	0.00	103.18
TOTAL EMISSIONS	0.20	2.72	0.34	0.02	0.02	0.00	612.72

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-28 Potential Construction Emissions from Unpaved Road Fugitives

Pembroke M&R Station - Robeson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	65.1
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	16.14	5.63	0.56

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	7.26	2.53	0.25
Controlled	lb/hr	4.36	1.52	0.15
Uncontrolled	tons	14.16	4.94	0.49
Controlled	**tons**	**8.50**	**2.96**	**0.30**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Red Springs 1 SE, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-29 Potential Construction Emissions from Paved Road Fugitives

Pembroke M&R Station - Robeson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	65.1
Truck Schedule	VMT/day	1,210
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0758	0.0152	0.0037

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	95.97	19.19	4.71

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	91.69	18.34	4.50
Total Emissions	**tons**	**17.88**	**3.58**	**0.88**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Red Springs 1 SE, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-30 Potential Construction Emissions from Material Handling
Pembroke M&R Station - Robeson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	5.32
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.7
Precip > 0.01 in (p)[3]	days	65.1
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	145,200
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	162,749
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	186.2
Daily Pile Height and Radius[8]	yd	5.62
Daily Pile Surface Area[8]	acre	0.871

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00225	0.00106	0.00016
Fugitive Wind Erosion Factor	lb/day	115.47	57.74	8.66

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.18**	**0.09**	**0.01**
Total Fugitive Wind Emissions	**tons**	**22.52**	**11.26**	**1.69**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Pope Air Force Base Weather Station data, average from 1937-2000
[2] Raleigh Weather Station data, frequency wind greater than calm, 1961-1990
[3] Red Springs 1 SE, NC 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-31 Potential Construction Emissions from Off-Road Engine Combustion
Smithville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Smithfield M&R Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	0	0	25%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	2	75%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	48.68	0.02	0.03	0.15	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	1	6	50%	900.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	124.00	0.10	0.35	0.68	0.07	0.06
Loaders	Tractors/Loaders/Backhoes	200	0	0	0%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	0%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	6	50%	900.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	106.39	0.04	0.15	0.44	0.03	0.03
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	1	10%	30.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	2.19	0.00	0.00	0.02	0.00	0.00
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	10	5%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	4	10	5%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	0	0	0%	0.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	1	4	5%	60.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	7.09	0.00	0.01	0.02	0.00	0.00
Manlifts	Aerial Lift	95	1	4	60%	720.00	0.0043	692.9047	0.99	5.30	4.72	0.75	0.72	0.00	52.24	0.07	0.40	0.36	0.06	0.05
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	5	95%	5700.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	152.50	0.18	0.79	1.04	0.13	0.12
Water Pump	Pumps	8	1	5	5%	75.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.39	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	5	90%	1350.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	11.38	0.01	0.05	0.10	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	6	20%	360.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.63	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**991.94**	**0.57**	**2.23**	**4.07**	**0.37**	**0.35**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-10-32 Potential Construction Emissions from On-Road Engine Combustion
Smithville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	25	20	500
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	190	190
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	20	80
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	25	75

Parameter	Units	Value
Construction Schedule[1]	days	390

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.07	1.68	0.09	0.01	0.00	0.00	98.10
Company Commute Trucks	0.01	0.06	0.00	0.00	0.00	0.00	15.13
Delivery Trucks (Warehouse)	0.03	0.11	0.08	0.01	0.01	0.00	163.36
Contractor Commute Trucks	0.02	0.23	0.02	0.00	0.00	0.00	60.53
Delivery Trucks (Local)	0.01	0.04	0.03	0.00	0.00	0.00	64.49
TOTAL EMISSIONS	0.14	2.12	0.23	0.01	0.01	0.00	401.62

Notes:

[1] Construction schedule assumed to be 13 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-10-33 Potential Construction Emissions from Unpaved Road Fugitives

Smithville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	77.9
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	3900

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.45	5.39	0.54

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.95	2.42	0.24
Controlled	lb/hr	4.17	1.45	0.15
Uncontrolled	tons	13.56	4.73	0.47
Controlled	**tons**	**8.13**	**2.84**	**0.28**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Smithfield, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-34 Potential Construction Emissions from Paved Road Fugitives

Smithville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	25	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.18
Precip > 0.01 in (p)[1]	days/yr	77.9
Truck Schedule	VMT/day	865
Construction Schedule[2]	days	390

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0793	0.0159	0.0039
E_{ext}	lb/VMT	0.0751	0.0150	0.0037

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	68.61	13.72	3.37

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	64.95	12.99	3.19
Total Emissions	**tons**	**12.67**	**2.53**	**0.62**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Smithfield, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 13 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-10-35 Potential Construction Emissions from Material Handling
Smithville M&R Station - Johnson County, NC
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	5.90
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.7
Precip > 0.01 in (p)[3]	days	77.9
Land Affected During Construction	acre	5.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	145,200
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	162,749
Construction Schedule[7]	days	390
Daily Pile Size	cubic yd	186.2
Daily Pile Height and Radius[8]	yd	5.62
Daily Pile Surface Area[8]	acre	0.871

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00257	0.00122	0.00018
Fugitive Wind Erosion Factor	lb/day	110.54	55.27	8.29

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.21**	**0.10**	**0.01**
Total Fugitive Wind Emissions	**tons**	**21.56**	**10.78**	**1.62**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Seymour-Johnson Air Force Base Weather Station data, average from 1943-2000
[2] Raleigh Weather Station data, frequency wind greater than calm, 1961-1990
[3] Smithfield, NC 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 13 months, 30 days/month, 10 hours/day
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-1 Potential Construction Emissions from Off-Road Engine Combustion
AP-1 Pipeline (Spread 1 through Spread 7) - VA and WV
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours AP-1 Pipeline				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	413	8.5	50%	421260.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.35	58041.11	47.07	163.95	320.12	30.79	29.86
Boring Machine	Bore/Drill Rigs	140	14	2	70%	4704.00	0.0033	530.04	0.32	1.10	3.87	0.23	0.22	0.00	384.78	0.23	0.80	2.81	0.17	0.16
Graders	Graders	200	14	4	20%	2688.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	317.84	0.09	0.24	0.74	0.04	0.04
Dozer - D-8	Crawler Tractor/Dozers	350	70	8.5	50%	71400.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.08	14774.31	4.35	21.60	53.29	3.16	3.07
Dozer - D7	Crawler Tractor/Dozers	240	245	8.5	50%	249900.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.19	35458.92	10.21	27.77	84.52	5.01	4.86
Dozer - D-6	Crawler Tractor/Dozers	200	49	8.5	50%	49980.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.03	5909.82	1.70	4.63	14.09	0.84	0.81
Sideboom	Cranes	290	385	6	50%	277200.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.26	47010.45	14.83	32.85	148.15	6.54	6.34
Farm Tractor	Tractors/Loaders/Backhoes	100	84	4	30%	24192.00	0.0042	693.58	0.77	4.89	3.94	0.70	0.68	0.01	1849.59	2.06	13.05	10.51	1.86	1.81
Dump Trucks	Off-highway Trucks	250	0	0	0%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles																				
Buses - 55 Passenger	Off-highway Trucks	200	28	6	5%	2016.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	238.41	0.06	0.07	0.28	0.01	0.01
Mechanics Rig	Bore/Drill Rigs	300	77	8.5	30%	47124.00	0.0032	530.12	0.29	0.93	3.66	0.19	0.18	0.05	8261.29	4.56	14.44	57.10	2.93	2.84
Welding Rigs	Welders	300	350	6	70%	352800.00	0.0039	624.28	0.72	2.92	4.29	0.50	0.49	0.45	72834.20	84.39	340.76	500.00	58.73	56.97
Pick-up Trucks (1/2 - 3/4 ton)	Off-highway Trucks	110	350	8.5	5%	35700.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.01	2321.95	0.59	1.03	2.92	0.17	0.16
Pick-up Trucks (1 ton)	Off-highway Trucks	150	350	6	5%	25200.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.01	2235.03	0.57	0.99	2.81	0.16	0.16
Flatbed Trucks (2 ton)	Off-highway Trucks	200	35	6	5%	2520.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	298.01	0.07	0.09	0.35	0.01	0.01
Truck Tractor	Tractors/Loaders/Backhoes	300	140	8.5	40%	114240.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.14	23609.94	19.15	66.69	130.22	12.52	12.15
2000 Gallon Water Truck	Off-highway Trucks	250	7	2	1%	33.60	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	4.97	0.00	0.00	0.01	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	250	28	6	15%	6048.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	894.02	0.22	0.27	1.06	0.03	0.03
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	0	0	0%	0.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressors																				
160-185 CFM Portable	Air Compressors	150	7	1	1%	8.40	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	0.74	0.00	0.00	0.00	0.00	0.00
700-850 CFM Portable	Air Compressors	400	7	1	1%	8.40	0.0032	530.40	0.20	0.83	3.02	0.13	0.12	0.00	1.96	0.00	0.00	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														1.60	**274,447.34**	**190.17**	**689.24**	**1,328.98**	**122.98**	**119.29**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
** 8.5 months is the construction schedule duration
***Assume TSP = PM-10

Table 9A-11-2 Potential Construction Emissions from On-Road Engine Combustion
AP-1 Pipeline (Spread 1 through Spread 7) - VA and WV
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity[3]	Daily Avg. Round Trip (mi)[3]	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	665	40	26600
Company Commute Trucks	Light Commercial Truck	140	100	14000
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	7	100	700
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	420	100	42000
Delivery Trucks (Local)	Short-Haul Truck (Local)	0	0	0

Parameter	Units	Value
Construction Schedule[1]	days	255

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	2.39	58.47	3.22	0.19	0.08	0.05	3,412.51
Company Commute Trucks	2.36	26.76	1.97	0.10	0.04	0.04	6,926.08
Delivery Trucks (Warehouse)	0.08	0.26	0.20	0.01	0.01	0.00	393.53
Contractor Commute Trucks	7.08	80.28	5.90	0.30	0.13	0.11	20,778.24
Delivery Trucks (Local)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL EMISSIONS	11.92	165.77	11.28	0.59	0.27	0.20	31,510.35

Notes:
[1] Construction schedule assumed to be 8.5 months, 30 days/month
[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion
[3] Average quantity and average round trip based on information in example calculations provided by Dominion; quantity multiplied by number of spreads (7)

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Table 9A-11-3 Potential Construction Emissions from Unpaved Road Fugitives
AP-1 Pipeline (Spread 1 through Spread 7) - VA and WV
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	72.1
Truck Schedule[3]	VMT/hr	3.94
Construction Schedule[4]	hours	2040

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.76	5.50	0.55

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	77.34	26.97	2.70
Controlled	lb/hr	46.41	16.18	1.62

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	62.07	21.64	2.16
Controlled	lb/hr	37.24	12.98	1.30
Uncontrolled	tons	63.31	22.07	2.21
Controlled	**tons**	**37.98**	**13.24**	**1.32**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

3 Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 8 hours/day; multiplied by number of spreads (7)

[4] Construction schedule assumed to be 8.5 months, 30 days/month, 8 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-4 Potential Construction Emissions from Paved Road Fugitives

AP-1 Pipeline (Spread 1 through Spread 7) - VA and WV

Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	665	1
Company Commute Trucks	140	2
Delivery Trucks (Warehouse)	7	13
Contractor Commute Trucks	420	7.25
Delivery Trucks (Local)	0	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.31
Precip > 0.01 in (p)[1]	days/yr	72.1
Truck Schedule	VMT/day	83,300
Construction Schedule[2]	days	255

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0828	0.0166	0.0041
E_{ext}	lb/VMT	0.0787	0.0157	0.0039

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	6895.87	1379.17	338.52

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	6555.33	1311.07	321.81
Total Emissions	**tons**	**835.80**	**167.16**	**41.03**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 22 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-5 Potential Construction Emissions from Material Handling
AP-1 Pipeline (Spread 1 through Spread 7) - VA and WV
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	8.07
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	92.7
Precip > 0.01 in (p)[3]	days	72.1
Length of Pipeline Segment	miles	300.1
Diameter of Pipeline	inches	42
Volume of Ground Material Moved[4]	cubic yd	33,249,057
Density of Ground Material[5]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	37,267,457
Construction Schedule[6]	days	255
Daily Pile Surface Area[7]	acre	350.109

Emission Factor Equation Parameters

Parameter	Units	TSP[12]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[8]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[9]	---	1	0.5	0.075
Material Moisture Content (M)[10]	%	2.2		
Surface Material Silt Content (s)[11]	%	15		

Calculated Emission Factors

	Units	TSP[12]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00386	0.00183	0.00028
Fugitive Wind Erosion Factor	lb/day	45845.08	22922.54	3438.38

Total Emissions (with rainfall)

	Units	TSP[12]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**71.95**	**34.03**	**5.15**
Total Fugitive Wind Emissions	**tons**	**5845.25**	**2922.62**	**438.39**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Richmond/Byrd Field Weather Station data, average from 1942-2000

[2] Richmond/Byrd Field Weather Station data, frequency wind greater than calm, 1961-1990

[3] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[4] Volume doubled because material is removed and replaced; see GE&F calculations

[5] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space

[6] Construction schedule assumed to be 22 months, 30 days/month

[7] Assume material remains excavated for an average of 30 days (1 month); see GE&F calculations

[8] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)

[9] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)

[10] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent

[11] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent

[12] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-6 Potential Construction Emissions from Off-Road Engine Combustion
AP-2 Pipeline (Spread 8 through Spread 10) - NC and VA
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours AP-2 Pipeline				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	165	9	50%	178200.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.15	24552.36	19.91	69.35	135.42	13.02	12.63
Boring Machine	Bore/Drill Rigs	140	6	2	70%	2016.00	0.0033	530.04	0.32	1.10	3.87	0.23	0.22	0.00	164.90	0.10	0.34	1.20	0.07	0.07
Graders	Graders	200	6	4	20%	1152.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	136.22	0.04	0.10	0.32	0.02	0.02
Dozer - D-8	Crawler Tractor/Dozers	350	12	9	50%	12960.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.02	2681.72	0.79	3.92	9.67	0.57	0.56
Dozer - D7	Crawler Tractor/Dozers	240	57	9	50%	61560.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.05	8734.90	2.51	6.84	20.82	1.23	1.20
Dozer - D-6	Crawler Tractor/Dozers	200	63	9	50%	68040.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.04	8045.30	2.32	6.30	19.18	1.14	1.10
Sideboom	Cranes	290	159	6	50%	114480.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.11	19414.70	6.13	13.57	61.18	2.70	2.62
Farm Tractor	Tractors/Loaders/Backhoes	100	42	4	30%	12096.00	0.0042	693.58	0.77	4.89	3.94	0.70	0.68	0.01	924.79	1.03	6.53	5.25	0.93	0.90
Dump Trucks	Off-highway Trucks	250	0	0	0%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles																				
Buses - 55 Passenger	Off-highway Trucks	200	12	6	5%	864.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	102.17	0.03	0.03	0.12	0.00	0.00
Mechanics Rig	Bore/Drill Rigs	300	36	9	30%	23328.00	0.0032	530.12	0.29	0.93	3.66	0.19	0.18	0.02	4089.62	2.26	7.15	28.27	1.45	1.41
Welding Rigs	Welders	300	120	6	70%	120960.00	0.0039	624.28	0.72	2.92	4.29	0.50	0.49	0.15	24971.73	28.93	116.83	171.43	20.14	19.53
Pick-up Trucks (1/2 - 3/4 ton)	Off-highway Trucks	110	150	9	5%	16200.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.01	1053.66	0.27	0.47	1.33	0.08	0.07
Pick-up Trucks (1 ton)	Off-highway Trucks	150	120	6	5%	8640.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	766.30	0.20	0.34	0.96	0.06	0.05
Flatbed Trucks (2 ton)	Off-highway Trucks	200	24	6	5%	1728.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	204.35	0.05	0.06	0.24	0.01	0.01
Truck Tractor	Tractors/Loaders/Backhoes	300	84	9	40%	72576.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.09	14999.26	12.16	42.37	82.73	7.96	7.72
2000 Gallon Water Truck	Off-highway Trucks	250	3	2	1%	14.40	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	2.13	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	250	12	6	15%	2592.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	383.15	0.10	0.12	0.45	0.01	0.01
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	0	0	2%	0.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressors																				
160-185 CFM Portable	Air Compressors	150	3	1	1%	3.60	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	0.32	0.00	0.00	0.00	0.00	0.00
700-850 CFM Portable	Air Compressors	400	3	1	1%	3.60	0.0032	530.40	0.20	0.83	3.02	0.13	0.12	0.00	0.84	0.00	0.00	0.00	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.65	**111,228.42**	**76.82**	**274.32**	**538.58**	**49.39**	**47.91**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-11-7 Potential Construction Emissions from On-Road Engine Combustion
AP-2 Pipeline (Spread 8 through Spread 10) - NC and VA
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity[3]	Daily Avg. Round Trip (mi)[3]	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	285	40	11400
Company Commute Trucks	Light Commercial Truck	60	100	6000
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	3	100	300
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	180	100	18000
Delivery Trucks (Local)	Short-Haul Truck (Local)	0	0	0

Parameter	Units	Value
Construction Schedule[1]	days	315

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	1.27	30.95	1.70	0.10	0.04	0.03	1,806.62
Company Commute Trucks	1.25	14.17	1.04	0.05	0.02	0.02	3,666.75
Delivery Trucks (Warehouse)	0.04	0.14	0.10	0.01	0.01	0.00	208.34
Contractor Commute Trucks	3.75	42.50	3.13	0.16	0.07	0.06	11,000.24
Delivery Trucks (Local)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL EMISSIONS	6.31	87.76	5.97	0.31	0.14	0.10	16,681.95

Notes:
[1] Construction schedule assumed to be 10.5 months, 30 days/month
[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion
[3] Average quantity and average round trip based on information in example calculations provided by Dominion; quantity multiplied by number of spreads (3)

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Table 9A-11-8 Potential Construction Emissions from Unpaved Road Fugitives
AP-2 Pipeline (Spread 8 through Spread 10) - NC and VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	65.1
Truck Schedule[3]	VMT/hr	1.69
Construction Schedule[4]	hours	2520

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	16.14	5.63	0.56

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	33.15	11.56	1.16
Controlled	lb/hr	19.89	6.93	0.69

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	27.24	9.50	0.95
Controlled	lb/hr	16.34	5.70	0.57
Uncontrolled	tons	34.32	11.96	1.20
Controlled	**tons**	**20.59**	**7.18**	**0.72**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Red Springs 1 SE, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

3 Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 8 hours/day; multiplied by number of spreads (3)

[4] Construction schedule assumed to be 10.5 months, 30 days/month, 8 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-9 Potential Construction Emissions from Paved Road Fugitives

AP-2 Pipeline (Spread 8 through Spread 10) - NC and VA

Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	285	1
Company Commute Trucks	60	2
Delivery Trucks (Warehouse)	3	13
Contractor Commute Trucks	180	7.25
Delivery Trucks (Local)	0	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.31
Precip > 0.01 in (p)[1]	days/yr	65.1
Truck Schedule	VMT/day	35,700
Construction Schedule[2]	days	315

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0828	0.0166	0.0041
E_{ext}	lb/VMT	0.0791	0.0158	0.0039

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	2955.37	591.07	145.08

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	2823.59	564.72	138.61
Total Emissions	**tons**	**444.72**	**88.94**	**21.83**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Red Springs 1 SE, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 22 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-10 Potential Construction Emissions from Material Handling
AP-2 Pipeline (Spread 8 through Spread 10) - NC and VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	10.93
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	96.4
Precip > 0.01 in (p)[3]	days	65.1
Length of Pipeline Segment	miles	183.0
Diameter of Pipeline	inches	36
Volume of Ground Material Moved[4]	cubic yd	10,586,011
Density of Ground Material[5]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	11,865,411
Construction Schedule[6]	days	315
Daily Pile Surface Area[7]	acre	138.843

Emission Factor Equation Parameters

Parameter	Units	TSP[12]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[8]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[9]	---	1	0.5	0.075
Material Moisture Content (M)[10]	%	2.2		
Surface Material Silt Content (s)[11]	%	15		

Calculated Emission Factors

	Units	TSP[12]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00573	0.00271	0.00041
Fugitive Wind Erosion Factor	lb/day	19358.29	9679.14	1451.87

Total Emissions (with rainfall)

	Units	TSP[12]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**33.98**	**16.07**	**2.43**
Total Fugitive Wind Emissions	**tons**	**3048.93**	**1524.47**	**228.67**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Norfolk International Airport Weather Station data, average from 1948-2000

[2] Norfolk International Airport Weather Station data, frequency wind greater than calm, 1961-1990

[3] Red Springs 1 SE, NC 30-year average of days > 0.1 inch precipitation (1981-2010)

[4] Volume doubled because material is removed and replaced; see GE&F calculations

[5] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space

[6] Construction schedule assumed to be 22 months, 30 days/month

[7] Assume material remains excavated for an average of 30 days (1 month); see GE&F calculations

[8] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)

[9] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)

[10] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent

[11] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent

[12] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-11 Potential Construction Emissions from Off-Road Engine Combustion
AP-3 Pipeline (Spread 11) - NC and VA
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours AP-3 Pipeline				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	50	9	50%	54000.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.04	7440.11	6.03	21.02	41.04	3.95	3.83
Boring Machine	Bore/Drill Rigs	140	2	2	70%	672.00	0.0033	530.04	0.32	1.10	3.87	0.23	0.22	0.00	54.97	0.03	0.11	0.40	0.02	0.02
Graders	Graders	200	2	4	20%	384.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	45.41	0.01	0.03	0.11	0.01	0.01
Dozer - D-8	Crawler Tractor/Dozers	350	4	9	50%	4320.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.01	893.91	0.26	1.31	3.22	0.19	0.19
Dozer - D7	Crawler Tractor/Dozers	240	17	9	50%	18360.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.01	2605.15	0.75	2.04	6.21	0.37	0.36
Dozer - D-6	Crawler Tractor/Dozers	200	25	9	50%	27000.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.02	3192.58	0.92	2.50	7.61	0.45	0.44
Sideboom	Cranes	290	39	6	50%	28080.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.03	4762.10	1.50	3.33	15.01	0.66	0.64
Farm Tractor	Tractors/Loaders/Backhoes	100	14	4	30%	4032.00	0.0042	693.58	0.77	4.89	3.94	0.70	0.68	0.00	308.26	0.34	2.18	1.75	0.31	0.30
Dump Trucks	Off-highway Trucks	250	0	0	0%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles																				
Buses - 55 Passenger	Off-highway Trucks	200	4	6	5%	288.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	34.06	0.01	0.01	0.04	0.00	0.00
Mechanics Rig	Bore/Drill Rigs	300	10	9	30%	6480.00	0.0032	530.12	0.29	0.93	3.66	0.19	0.18	0.01	1136.01	0.63	1.99	7.85	0.40	0.39
Welding Rigs	Welders	300	32	6	70%	32256.00	0.0039	624.28	0.72	2.92	4.29	0.50	0.49	0.04	6659.13	7.72	31.16	45.71	5.37	5.21
Pick-up Trucks (1/2 - 3/4 ton)	Off-highway Trucks	110	50	9	5%	5400.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	351.22	0.09	0.16	0.44	0.03	0.02
Pick-up Trucks (1 ton)	Off-highway Trucks	150	32	6	5%	2304.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	204.35	0.05	0.09	0.26	0.01	0.01
Flatbed Trucks (2 ton)	Off-highway Trucks	200	9	6	5%	648.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	76.63	0.02	0.02	0.09	0.00	0.00
Truck Tractor	Tractors/Loaders/Backhoes	300	19	9	40%	16416.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.02	3392.69	2.75	9.58	18.71	1.80	1.75
2000 Gallon Water Truck	Off-highway Trucks	250	1	2	1%	4.80	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.71	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	250	3	6	15%	648.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	95.79	0.02	0.03	0.11	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	0	0	2%	0.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressors																				
160-185 CFM Portable	Air Compressors	150	1	1	1%	1.20	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	0.11	0.00	0.00	0.00	0.00	0.00
700-850 CFM Portable	Air Compressors	400	1	1	1%	1.20	0.0032	530.40	0.20	0.83	3.02	0.13	0.12	0.00	0.28	0.00	0.00	0.00	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.18	**31,253.44**	**21.15**	**75.55**	**148.57**	**13.58**	**13.17**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-11-12 Potential Construction Emissions from On-Road Engine Combustion
AP-3 Pipeline (Spread 11) - NC and VA
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity[3]	Daily Avg. Round Trip (mi)[3]	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	95	40	3800
Company Commute Trucks	Light Commercial Truck	20	100	2000
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	100	100
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	60	100	6000
Delivery Trucks (Local)	Short-Haul Truck (Local)	0	0	0

Parameter	Units	Value
Construction Schedule[1]	days	315

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.42	10.32	0.57	0.03	0.01	0.01	602.21
Company Commute Trucks	0.42	4.72	0.35	0.02	0.01	0.01	1,222.25
Delivery Trucks (Warehouse)	0.01	0.05	0.03	0.00	0.00	0.00	69.45
Contractor Commute Trucks	1.25	14.17	1.04	0.05	0.02	0.02	3,666.75
Delivery Trucks (Local)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL EMISSIONS	2.10	29.25	1.99	0.10	0.05	0.03	5,560.65

Notes:

[1] Construction schedule assumed to be 10.5 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

[3] Average quantity and average round trip based on information in example calculations provided by Dominion

Table 9A-11-13 Potential Construction Emissions from Unpaved Road Fugitives
AP-3 Pipeline (Spread 11) - NC and VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	74.8
Truck Schedule[3]	VMT/hr	0.56
Construction Schedule[4]	hours	2520

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.62	5.45	0.54

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	11.05	3.85	0.39
Controlled	lb/hr	6.63	2.31	0.23

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.78	3.06	0.31
Controlled	lb/hr	5.27	1.84	0.18
Uncontrolled	tons	11.07	3.86	0.39
Controlled	**tons**	**6.64**	**2.32**	**0.23**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Emporia 1 WNW, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

3 Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 8 hours/day

[4] Construction schedule assumed to be 10.5 months, 30 days/month, 8 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-14 Potential Construction Emissions from Paved Road Fugitives

AP-3 Pipeline (Spread 11) - NC and VA

Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	95	1
Company Commute Trucks	20	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	60	7.25
Delivery Trucks (Local)	0	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.31
Precip > 0.01 in (p)[1]	days/yr	74.8
Truck Schedule	VMT/day	11,900
Construction Schedule[2]	days	315

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0828	0.0166	0.0041
E_{ext}	lb/VMT	0.0785	0.0157	0.0039

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	985.12	197.02	48.36

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	934.65	186.93	45.88
Total Emissions	**tons**	**147.21**	**29.44**	**7.23**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Emporia 1 WNW, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 10 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-15 Potential Construction Emissions from Material Handling
AP-3 Pipeline (Spread 11) - NC and VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	10.93
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	96.4
Precip > 0.01 in (p)[3]	days	74.8
Length of Pipeline Segment	miles	79.3
Diameter of Pipeline	inches	20
Volume of Ground Material Moved[4]	cubic yd	3,088,919
Density of Ground Material[5]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	3,462,238
Construction Schedule[6]	days	315
Daily Pile Surface Area[7]	acre	53.847

Emission Factor Equation Parameters

Parameter	Units	TSP[12]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[8]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[9]	---	1	0.5	0.075
Material Moisture Content (M)[10]	%	2.2		
Surface Material Silt Content (s)[11]	%	15		

Calculated Emission Factors

	Units	TSP[12]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00573	0.00271	0.00041
Fugitive Wind Erosion Factor	lb/day	7264.88	3632.44	544.87

Total Emissions (with rainfall)

	Units	TSP[12]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**9.92**	**4.69**	**0.71**
Total Fugitive Wind Emissions	**tons**	**1144.22**	**572.11**	**85.82**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Norfolk International Airport Weather Station data, average from 1948-2000
[2] Norfolk International Airport Weather Station data, frequency wind greater than calm, 1961-1990
[3] Emporia 1 WNW, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Volume doubled because material is removed and replaced; see GE&F calculations
[5] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[6] Construction schedule assumed to be 10 months, 30 days/month
[7] Assume material remains excavated for an average of 30 days (1 month); see GE&F calculations
[8] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[9] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[10] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[11] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[12] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-16 Potential Construction Emissions from Off-Road Engine Combustion
AP-4 and AP-5 Pipeline (Spread 12) - VA
Atlantic Coast Pipeline

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours AP-4/5 Pipeline				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	0	0	50%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boring Machine	Bore/Drill Rigs	140	0	0	70%	0.00	0.0033	530.04	0.32	1.10	3.87	0.23	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Graders	Graders	200	0	0	20%	0.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	350	0	0	50%	0.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D7	Crawler Tractor/Dozers	240	0	0	50%	0.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dozer - D-6	Crawler Tractor/Dozers	200	0	0	50%	0.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sideboom	Cranes	290	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Farm Tractor	Tractors/Loaders/Backhoes	100	0	0	30%	0.00	0.0042	693.58	0.77	4.89	3.94	0.70	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dump Trucks	Off-highway Trucks	250	0	0	0%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles																				
Buses - 55 Passenger	Off-highway Trucks	200	0	0	5%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mechanics Rig	Bore/Drill Rigs	300	0	0	30%	0.00	0.0032	530.12	0.29	0.93	3.66	0.19	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Welding Rigs	Welders	300	0	0	70%	0.00	0.0039	624.28	0.72	2.92	4.29	0.50	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pick-up Trucks (1/2 - 3/4 ton)	Off-highway Trucks	110	0	0	5%	0.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pick-up Trucks (1 ton)	Off-highway Trucks	150	0	0	5%	0.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	200	0	0	5%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Truck Tractor	Tractors/Loaders/Backhoes	300	0	0	40%	0.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	250	0	0	1%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	250	0	0	15%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	0	0	2%	0.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressors																				
160-185 CFM Portable	Air Compressors	150	0	0	1%	0.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
700-850 CFM Portable	Air Compressors	400	0	0	1%	0.00	0.0032	530.40	0.20	0.83	3.02	0.13	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
** NonRoad engine emissions for AP-4/5 are included in AP-1 NonRoad calculations
***Assume TSP = PM-10

Table 9A-11-17 Potential Construction Emissions from On-Road Engine Combustion
AP-4 and AP-5 Pipeline (Spread 12) - VA
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity[3]	Daily Avg. Round Trip (mi)[3]	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	95	40	3800
Company Commute Trucks	Light Commercial Truck	20	100	2000
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	100	100
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	60	100	6000
Delivery Trucks (Local)	Short-Haul Truck (Local)	0	0	0

Parameter	Units	Value
Construction Schedule[1]	days	315

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.42	10.32	0.57	0.03	0.01	0.01	602.21
Company Commute Trucks	0.42	4.72	0.35	0.02	0.01	0.01	1,222.25
Delivery Trucks (Warehouse)	0.01	0.05	0.03	0.00	0.00	0.00	69.45
Contractor Commute Trucks	1.25	14.17	1.04	0.05	0.02	0.02	3,666.75
Delivery Trucks (Local)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL EMISSIONS	2.10	29.25	1.99	0.10	0.05	0.03	5,560.65

Notes:

[1] Construction schedule assumed to be 10.5 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

[3] Average quantity and average round trip based on information in example calculations provided by Dominion

Table 9A-11-18 Potential Construction Emissions from Unpaved Road Fugitives
AP-4 and AP-5 Pipeline (Spread 12) - VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	72.1
Truck Schedule[3]	VMT/hr	0.56
Construction Schedule[4]	hours	2520

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.76	5.50	0.55

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	11.05	3.85	0.39
Controlled	lb/hr	6.63	2.31	0.23

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.87	3.09	0.31
Controlled	lb/hr	5.32	1.85	0.19
Uncontrolled	tons	11.17	3.90	0.39
Controlled	**tons**	**6.70**	**2.34**	**0.23**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

3 Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 8 hours/day

[4] Construction schedule assumed to be 10.5 months, 30 days/month, 8 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-19 Potential Construction Emissions from Paved Road Fugitives
AP-4 and AP-5 Pipeline (Spread 12) - VA
Atlantic Coast Pipeline

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	95	1
Company Commute Trucks	20	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	60	7.25
Delivery Trucks (Local)	0	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.31
Precip > 0.01 in (p)[1]	days/yr	72.1
Truck Schedule	VMT/day	11,900
Construction Schedule[2]	days	315

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0828	0.0166	0.0041
E_{ext}	lb/VMT	0.0787	0.0157	0.0039

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	985.12	197.02	48.36

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	936.48	187.30	45.97
Total Emissions	**tons**	**147.49**	**29.50**	**7.24**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 10 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-20 Potential Construction Emissions from Material Handling
AP-4 and AP-5 Pipeline (Spread 12) - VA
Atlantic Coast Pipeline

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	8.07
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	92.7
Precip > 0.01 in (p)[3]	days	72.1
Length of Pipeline Segment	miles	1.7
Diameter of Pipeline	inches	16
Volume of Ground Material Moved[4]	cubic yd	65,298
Density of Ground Material[5]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	73,190
Construction Schedule[6]	days	315
Daily Pile Surface Area[7]	acre	1.150

Emission Factor Equation Parameters

Parameter	Units	TSP[12]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[8]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[9]	---	1	0.5	0.075
Material Moisture Content (M)[10]	%	2.2		
Surface Material Silt Content (s)[11]	%	15		

Calculated Emission Factors

	Units	TSP[12]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00386	0.00183	0.00028
Fugitive Wind Erosion Factor	lb/day	150.54	75.27	11.29

Total Emissions (with rainfall)

	Units	TSP[12]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.14**	**0.07**	**0.01**
Total Fugitive Wind Emissions	**tons**	**23.71**	**11.85**	**1.78**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Richmond/Byrd Field Weather Station data, average from 1942-2000
[2] Richmond/Byrd Field Weather Station data, frequency wind greater than calm, 1961-1990
[3] Lawrenceville 3 E, VA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Volume doubled because material is removed and replaced; see GE&F calculations
[5] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[6] Construction schedule assumed to be 10 months, 30 days/month
[7] Assume material remains excavated for an average of 30 days (1 month); see GE&F calculations
[8] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[9] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[10] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[11] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[12] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-11-21 Potential Construction Emissions from Material Handling - Supplemental Calculations

Atlantic Coast Pipeline

Project Aspect	Parameter	Units	AP-1	AP-2	AP-3	AP-4/5
All Aspects	Pipe Length	miles	300.1	183	79.3	1.7
	Pipe Length	yards	528,176	322,080	139,568	2,992
Trench Spoil & Pile	Pipe Diameter	inches	42	36	20	16
	Max. Trench Bottom Width[1]	feet	5.50	5.00	3.67	3.33
	Max. Trench Top Width	feet	30	20	15	15
	Max. Trench Depth	feet	13.5	9	8	8
	Cross Sectional Area[2]	square yards	26.63	12.50	8.30	8.15
	Volume Ground Material Moved	cubic yards	14,062,686	4,026,000	1,157,897	24,379
	Pile Surface Area[3]	square yards	7,708,475	3,220,800	1,137,033	24,157
Trench Top Soil & Pile	Max. Depth of Topsoil Removal	inches	12	12	12	12
	Width of Top Soil Removal[4]	feet	60.96	41.21	32.28	32.13
	Cross Sectional Area	square yards	2.26	1.53	1.20	1.19
	Volume Ground Material Moved	cubic yards	1,192,497	491,628	166,872	3,560
	Pile Surface Area[3]	square yards	2,244,724	1,125,499	431,647	9,231
Agricultural Top Soil & Pile	Max. Depth of Topsoil Removal	inches	12	12	12	12
	Width of Top Soil Removal[5]	feet	70.0	65.0	42.5	42.5
	Cross Sectional Area	square yards	2.59	2.41	1.57	1.57
	Volume Ground Material Moved	cubic yards	1,369,345	775,378	219,690	4,710
	Pile Surface Area[6]	square yards	4,450,273	2,709,682	1,167,837	25,036
GRAND TOTAL VOLUME MATERIAL MOVED[7]		**cubic yards**	**16,624,528**	**5,293,006**	**1,544,459**	**32,649**
GRAND TOTAL SURFACE AREA[7]		**square yards**	**14,403,473**	**7,055,981**	**2,736,517**	**58,423**
GRAND TOTAL SURFACE AREA[7]		**acres**	**2,975.93**	**1,457.85**	**565.40**	**12.07**

Notes:

[1] Assume one foot of space between trench walls and each side of pipe

[2] Trench is in the shape of a trapezoid

[3] Assume pile is a triangular mound, with 45 degree slopes, that runs along the length of the trench; ignore ends

[4] Equal to width of trench plus width of base of trench spoil pile

[5] Based on width of land from pipeline trench to 25 feet from temporary boundary

[6] Assume pile is a triangular mound, with 25 foot base, that runs along the length of the trench; ignore ends

[7] Assumes worst case of maximum trench size, maximum depth of topsoil removal, and agricultural topsoil removal along entire length of pipeline

Table 9A-12-1 Potential Construction Emissions from Off-Road Engine Combustion
SHP Burch Ridge Compressor Station - Marshall County, West Virginia
Supply Header Project

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Burch Ridge Compressor Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	0	0	50%	0.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100 Ton Hydraulic Crane	Cranes	225	1	2	25%	150.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	19.74	0.01	0.01	0.06	0.00	0.00
50 Ton Hydraulic Crane	Cranes	185	1	3	75%	675.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	73.03	0.02	0.05	0.23	0.01	0.01
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	2	4	50%	1200.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	165.34	0.13	0.47	0.91	0.09	0.09
Loaders	Tractors/Loaders/Backhoes	200	1	4	50%	600.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	82.67	0.07	0.23	0.46	0.04	0.04
Graders	Graders	200	1	2	25%	150.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	17.74	0.01	0.01	0.04	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	2	50%	300.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	70.95	0.02	0.10	0.26	0.02	0.01
Dozer - D-6	Crawler Tractor/Dozers	300	1	2	50%	300.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	53.21	0.02	0.04	0.13	0.01	0.01
Compactor	Surfacing Equipment	200	1	4	50%	600.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	70.93	0.03	0.10	0.29	0.02	0.02
Dump Trucks	Off-highway Trucks	400	1	4	40%	480.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	113.52	0.03	0.08	0.22	0.01	0.01
Concrete Pump	Pumps	125	1	4	20%	240.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	17.53	0.01	0.04	0.13	0.01	0.01
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	2	4	10%	240.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	3.67	0.00	0.02	0.02	0.00	0.00
Pick-up Trucks	Off-highway Trucks	300	2	4	10%	240.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	42.57	0.01	0.01	0.05	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	2	4	5%	120.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	28.38	0.01	0.02	0.06	0.00	0.00
2000 Gallon Water Truck	Off-highway Trucks	400	1	4	5%	60.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	14.19	0.00	0.01	0.03	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	4	1%	12.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	2.84	0.00	0.00	0.01	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	4	25%	900.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	106.40	0.04	0.12	0.36	0.02	0.02
Manlifts	Aerial Lift	95	6	4	60%	4320.00	0.0043	692.905	0.99	5.30	4.72	0.75	0.72	0.00	313.46	0.45	2.40	2.14	0.34	0.33
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	4	50%	600.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	52.62	0.02	0.06	0.22	0.01	0.01
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	4	4	95%	4560.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	122.00	0.14	0.63	0.83	0.10	0.10
Water Pump	Pumps	8	1	4	5%	60.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	0.31	0.00	0.00	0.00	0.00	0.00
Generator	Generator Sets	13	1	4	90%	1080.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	9.11	0.01	0.04	0.08	0.01	0.01
Lighting Towers (portable)	Generator Sets	7	1	4	20%	240.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	1.09	0.00	0.01	0.01	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.01	**1,381.28**	**1.02**	**4.46**	**6.53**	**0.70**	**0.68**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-12-2 Potential Construction Emissions from On-Road Engine Combustion
SHP Burch Ridge Compressor Station - Marshall County, West Virginia
Supply Header Project

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	30	20	600
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	0	0	0
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	4	20	80
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.13	3.10	0.17	0.01	0.00	0.00	181.12
Company Commute Trucks	0.01	0.09	0.01	0.00	0.00	0.00	23.28
Delivery Trucks (Warehouse)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contractor Commute Trucks	0.03	0.36	0.03	0.00	0.00	0.00	93.12
Delivery Trucks (Local)	0.03	0.10	0.08	0.01	0.01	0.00	158.73
TOTAL EMISSIONS	0.20	3.66	0.28	0.02	0.01	0.00	456.25

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-12-3 Potential Construction Emissions from Unpaved Road Fugitives
SHP Burch Ridge Compressor Station - Marshall County, West Virginia
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	87.2
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	14.95	5.21	0.52

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.73	2.35	0.23
Controlled	lb/hr	4.04	1.41	0.14
Uncontrolled	tons	20.18	7.04	0.70
Controlled	**tons**	**12.11**	**4.22**	**0.42**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] Moundsville, WV 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-4 Potential Construction Emissions from Paved Road Fugitives

SHP Burch Ridge Compressor Station - Marshall County, West Virginia

Supply Header Project

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	30	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	0	13
Contractor Commute Trucks	4	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.63
Precip > 0.01 in (p)[1]	days/yr	87.2
Truck Schedule	VMT/day	820
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0655	0.0131	0.0032
E_{ext}	lb/VMT	0.0616	0.0123	0.0030

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	53.68	10.74	2.64

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	50.47	10.09	2.48
Total Emissions	**tons**	**15.14**	**3.03**	**0.74**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Moundsville, WV 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-5 Potential Construction Emissions from Material Handling
SHP Burch Ridge Compressor Station - Marshall County, West Virginia
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	7.53
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.8
Precip > 0.01 in (p)[3]	days	87.2
Land Affected During Construction	acre	0.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	0
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	0
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	0.0
Daily Pile Height and Radius[8]	yd	0.00
Daily Pile Surface Area[8]	acre	0.000

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00353	0.00167	0.00025
Fugitive Wind Erosion Factor	lb/day	0.00	0.00	0.00

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.00**	**0.00**	**0.00**
Total Fugitive Wind Emissions	**tons**	**0.00**	**0.00**	**0.00**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Wheeling/Ohio County Weather Station data, average from 1972-2000
[2] Pittsburgh International Airport Weather Station data, frequency wind greater than calm, 1961-1990
[3] Moundsville, WV 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 20 months, 30 days/month
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-6 Potential Construction Emissions from Off-Road Engine Combustion
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Crayne Compressor Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	1	2	50%	300.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	46.14	0.01	0.03	0.15	0.01	0.01
100 Ton Hydraulic Crane	Cranes	225	1	4	25%	300.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	39.47	0.01	0.03	0.12	0.01	0.01
50 Ton Hydraulic Crane	Cranes	185	1	6	75%	1350.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	146.05	0.05	0.10	0.46	0.02	0.02
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	3	8	50%	3600.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	496.01	0.40	1.40	2.74	0.26	0.26
Loaders	Tractors/Loaders/Backhoes	200	1	4	50%	600.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	82.67	0.07	0.23	0.46	0.04	0.04
Graders	Graders	200	1	2	25%	150.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	17.74	0.01	0.01	0.04	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	4	50%	600.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	141.89	0.04	0.21	0.51	0.03	0.03
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	8	50%	1200.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	141.85	0.05	0.20	0.58	0.04	0.04
Dump Trucks	Off-highway Trucks	400	2	8	40%	1920.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	454.09	0.12	0.32	0.90	0.05	0.04
Concrete Pump	Pumps	125	1	8	20%	480.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	35.05	0.02	0.08	0.26	0.02	0.02
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	2	10	10%	600.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	9.18	0.01	0.04	0.06	0.01	0.01
Pick-up Trucks	Off-highway Trucks	300	2	10	10%	600.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	106.43	0.03	0.03	0.13	0.00	0.00
Flatbed Trucks (2 ton)	Off-highway Trucks	400	2	10	5%	300.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	70.95	0.02	0.05	0.14	0.01	0.01
2000 Gallon Water Truck	Off-highway Trucks	400	1	10	5%	150.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	35.48	0.01	0.02	0.07	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	10	1%	30.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	7.10	0.00	0.00	0.01	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	10	25%	2250.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	266.01	0.09	0.31	0.91	0.06	0.06
Manlifts	Aerial Lift	95	6	10	60%	10800.00	0.0043	692.905	0.99	5.30	4.72	0.75	0.72	0.00	783.66	1.12	5.99	5.34	0.84	0.82
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	8	8	95%	18240.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.00	487.99	0.57	2.53	3.32	0.40	0.39
Water Pump	Pumps	8	2	10	5%	300.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	1.56	0.00	0.01	0.01	0.00	0.00
Generator	Generator Sets	13	2	10	90%	5400.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	45.54	0.05	0.21	0.38	0.03	0.03
Lighting Towers (portable)	Generator Sets	7	2	6	20%	720.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	3.27	0.00	0.03	0.03	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.02	**3,603.47**	**2.74**	**12.00**	**17.20**	**1.87**	**1.81**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-12-7 Potential Construction Emissions from On-Road Engine Combustion
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	60	20	1200
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	0	0	0
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	8	20	160
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.25	6.21	0.34	0.02	0.01	0.01	362.23
Company Commute Trucks	0.01	0.09	0.01	0.00	0.00	0.00	23.28
Delivery Trucks (Warehouse)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contractor Commute Trucks	0.06	0.72	0.05	0.00	0.00	0.00	186.25
Delivery Trucks (Local)	0.03	0.10	0.08	0.01	0.01	0.00	158.73
TOTAL EMISSIONS	0.36	7.12	0.48	0.03	0.02	0.01	730.49

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-12-8 Potential Construction Emissions from Unpaved Road Fugitives

SHP Crayne Compressor Station - Greene County, Pennsylvania

Supply Header Project

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	85.8
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.03	5.24	0.52

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.76	2.36	0.24
Controlled	lb/hr	4.06	1.41	0.14
Uncontrolled	tons	20.28	7.07	0.71
Controlled	**tons**	**12.17**	**4.24**	**0.42**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Waynesburg 1 E, PA 30-year average of days > 0.1 inch precipitation (1981-2010)

[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day

[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-9 Potential Construction Emissions from Paved Road Fugitives

SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	60	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	0	13
Contractor Commute Trucks	8	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.21
Precip > 0.01 in (p)[1]	days/yr	85.8
Truck Schedule	VMT/day	1,500
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0547	0.0109	0.0027
E_{ext}	lb/VMT	0.0515	0.0103	0.0025

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	82.11	16.42	4.03

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	77.29	15.46	3.79
Total Emissions	**tons**	**23.19**	**4.64**	**1.14**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Waynesburg 1 E, PA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-10 Potential Construction Emissions from Material Handling
SHP Crayne Compressor Station - Greene County, Pennsylvania
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	9.61
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.8
Precip > 0.01 in (p)[3]	days	85.8
Land Affected During Construction	acre	10.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	290,400
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	325,497
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	242.0
Daily Pile Height and Radius[8]	yd	6.14
Daily Pile Surface Area[8]	acre	1.037

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00485	0.00229	0.00035
Fugitive Wind Erosion Factor	lb/day	128.19	64.09	9.61

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.79**	**0.37**	**0.06**
Total Fugitive Wind Emissions	**tons**	**38.46**	**19.23**	**2.88**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Pittsburgh International Airport Weather Station data, average from 1945-2000
[2] Pittsburgh International Airport Weather Station data, frequency wind greater than calm, 1961-1990
[3] Waynesburg 1 E, PA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 20 months, 30 days/month
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-11 Potential Construction Emissions from Off-Road Engine Combustion
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			JB Tonkin Compressor Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	1	3	50%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	69.21	0.02	0.05	0.22	0.01	0.01
100 Ton Hydraulic Crane	Cranes	225	1	6	25%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	59.21	0.02	0.04	0.19	0.01	0.01
50 Ton Hydraulic Crane	Cranes	185	1	10	75%	2250.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	243.42	0.08	0.17	0.77	0.03	0.03
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	3	14	50%	6300.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.01	868.01	0.70	2.45	4.79	0.46	0.45
Loaders	Tractors/Loaders/Backhoes	200	1	10	50%	1500.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	206.67	0.17	0.58	1.14	0.11	0.11
Graders	Graders	200	1	4	25%	300.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	35.47	0.01	0.03	0.08	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	4	50%	600.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	141.89	0.04	0.21	0.51	0.03	0.03
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	14	50%	2100.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	248.24	0.09	0.34	1.02	0.06	0.06
Dump Trucks	Off-highway Trucks	400	2	10	40%	2400.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	567.62	0.15	0.39	1.12	0.06	0.06
Concrete Pump	Pumps	125	1	10	20%	600.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	43.82	0.03	0.10	0.32	0.02	0.02
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	18	10%	2160.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	33.05	0.03	0.15	0.22	0.02	0.02
Pick-up Trucks	Off-highway Trucks	300	4	18	10%	2160.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	383.15	0.10	0.12	0.45	0.01	0.01
Flatbed Trucks (2 ton)	Off-highway Trucks	400	4	12	5%	720.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	170.29	0.04	0.12	0.34	0.02	0.02
2000 Gallon Water Truck	Off-highway Trucks	400	1	12	5%	180.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	42.57	0.01	0.03	0.08	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	18	1%	54.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	12.77	0.00	0.01	0.03	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	10	25%	2250.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	266.01	0.09	0.31	0.91	0.06	0.06
Manlifts	Aerial Lift	95	6	10	60%	10800.00	0.0043	692.905	0.99	5.30	4.72	0.75	0.72	0.00	783.66	1.12	5.99	5.34	0.84	0.82
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	8	14	95%	31920.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.01	853.97	1.01	4.42	5.81	0.71	0.68
Water Pump	Pumps	8	2	10	5%	300.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	1.56	0.00	0.01	0.01	0.00	0.00
Generator	Generator Sets	13	2	14	90%	7560.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	63.75	0.06	0.29	0.53	0.04	0.04
Lighting Towers (portable)	Generator Sets	7	2	6	20%	720.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	3.27	0.00	0.03	0.03	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.03	**5,282.97**	**3.84**	**16.00**	**24.49**	**2.55**	**2.47**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-12-12 Potential Construction Emissions from On-Road Engine Combustion
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	60	20	1200
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	0	0	0
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	8	20	160
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.25	6.21	0.34	0.02	0.01	0.01	362.23
Company Commute Trucks	0.01	0.09	0.01	0.00	0.00	0.00	23.28
Delivery Trucks (Warehouse)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contractor Commute Trucks	0.06	0.72	0.05	0.00	0.00	0.00	186.25
Delivery Trucks (Local)	0.03	0.10	0.08	0.01	0.01	0.00	158.73
TOTAL EMISSIONS	0.36	7.12	0.48	0.03	0.02	0.01	730.49

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-12-13 Potential Construction Emissions from Unpaved Road Fugitives
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	83.6
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.14	5.28	0.53

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.81	2.38	0.24
Controlled	lb/hr	4.09	1.43	0.14
Uncontrolled	tons	20.44	7.13	0.71
Controlled	**tons**	**12.27**	**4.28**	**0.43**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] New Stanton, PA 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-14 Potential Construction Emissions from Paved Road Fugitives

SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania

Supply Header Project

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	60	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	0	13
Contractor Commute Trucks	8	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.21
Precip > 0.01 in (p)[1]	days/yr	83.6
Truck Schedule	VMT/day	1,500
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0547	0.0109	0.0027
E_{ext}	lb/VMT	0.0516	0.0103	0.0025

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	82.11	16.42	4.03

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	77.41	15.48	3.80
Total Emissions	**tons**	**23.22**	**4.64**	**1.14**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] New Stanton, PA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-15 Potential Construction Emissions from Material Handling
SHP JB Tonkin Compressor Station - Westmoreland County, Pennsylvania
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	9.61
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.8
Precip > 0.01 in (p)[3]	days	83.6
Land Affected During Construction	acre	10.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	290,400
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	325,497
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	242.0
Daily Pile Height and Radius[8]	yd	6.14
Daily Pile Surface Area[8]	acre	1.037

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00485	0.00229	0.00035
Fugitive Wind Erosion Factor	lb/day	129.20	64.60	9.69

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.79**	**0.37**	**0.06**
Total Fugitive Wind Emissions	**tons**	**38.76**	**19.38**	**2.91**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Pittsburgh International Airport Weather Station data, average from 1945-2000
[2] Pittsburgh International Airport Weather Station data, frequency wind greater than calm, 1961-1990
[3] New Stanton, PA 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 20 months, 30 days/month
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-16 Potential Construction Emissions from Off-Road Engine Combustion
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours (10 hr work day)				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Mockingbird Compressor Station			Project														
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Cranes																				
150 ton Crawler Crane	Cranes	263	1	3	50%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	69.21	0.02	0.05	0.22	0.01	0.01
100 Ton Hydraulic Crane	Cranes	225	1	6	25%	450.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	59.21	0.02	0.04	0.19	0.01	0.01
50 Ton Hydraulic Crane	Cranes	185	1	10	75%	2250.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.00	243.42	0.08	0.17	0.77	0.03	0.03
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	3	14	50%	6300.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.01	868.01	0.70	2.45	4.79	0.46	0.45
Loaders	Tractors/Loaders/Backhoes	200	1	10	50%	1500.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	206.67	0.17	0.58	1.14	0.11	0.11
Graders	Graders	200	1	4	25%	300.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	35.47	0.01	0.03	0.08	0.00	0.00
Dozer - D-8	Crawler Tractor/Dozers	400	1	4	50%	600.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	141.89	0.04	0.21	0.51	0.03	0.03
Dozer - D-6	Crawler Tractor/Dozers	300	1	4	50%	600.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	106.42	0.03	0.08	0.25	0.02	0.01
Compactor	Surfacing Equipment	200	1	14	50%	2100.00	0.0031	536.19	0.20	0.74	2.19	0.14	0.13	0.00	248.24	0.09	0.34	1.02	0.06	0.06
Dump Trucks	Off-highway Trucks	400	2	10	40%	2400.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	567.62	0.15	0.39	1.12	0.06	0.06
Concrete Pump	Pumps	125	1	10	20%	600.00	0.0033	529.98	0.34	1.16	3.86	0.24	0.23	0.00	43.82	0.03	0.10	0.32	0.02	0.02
Vehicles																				
ATVs	Tractors/Loaders/Backhoes	20	4	18	10%	2160.00	0.0047	694.13	0.59	3.06	4.61	0.42	0.41	0.00	33.05	0.80	0.15	0.22	0.02	0.02
Pick-up Trucks	Off-highway Trucks	300	4	18	10%	2160.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	383.15	0.10	0.12	0.45	0.01	0.01
Flatbed Trucks (2 ton)	Off-highway Trucks	400	4	12	5%	720.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	170.29	0.04	0.12	0.34	0.02	0.02
2000 Gallon Water Truck	Off-highway Trucks	400	1	12	5%	180.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	42.57	0.01	0.03	0.08	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	400	1	18	1%	54.00	0.0028	536.39	0.14	0.37	1.06	0.05	0.05	0.00	12.77	0.00	0.01	0.03	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	3	10	25%	2250.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	266.01	0.09	0.31	0.91	0.06	0.06
Manlifts	Aerial Lift	95	6	10	60%	10800.00	0.0043	692.905	0.99	5.30	4.72	0.75	0.72	0.00	783.66	1.12	5.99	5.34	0.84	0.82
Air Compressors																				
160-185 CFM Portable	Air Compressors	150	1	6	50%	900.00	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	78.93	0.03	0.09	0.33	0.02	0.02
Miscelaneous Equipment																				
Welding Machines (300 - 400 AMP)	Welders	35	8	14	95%	31920.00	0.0043	693.44	0.82	3.59	4.72	0.57	0.56	0.01	853.97	1.01	4.42	5.81	0.71	0.68
Water Pump	Pumps	8	2	10	5%	300.00	0.0040	588.30	0.65	4.47	4.82	0.46	0.45	0.00	1.56	0.00	0.01	0.01	0.00	0.00
Generator	Generator Sets	13	2	14	90%	7560.00	0.0040	588.48	0.60	2.68	4.93	0.40	0.39	0.00	63.75	0.06	0.29	0.53	0.04	0.04
Lighting Towers (portable)	Generator Sets	7	2	6	20%	720.00	0.0040	588.13	0.71	4.52	5.12	0.50	0.49	0.00	3.27	0.00	0.03	0.03	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.03	**5,282.97**	**4.61**	**16.00**	**24.49**	**2.55**	**2.47**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-12-17 Potential Construction Emissions from On-Road Engine Combustion
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity	Daily Avg. Round Trip (mi)	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	60	20	1200
Company Commute Trucks	Light Commercial Truck	1	20	20
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	0	0	0
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	8	20	160
Delivery Trucks (Local)	Short-Haul Truck (Local)	3	40	120

Parameter	Units	Value
Construction Schedule[1]	days	600

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.25	6.21	0.34	0.02	0.01	0.01	362.23
Company Commute Trucks	0.01	0.09	0.01	0.00	0.00	0.00	23.28
Delivery Trucks (Warehouse)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contractor Commute Trucks	0.06	0.72	0.05	0.00	0.00	0.00	186.25
Delivery Trucks (Local)	0.03	0.10	0.08	0.01	0.01	0.00	158.73
TOTAL EMISSIONS	0.36	7.12	0.48	0.03	0.02	0.01	730.49

Notes:

[1] Construction schedule assumed to be 20 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

Table 9A-12-18 Potential Construction Emissions from Unpaved Road Fugitives
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	83.7
Truck Schedule[3]	VMT/hr	0.45
Construction Schedule[4]	hours	6000

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.14	5.28	0.53

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.84	3.08	0.31
Controlled	lb/hr	5.30	1.85	0.18

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	6.81	2.38	0.24
Controlled	lb/hr	4.09	1.43	0.14
Uncontrolled	tons	20.44	7.13	0.71
Controlled	**tons**	**12.26**	**4.28**	**0.43**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion
[2] Hannibal Lock and Dam, OH 30-year average of days > 0.1 inch precipitation (1981-2010)
[3] Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 10 hours/day
[4] Construction schedule assumed to be 20 months, 30 days/month, 10 hours/day
[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent
[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads
[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)
[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-19 Potential Construction Emissions from Paved Road Fugitives

SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia

Supply Header Project

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	60	1
Company Commute Trucks	1	2
Delivery Trucks (Warehouse)	0	13
Contractor Commute Trucks	8	7.25
Delivery Trucks (Local)	3	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	2.21
Precip > 0.01 in (p)[1]	days/yr	83.7
Truck Schedule	VMT/day	1,500
Construction Schedule[2]	days	600

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0547	0.0109	0.0027
E_{ext}	lb/VMT	0.0516	0.0103	0.0025

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	82.11	16.42	4.03

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	77.41	15.48	3.80
Total Emissions	**tons**	**23.22**	**4.64**	**1.14**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Hannibal Lock and Dam, OH 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 20 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-12-20 Potential Construction Emissions from Material Handling
SHP Mockingbird Hill Compressor Station - Wetzel County, West Virginia
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	6.19
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	77.4
Precip > 0.01 in (p)[3]	days	83.7
Land Affected During Construction	acre	10.0
Depth of Land Excavated[4]	feet	9.0
Volume of Ground Material Moved[5]	cubic yd	290,400
Density of Ground Material[6]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	325,497
Construction Schedule[7]	days	600
Daily Pile Size	cubic yd	242.0
Daily Pile Height and Radius[8]	yd	6.14
Daily Pile Surface Area[8]	acre	1.037

Emission Factor Equation Parameters

Parameter	Units	TSP[13]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[9]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[10]	---	1	0.5	0.075
Material Moisture Content (M)[11]	%	2.2		
Surface Material Silt Content (s)[12]	%	15		

Calculated Emission Factors

	Units	TSP[13]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00274	0.00129	0.00020
Fugitive Wind Erosion Factor	lb/day	108.89	54.45	8.17

Total Emissions (with rainfall)

	Units	TSP[13]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.45**	**0.21**	**0.03**
Total Fugitive Wind Emissions	**tons**	**32.67**	**16.33**	**2.45**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Clarksburg/Benedum Weather Station data, average from 1972-2000
[2] Elkins/Randolph FieldWeather Station data, frequency wind greater than calm, 1961-1990
[3] Hannibal Lock and Dam, OH 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Based on maximum depth of pipeline trench
[5] Volume doubled because material is removed and replaced; see GE&F calculations
[6] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[7] Construction schedule assumed to be 20 months, 30 days/month
[8] Assume pile is conical with a 45 degree slope (radius = height); assume material remains excavated for an average of 30 days (1 month)
[9] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[10] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[11] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[12] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[13] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-1 Potential Construction Emissions from Off-Road Engine Combustion
TL-635 Pipeline (Spread 2) - WV
Supply Header Project

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours TL-635 Pipeline				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	55	9	50%	59400.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.05	8184.12	6.64	23.12	45.14	4.34	4.21
Boring Machine	Bore/Drill Rigs	140	2	2	70%	672.00	0.0033	530.04	0.32	1.10	3.87	0.23	0.22	0.00	54.97	0.03	0.11	0.40	0.02	0.02
Graders	Graders	200	2	4	20%	384.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	45.41	0.01	0.03	0.11	0.01	0.01
Dozer - D-8	Crawler Tractor/Dozers	350	10	9	50%	10800.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.01	2234.77	0.66	3.27	8.06	0.48	0.46
Dozer - D7	Crawler Tractor/Dozers	240	35	9	50%	37800.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.03	5363.53	1.54	4.20	12.78	0.76	0.74
Dozer - D-6	Crawler Tractor/Dozers	200	7	9	50%	7560.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	893.92	0.26	0.70	2.13	0.13	0.12
Sideboom	Cranes	290	55	6	50%	39600.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.04	6715.78	2.12	4.69	21.16	0.93	0.91
Farm Tractor	Tractors/Loaders/Backhoes	100	12	4	30%	3456.00	0.0042	693.58	0.77	4.89	3.94	0.70	0.68	0.00	264.23	0.29	1.86	1.50	0.27	0.26
Dump Trucks	Off-highway Trucks	250	0	0	0%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles																				
Buses - 55 Passenger	Off-highway Trucks	200	4	6	5%	288.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	34.06	0.01	0.01	0.04	0.00	0.00
Mechanics Rig	Bore/Drill Rigs	300	11	9	30%	7128.00	0.0032	530.12	0.29	0.93	3.66	0.19	0.18	0.01	1249.61	0.69	2.18	8.64	0.44	0.43
Welding Rigs	Welders	300	50	6	70%	50400.00	0.0039	624.28	0.72	2.92	4.29	0.50	0.49	0.06	10404.89	12.06	48.68	71.43	8.39	8.14
Pick-up Trucks (1/2 - 3/4 ton)	Off-highway Trucks	110	50	9	5%	5400.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	351.22	0.09	0.16	0.44	0.03	0.02
Pick-up Trucks (1 ton)	Off-highway Trucks	150	50	6	5%	3600.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	319.29	0.08	0.14	0.40	0.02	0.02
Flatbed Trucks (2 ton)	Off-highway Trucks	200	5	6	5%	360.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	42.57	0.01	0.01	0.05	0.00	0.00
Truck Tractor	Tractors/Loaders/Backhoes	300	20	9	40%	17280.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.02	3571.25	2.90	10.09	19.70	1.89	1.84
2000 Gallon Water Truck	Off-highway Trucks	250	2	2	1%	9.60	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	1.42	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	250	4	6	15%	864.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	127.72	0.03	0.04	0.15	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	0	0	0%	0.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressors																				
160-185 CFM Portable	Air Compressors	150	1	1	1%	1.20	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	0.11	0.00	0.00	0.00	0.00	0.00
700-850 CFM Portable	Air Compressors	400	1	1	1%	1.20	0.0032	530.40	0.20	0.83	3.02	0.13	0.12	0.00	0.28	0.00	0.00	0.00	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.23	**39,859.13**	**27.42**	**99.30**	**192.14**	**17.72**	**17.19**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**Assume TSP = PM-10

Table 9A-13-2 Potential Construction Emissions from On-Road Engine Combustion
TL-635 Pipeline (Spread 2) - WV
Supply Header Project

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity[3]	Daily Avg. Round Trip (mi)[3]	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	95	40	3800
Company Commute Trucks	Light Commercial Truck	20	100	2000
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	100	100
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	60	100	6000
Delivery Trucks (Local)	Short-Haul Truck (Local)	0	0	0

Parameter	Units	Value
Construction Schedule[1]	days	315

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.42	10.32	0.57	0.03	0.01	0.01	602.21
Company Commute Trucks	0.42	4.72	0.35	0.02	0.01	0.01	1,222.25
Delivery Trucks (Warehouse)	0.01	0.05	0.03	0.00	0.00	0.00	69.45
Contractor Commute Trucks	1.25	14.17	1.04	0.05	0.02	0.02	3,666.75
Delivery Trucks (Local)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL EMISSIONS	2.10	29.25	1.99	0.10	0.05	0.03	5,560.65

Notes:

[1] Construction schedule assumed to be 10.5 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

[3] Average quantity and average round trip based on information in example calculations provided by Dominion

Table 9A-13-3 Potential Construction Emissions from Unpaved Road Fugitives

TL-635 Pipeline (Spread 2) - WV

Supply Header Project

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	83.7
Truck Schedule[3]	VMT/hr	0.56
Construction Schedule[4]	hours	2520

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.14	5.28	0.53

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	11.05	3.85	0.39
Controlled	lb/hr	6.63	2.31	0.23

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.52	2.97	0.30
Controlled	lb/hr	5.11	1.78	0.18
Uncontrolled	tons	10.73	3.74	0.37
Controlled	**tons**	**6.44**	**2.24**	**0.22**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] Hannibal Lock and Dam, OH 30-year average of days > 0.1 inch precipitation (1981-2010)

3 Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 8 hours/day

[4] Construction schedule assumed to be 10.5 months, 30 days/month, 8 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-4 Potential Construction Emissions from Paved Road Fugitives

TL-635 Pipeline (Spread 2) - WV

Supply Header Project

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	95	1
Company Commute Trucks	20	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	60	7.25
Delivery Trucks (Local)	0	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.31
Precip > 0.01 in (p)[1]	days/yr	83.7
Truck Schedule	VMT/day	11,900
Construction Schedule[2]	days	315

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2	2.4		
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0828	0.0166	0.0041
E_{ext}	lb/VMT	0.0780	0.0156	0.0038

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	985.12	197.02	48.36

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	928.65	185.73	45.59
Total Emissions	**tons**	**146.26**	**29.25**	**7.18**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] Hannibal Lock and Dam, OH 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 22 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-5 Potential Construction Emissions from Material Handling
TL-635 Pipeline (Spread 2) - WV
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	6.19
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	77.4
Precip > 0.01 in (p)[3]	days	83.7
Length of Pipeline Segment	miles	32.8
Diameter of Pipeline	inches	30
Volume of Ground Material Moved[4]	cubic yd	1,867,608
Density of Ground Material[5]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	2,093,322
Construction Schedule[6]	days	315
Daily Pile Surface Area[7]	acre	24.761

Emission Factor Equation Parameters

Parameter	Units	TSP[12]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[8]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[9]	---	1	0.5	0.075
Material Moisture Content (M)[10]	%	2.2		
Surface Material Silt Content (s)[11]	%	15		

Calculated Emission Factors

	Units	TSP[12]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00274	0.00129	0.00020
Fugitive Wind Erosion Factor	lb/day	2599.98	1299.99	195.00

Total Emissions (with rainfall)

	Units	TSP[12]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**2.86**	**1.35**	**0.21**
Total Fugitive Wind Emissions	**tons**	**409.50**	**204.75**	**30.71**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Clarksburg/Benedum Field Weather Station data, average from 1972-2000
[2] Elkins/Randolph Field Weather Station data, frequency wind greater than calm, 1961-1990
[3] Hannibal Lock and Dam, OH 30-year average of days > 0.1 inch precipitation (1981-2010)
[4] Volume doubled because material is removed and replaced; see GE&F calculations
[5] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space
[6] Construction schedule assumed to be 22 months, 30 days/month
[7] Assume material remains excavated for an average of 30 days (1 month); see GE&F calculations
[8] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)
[9] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)
[10] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent
[11] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent
[12] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-6 Potential Construction Emissions from Off-Road Engine Combustion
TL-636 Pipeline (Spread 1) - PA
Supply Header Project

Equipment Type	MOVES Equipment Type	HP	Estimated Operating Hours TL-636 Pipeline				Emission Factors (g/hp-hr)*							Estimated Emissions (tons)						
			Number	Months at Project	% Utilization	Total Hours	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2	HC	CO	NOx	PM-10	PM-2.5
Earthwork / Concrete Equipment																				
Excavators / Backhoes	Tractors/Loaders/Backhoes	200	20	7	50%	16800.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.01	2314.70	1.88	6.54	12.77	1.23	1.19
Boring Machine	Bore/Drill Rigs	140	2	2	70%	672.00	0.0033	530.04	0.32	1.10	3.87	0.23	0.22	0.00	54.97	0.03	0.11	0.40	0.02	0.02
Graders	Graders	200	2	4	20%	384.00	0.0028	536.35	0.15	0.41	1.25	0.07	0.07	0.00	45.41	0.01	0.03	0.11	0.01	0.01
Dozer - D-8	Crawler Tractor/Dozers	350	4	7	50%	3360.00	0.0031	536.33	0.16	0.78	1.93	0.11	0.11	0.00	695.26	0.20	1.02	2.51	0.15	0.14
Dozer - D7	Crawler Tractor/Dozers	240	6	7	50%	5040.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.00	715.14	0.21	0.56	1.70	0.10	0.10
Dozer - D-6	Crawler Tractor/Dozers	200	12	7	50%	10080.00	0.0029	536.34	0.15	0.42	1.28	0.08	0.07	0.01	1191.90	0.34	0.93	2.84	0.17	0.16
Sideboom	Cranes	290	8	6	50%	5760.00	0.0030	530.51	0.17	0.37	1.67	0.07	0.07	0.01	976.84	0.31	0.68	3.08	0.14	0.13
Farm Tractor	Tractors/Loaders/Backhoes	100	4	4	30%	1152.00	0.0042	693.58	0.77	4.89	3.94	0.70	0.68	0.00	88.08	0.10	0.62	0.50	0.09	0.09
Dump Trucks	Off-highway Trucks	250	0	0	0%	0.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicles																				
Buses - 55 Passenger	Off-highway Trucks	200	2	6	5%	144.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	17.03	0.00	0.01	0.02	0.00	0.00
Mechanics Rig	Bore/Drill Rigs	300	5	7	30%	2520.00	0.0032	530.12	0.29	0.93	3.66	0.19	0.18	0.00	441.78	0.24	0.77	3.05	0.16	0.15
Welding Rigs	Welders	300	8	6	70%	8064.00	0.0039	624.28	0.72	2.92	4.29	0.50	0.49	0.01	1664.78	1.93	7.79	11.43	1.34	1.30
Pick-up Trucks (1/2 - 3/4 ton)	Off-highway Trucks	110	20	7	5%	1680.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	109.27	0.03	0.05	0.14	0.01	0.01
Pick-up Trucks (1 ton)	Off-highway Trucks	150	16	6	5%	1152.00	0.0027	536.40	0.14	0.24	0.67	0.04	0.04	0.00	102.17	0.03	0.05	0.13	0.01	0.01
Flatbed Trucks (2 ton)	Off-highway Trucks	200	6	6	5%	432.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	51.09	0.01	0.02	0.06	0.00	0.00
Truck Tractor	Tractors/Loaders/Backhoes	300	4	7	40%	2688.00	0.0037	624.96	0.51	1.77	3.45	0.33	0.32	0.00	555.53	0.45	1.57	3.06	0.29	0.29
2000 Gallon Water Truck	Off-highway Trucks	250	1	2	1%	4.80	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	0.71	0.00	0.00	0.00	0.00	0.00
2000 Gallon Fuel Truck	Off-highway Trucks	250	3	6	15%	648.00	0.0026	536.40	0.13	0.16	0.63	0.02	0.02	0.00	95.79	0.02	0.03	0.11	0.00	0.00
Forklifts / Manlifts																				
Forklifts (5 ton)	Rough Terrain Forklifts	200	0	0	2%	0.00	0.0030	536.27	0.18	0.62	1.83	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Compressors																				
160-185 CFM Portable	Air Compressors	150	1	1	1%	1.20	0.0031	530.39	0.21	0.58	2.23	0.14	0.13	0.00	0.11	0.00	0.00	0.00	0.00	0.00
700-850 CFM Portable	Air Compressors	400	1	1	1%	1.20	0.0032	530.40	0.20	0.83	3.02	0.13	0.12	0.00	0.28	0.00	0.00	0.00	0.00	0.00
Total Estimated Project Emissions (Tons/Project)														**SO2**	**CO2**	**HC**	**CO**	**NOx**	**PM-10**	**PM-2.5**
														0.05	**9,120.82**	**5.80**	**20.78**	**41.91**	**3.72**	**3.60**

* Emission factors generated from EPA's MOVES2014 model. Model run based on June 2017 weekday construction in Nelson, Virginia; representative of a worst-case emissions.
**7 months is the construction schedule duration
***Assume TSP = PM-10

Table 9A-13-7 Potential Construction Emissions from On-Road Engine Combustion
TL-636 Pipeline (Spread 1) - PA
Supply Header Project

Site-Specific Information

Equipment Type	MOVES Equipment Type	Average Quantity[3]	Daily Avg. Round Trip (mi)[3]	Total VMT
Worker Commute Vehicles	Passenger Car/Pickups	95	40	3800
Company Commute Trucks	Light Commercial Truck	20	100	2000
Delivery Trucks (Warehouse)	Short-Haul Truck (Warehouse)	1	100	100
Contractor Commute Trucks (Welding)	Light Commercial Truck (Welding)	60	100	6000
Delivery Trucks (Local)	Short-Haul Truck (Local)	0	0	0

Parameter	Units	Value
Construction Schedule[1]	days	210

MOVES Emission Factors[2]

Emission Factors (Units: gram/VMT)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.32	7.82	0.43	0.025	0.011	0.0069	456.4
Company Commute Trucks	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Warehouse)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000
Contractor Commute Trucks (Welding)	0.6	6.8	0.5	0.025	0.011	0.0091	1,760
Delivery Trucks (Local)	0.4	1.3	1.0	0.07	0.07	0.0032	2,000

Total OnRoad Emissions

Total Emissions (tons)							
Equipment Type	HC	CO	NOx	PM-10	PM-2.5	SO2	CO2
Worker Commute Vehicles	0.28	6.88	0.38	0.02	0.01	0.01	401.47
Company Commute Trucks	0.28	3.15	0.23	0.01	0.01	0.00	814.83
Delivery Trucks (Warehouse)	0.01	0.03	0.02	0.00	0.00	0.00	46.30
Contractor Commute Trucks	0.83	9.44	0.69	0.03	0.02	0.01	2,444.50
Delivery Trucks (Local)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL EMISSIONS	1.40	19.50	1.33	0.07	0.03	0.02	3,707.10

Notes:

[1] Construction schedule assumed to be 7 months, 30 days/month

[2] Emission factors from EPA OTAQ's MOVES2014 program, found in example calculations provided by Dominion

[3] Average quantity and average round trip based on information in example calculations provided by Dominion

Table 9A-13-8 Potential Construction Emissions from Unpaved Road Fugitives
TL-636 Pipeline (Spread 1) - PA
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Average Weight of Vehicle (W)[1]	tons	23.86
Precip > 0.01 in (p)[2]	days/yr	83.6
Truck Schedule[3]	VMT/hr	0.56
Construction Schedule[4]	hours	1680

Emission Factor Equation Parameters

Parameter	Units	TSP[8]	PM-10	PM-2.5
Surface Material Silt Content (s)[5]	%	23		
Particle Size Multiplier (k)[6]	lb/VMT	4.9	1.5	0.15
Emperical Constant (a)[6]	---	0.7	0.9	0.9
Emperical Constant (b)[6]	---	0.45	0.45	0.45
Water Spray Control Efficiency[7]	%	40		

Calculated Emission Factors

	Units	TSP[8]	PM-10	PM-2.5
E	lb/VMT	19.64	6.85	0.68
E_{ext}	lb/VMT	15.14	5.28	0.53

Maximum Hourly Emissions (no rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	11.05	3.85	0.39
Controlled	lb/hr	6.63	2.31	0.23

Total Emissions (with rainfall)

	Units	TSP[8]	PM-10	PM-2.5
Uncontrolled	lb/hr	8.52	2.97	0.30
Controlled	lb/hr	5.11	1.78	0.18
Uncontrolled	tons	7.16	2.49	0.25
Controlled	**tons**	**4.29**	**1.50**	**0.15**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.2 Unpaved Roads (November 2006)

(2) Background Document Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads Final Report (September 1998)

Emission Factor Equations:

Equation 1a from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[(s/12)^a]*(W/3)^b

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[(365-P)/365]

Notes:

[1] Weight based on information in example calculations provided by Dominion

[2] New Stanton, PA 30-year average of days > 0.1 inch precipitation (1981-2010)

3 Based on 9 construction vehicles, 0.5 miles per day for each vehicle, 8 hours/day

[4] Construction schedule assumed to be 7 months, 30 days/month, 8 hours/day

[5] Based on Table 13.2.2.1 of Calculation Source (1) Construction Sites Range from 0.56 - 23 percent

[6] Based on Table 13.2.2.2 of Calculation Source (1) for Unpaved Industrial Roads

[7] Control efficiency based on low of test data range of 40-70% for PM-10 from Calculation Source (2)

[8] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-9 Potential Construction Emissions from Paved Road Fugitives

TL-636 Pipeline (Spread 1) - PA

Supply Header Project

Site-Specific Information

Equipment Type	Average Quantity	Unit Weight (tons)[5]
Worker Commute Vehicles	95	1
Company Commute Trucks	20	2
Delivery Trucks (Warehouse)	1	13
Contractor Commute Trucks	60	7.25
Delivery Trucks (Local)	0	13

Parameter	Units	Value
Average Weight of Vehicle (W)	tons	3.31
Precip > 0.01 in (p)[1]	days/yr	83.6
Truck Schedule	VMT/day	11,900
Construction Schedule[2]	days	210

Emission Factor Equation Parameters

Parameter	Units	TSP[6]	PM-10	PM-2.5
Surface Material Silt Loading (sL)[3]	g/m^2		2.4	
Particle Size Multiplier (k)[4]	lb/VMT	0.011	0.0022	0.00054

Calculated Emission Factors

	Units	TSP[6]	PM-10	PM-2.5
E	lb/VMT	0.0828	0.0166	0.0041
E_{ext}	lb/VMT	0.0780	0.0156	0.0038

Maximum Daily Emissions (no rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	985.12	197.02	48.36

Total Emissions (with rainfall)

	Units	TSP[6]	PM-10	PM-2.5
Emission Rate	lb/day	928.72	185.74	45.59
Total Emissions	**tons**	**97.52**	**19.50**	**4.79**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources Final Section of 13.2.1 Paved Roads (January 2011)

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Hourly Emission Factor (lb/VMT):
E = k*[sL^0.91]*(W^1.02)

Equation 2 from Calculation Source (1) - Annual Emission Factor (lb/VMT):
E_{ext} = E*[1-P/(4*N)]

Notes:

[1] New Stanton, PA 30-year average of days > 0.1 inch precipitation (1981-2010)

[2] Construction schedule assumed to be 10 months, 30 days/month

[3] Based on Table 13.2.1-2 of Calculation Source (1); worst-case baseline and highest winter multiplier

[4] Based on Table 13.2.1-1 of Calculation Source (1) for paved roads

[5] Weights based on information in example calculations provided by Dominion

[6] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-10 Potential Construction Emissions from Material Handling
TL-636 Pipeline (Spread 1) - PA
Supply Header Project

Site-Specific Information

Parameter	Units	Value
Mean Wind Speed (U)[1]	mph	9.61
Frequency that wind speed exceeds 5.4 m/s (f)[2]	%	91.8
Precip > 0.01 in (p)[3]	days	83.6
Length of Pipeline Segment	miles	3.9
Diameter of Pipeline	inches	36
Volume of Ground Material Moved[4]	cubic yd	225,604
Density of Ground Material[5]	lb/cubic yd	2,241.72
Tons of Earth Moved	tons	252,869
Construction Schedule[6]	days	210
Daily Pile Surface Area[7]	acre	4.438

Emission Factor Equation Parameters

Parameter	Units	TSP[12]	PM-10	PM-2.5
Handling Particle Size Multiplier (k)[8]	---	0.74	0.35	0.053
Fugitive Particle Size Multiplier (k)[9]	---	1	0.5	0.075
Material Moisture Content (M)[10]	%	2.2		
Surface Material Silt Content (s)[11]	%	15		

Calculated Emission Factors

	Units	TSP[12]	PM-10	PM-2.5
Material Handling Emission Factor	lb/ton	0.00485	0.00229	0.00035
Fugitive Wind Erosion Factor	lb/day	552.95	276.47	41.47

Total Emissions (with rainfall)

	Units	TSP[12]	PM-10	PM-2.5
Total Material Handling Emissions	**tons**	**0.61**	**0.29**	**0.04**
Total Fugitive Wind Emissions	**tons**	**58.06**	**29.03**	**4.35**

Calculation Sources:

(1) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.0 – Introduction to Miscellaneous Sources, Section 13.2 – Introduction to Fugitive Dust Sources, Final Section of 13.2.4 - Aggregate Handling and Storage Piles (November 2006)

(2) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 11.0 – Introduction to Mineral Products Industry, Final Section of 11.9 – Western Surface Coal Mining (October 1998)

(3) EPA's Fugitive Dust Background Document (EPA-450/2-92-004)

(4) EPA's AP 42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Chapter 13.2.5 – Industrial Wind Erosion, November 2006

Emission Factor Equations:

Equation 1 from Calculation Source (1) - Emission Factor (lb/ton):
E = k*0.0032*[(U/5)^1.3]/[(M/2)^1.4]

Equation 2 from Calculation Source (3) - Emission Factor (lb/day/acre):
E = 1.7*(s/1.5)*[(365-p)/235]*(f/15)*k

Notes:

[1] Pittsburgh International Airport Weather Station data, average from 1945-2000

[2] Pittsburgh International Airport Weather Station data, frequency wind greater than calm, 1961-1990

[3] New Stanton, PA 30-year average of days > 0.1 inch precipitation (1981-2010)

[4] Volume doubled because material is removed and replaced; see GE&F calculations

[5] USDA NRCS' "Soil Quality Indicators"; Medium textured soil, 50% pore space

[6] Construction schedule assumed to be 10 months, 30 days/month

[7] Assume material remains excavated for an average of 30 days (1 month); see GE&F calculations

[8] Based on Aerodynamic Particle Size Multiplier (k) For Equation 1 table in Calculation Source (1)

[9] Based on Aerodynamic Particle Size Multipliers For Equation 2 table in Calculation Source (4)

[10] Based on Table 11.9-3 of Calculation Source (2) Overburden Range from 2.2 - 16.8 percent

[11] Based on Table 13.2.4-1 of Calculation Source (1) Overburden Range from 3.8 - 15 percent

[12] Total Suspended Particulate (TSP) based on Particulate Matter less than 30 microns (PM-30)

Table 9A-13-11 Potential Construction Emissions from Material Handling - Supplemental Calculations
Supply Header Project

Project Aspect	Parameter	Units	TL-635	TL-636
All Aspects	Pipe Length	miles	32.8	3.9
	Pipe Length	yards	57,728	6,864
Trench Spoil & Pile	Pipe Diameter	inches	30	36
	Max. Trench Bottom Width[1]	feet	4.50	5.00
	Max. Trench Top Width	feet	20	20
	Max. Trench Depth	feet	9	9
	Cross Sectional Area[2]	square yards	12.25	12.50
	Volume Ground Material Moved	cubic yards	707,168	85,800
	Pile Surface Area[3]	square yards	571,478	68,640
Trench Top Soil & Pile	Max. Depth of Topsoil Removal	inches	12	12
	Width of Top Soil Removal[4]	feet	41.00	41.21
	Cross Sectional Area	square yards	1.52	1.53
	Volume Ground Material Moved	cubic yards	87,661	10,477
	Pile Surface Area[3]	square yards	201,206	23,986
Agricultural Top Soil & Pile	Max. Depth of Topsoil Removal	inches	12	12
	Width of Top Soil Removal[5]	feet	65.0	65.0
	Cross Sectional Area	square yards	2.41	2.41
	Volume Ground Material Moved	cubic yards	138,975	16,524
	Pile Surface Area[6]	square yards	485,670	57,747
GRAND TOTAL VOLUME MATERIAL MOVED[7]		**cubic yards**	**933,804**	**112,802**
GRAND TOTAL SURFACE AREA[7]		**square yards**	**1,258,354**	**150,373**
GRAND TOTAL SURFACE AREA[7]		**acres**	**259.99**	**31.07**

Notes:

[1] Assume one foot of space between trench walls and each side of pipe

[2] Trench is in the shape of a trapezoid

[3] Assume pile is a triangular mound, with 45 degree slopes, that runs along the length of the trench; ignore ends

[4] Equal to width of trench plus width of base of trench spoil pile

[5] Based on width of land from pipeline trench to 25 feet from temporary boundary

[6] Assume pile is a triangular mound, with 25 foot base, that runs along the length of the trench; ignore ends

[7] Assumes worst case of maximum trench size, maximum depth of topsoil removal, and agricultural topsoil removal along entire length of pipeline

ATLANTIC COAST PIPELINE, LLC
ATLANTIC COAST PIPELINE

and

DOMINION TRANSMISSION, INC.
SUPPLY HEADER PROJECT

Resource Report 9
Air and Noise Quality

APPENDIX 9B
Preconstruction Noise Survey and Acoustical Analysis Reports

ENVIRONMENTAL NOISE CONTROL
260 Arbor Street
Lunenburg, MA 01462-1458
(978) 582-9204
Fax (978) 582-7102

11 June 2015

Dominion Transmission, Inc.
445 West Main Street
PO Box 2450
Clarksburg, West Virginia 26302-2450

Attention: Mr. Jay C. Riley

Subject: ENC Report No. 535:
Ambient Sound Survey and Noise Analysis for the Installation of Four Turbine Compressor Units and a Measurement Station at the Proposed Marts Compressor Station for the Atlantic Coast Pipeline Project
ENC Project No. 15-01

Dear Mr. Riley:

Environmental Noise Control (ENC) has conducted an ambient sound survey and a noise analysis of the sound levels due to the installation of one Solar Titan Model 130S, one Solar Mars Model 100S, one Taurus Model 70S, and one Taurus Model 60S turbine compressor units and a measurement station at the proposed Marts Compressor Station for the Atlantic Coast Pipeline Project.

1.0 PURPOSE

The purpose of the property line and noise sensitive area (NSA) sound survey was to document the existing ambient sound levels for the environmental report to be submitted for the installation of one Solar Titan Model 130S, one Solar Mars Model 100S, one Taurus Model 70S, and one Taurus Model 60S turbine compressor units and a measurement station at the proposed Marts Compressor Station. Presented below are descriptions of the proposed Marts Compressor Station site, the sound survey measurement locations, and the measured ambient sound levels.

1.1 SITE DESCRIPTION

The site of the proposed Marts Compressor Station is located in the Town of Jane Lew, Lewis County, West Virginia approximately 1500 feet west of the intersection of County Highway 35/10 and Hollick Run Road. It is planned that the four proposed turbine compressor units will be located in two acoustically insulated compressor buildings with two compressor units in each compressor building. Four ultrasonic meters will be located in an acoustically insulated measurement building approximately 200 feet northeast of the compressor buildings.

The land uses surrounding the site of the proposed compressor station are residential, agricultural, industrial and forested areas. The Dominion Transmission, Inc. Lightburn Compressor Station and Extraction Plant are located approximately one mile southeast of the proposed compressor station. The nearest NSAs are residences approximately 3000 and 3600 feet north-northwest, 1800 feet north, 2000 feet north-northeast, 2300 feet east-northeast, 1900 feet east, 1900 feet east-southeast, 1000 feet south-southeast, 2800 feet south-southwest, and 2900 feet southwest of the proposed compressor buildings. (See the attached plot plan drawing). There are no NSAs within one mile to the west of the proposed compressor buildings.

1.2 SOUND SURVEY MEASUREMENTS

Sound survey measurements were conducted at the property lines and NSAs on 5 February 2015. Daytime measurements were conducted between 10:00 AM and 2 PM and nighttime measurements were conducted between 10 PM and midnight. The weather conditions during the daytime measurements were a temperature of 26 degrees F decreasing to 22 degrees F, a relative humidity of 45% increasing to 60%, partly cloudy skies and light west winds (1 to 6 mph). During the nighttime measurements, the weather conditions were a temperature of 11 degrees F decreasing to 9 degrees F, a relative humidity of 50% decreasing to 45%, clear skies and calm winds.

Audible sources of daytime ambient sound were birds, aircraft, dogs barking, water flowing in creeks and roadside ditches, wind blowing through the trees, traffic on County Highways 35/10 and 35/7, and Hollick Run Road, water dripping off houses, the Dominion Transmission Inc. Lightburn Compressor Station, horses neighing at S7, and a cat meowing at S10. During the nighttime, audible ambient sound sources were aircraft, water flowing in creeks and roadside ditches, traffic on County Highways 35/10 and 35/7, and Hollick Run Road, and the Dominion Transmission, Inc. Lightburn Compressor Station.

At the property lines and NSAs, the measured daytime ambient L_{eq} sound levels ranged from 31.7 to 43.3 dBA. The measured nighttime ambient L_{eq} sound levels ranged from 30.6 to 44.1 dBA. The calculated ambient L_{dn} sound levels ranged from 37.5 to 50.0 dBA.

2.0 NOISE ANALYSIS OF PROPOSED MARTS COMPRESSOR STATION

The proposed Marts Compressor Station sound levels will be the sound levels from one Solar Titan Model 130S, one Solar Mars Model 100S, one Solar Taurus Model 70S, and one Solar Taurus Model 60S turbine compressor units and the measurement station with the noise control materials installed. Presented below are the predicted sound levels from the four proposed turbine compressor units and the measurement station, the noise control measures/specifications necessary to reduce the sound levels from the four proposed turbine compressor units and the measurement station, and the total sound levels predicted after the installation of the four proposed turbine compressor units and the measurement station.

2.1 PREDICTED SOUND LEVELS FROM PROPOSED MARTS COMPRESSOR STATION

The proposed Marts Compressor Station has been designed so that the continuous sound from one Solar Titan Model 130S, one Solar Mars Model 100S, one Taurus Model 70S, and one Taurus Model 60S turbine compressor units operating at full rated load and the measurement station will not exceed a day-night sound level (L_{dn}) of 55 dBA at the NSAs around the station. The predicted sound levels from the four proposed turbine compressor units are based upon sound level information provided by the turbine manufacturer (Solar Turbines Incorporated). Minimum dynamic insertion loss (DIL) requirements for the turbine exhaust mufflers, turbine air intake cleaners/silencers, and compressor building air handling unit, ventilation air inlet and ventilation air discharge mufflers have been specified. Included are specifications for the minimum sound transmission loss (STC) requirements for the wall and roof panels, and personnel doors of the two compressor buildings. Maximum sound levels for the air handling units, the wall air inlet fans and the lube oil coolers have been specified. Also, specified are the maximum sound power levels for the gas coolers. Insulation minimum insertion loss (IL) values have been specified for the noise control insulations to be used on the turbine exhaust pipes, the turbine air intake ducts, all aboveground compressor unit suction, discharge and bypass lines, and the gas cooler inlet and outlet headers and piping. The maximum sound pressure levels for the four ultrasonic meters are specified. Also, minimum requirements for the measurement building wall and roof panels, personnel doors, and ventilation air inlet acoustic louvers are included.

2.2 NOISE CONTROL MEASURES/SPECIFICATIONS FOR THE FOUR PROPOSED COMPRESSOR UNITS AND MEASUREMENT STATION

Implementation of the following noise control measures/specifications is necessary to ensure that the continuous sound from one Solar Titan Model 130S, one Solar Mars Model 100S, one Solar Taurus Model 70S, and one Solar Taurus Model 60S turbine compressor units and the measurement station will not exceed a day-night sound level (L_{dn}) of 55 dBA at the NSAs.

1. A muffler must be installed on the exhaust of the proposed Solar Titan Model 130S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Titan Model 130S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	24	31	41	49	46	42	33	24

2. A muffler must be installed on the exhaust of the proposed Solar Mars Model 100S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Mars Model 100S Turbine Exhaust Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	24	31	41	49	46	42	33	24

3. A muffler must be installed on the exhaust of the proposed Solar Taurus Model 70S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 70S Turbine Exhaust Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	22	29	41	51	46	39	32	25

4. A muffler must be installed on the exhaust of the proposed Solar Taurus Model 60S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 60S Turbine Exhaust Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	22	29	41	51	46	39	32	25

5. The exhaust pipes of the four proposed turbines must be acoustically insulated from the walls of the compressor buildings to the exhaust muffler inlet flanges (including expansion joints). This acoustic pipe insulation must have minimum Insertion Loss (IL) values as follows:

Turbine Exhaust Pipe Acoustic Insulation Minimum IL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	0	5	10	25	25	20

6. An air cleaner/silencer must be installed on the air intake of the proposed Solar Titan Model 130S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Titan Model 130S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	5	18	33	41	46	50	57	88	81

7. An air cleaner/silencer must be installed on the air intake of the proposed Solar Mars Model 100S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Mars Model 100S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	5	18	33	41	46	50	57	87	80

8. An air cleaner/silencer must be installed on the air intake of the proposed Solar Taurus Model 70S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 70S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	15	31	40	49	50	52	80	78

9. An air cleaner/silencer must be installed on the air intake of the proposed Solar Taurus Model 60S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 60S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	15	31	40	49	50	52	80	78

10. The intake ducts of the four proposed turbines must be acoustically insulated from the walls of the compressor buildings to the air intake cleaner outlet flanges (including expansion joints). This acoustic duct insulation must have minimum Insertion Loss (IL) values as follows:

Turbine Intake Duct Acoustic Insulation Minimum IL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	6	12	20	26	26	22

11. The wall and roof panels of the two proposed Marts Compressor Station compressor buildings must have a minimum Sound Transmission Class (STC) of 49 and a minimum Noise Reduction Coefficient (NRC) of 0.90. In addition, these panels must have minimum Sound Transmission Loss (TL) values as follows:

Compressor Building Wall and Roof Panel Minimum TL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	9	15	22	38	46	48	52	53	54

12. The personnel doors of the two proposed Marts Compressor Station compressor buildings must be insulated, metal doors with full weather-stripping. The STC rating of these doors must be a minimum of 38 as provided by CECO Medallion doors or equal. Any windows in these doors must be double glazed using minimum 1/4 inch thick safety glass or acrylic panels separated by a minimum 1/2 inch airspace.

13. The equipment doors of the two proposed Marts Compressor Station compressor buildings must be insulated, metal doors with full weather-stripping.

14. The two proposed Marts Compressor Station compressor buildings must have ventilation systems installed to provide adequate cooling of the buildings to allow full load operation of the four proposed turbine compressor units with all doors closed.

14A. The ventilation systems of the two compressor buildings can have a total of six air handling units. The maximum A-weighted sound level from each air handling unit must not exceed 70 dBA at 3 feet when measured outside of each air handling unit in all directions with maximum octave band sound pressure levels (SPL) as follows:

Air Handling Unit Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	92	89	79	71	64	60	55	54	54

14B. Ventilation air inlet mufflers must be located in the air paths between the air handing units and the compressor building wall penetrations to reduce the sound from the proposed turbine compressor units that escapes through these openings. Each air handling unit muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Air Handling Unit Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	4	12	20	23	42	48	45	38	21

14C. The ventilation systems of the two compressor buildings can have a total of eight wall air inlet fans. The maximum A-weighted sound level from each wall air inlet fan must not exceed 90 dBA at 3 feet when measured inside the compressor

buildings without the proposed turbine compressor units operating with maximum octave band sound pressure levels (SPL) as follows:

Wall Air Inlet Fan Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	99	97	95	90	86	84	82	80	77

14D. Ventilation air inlet mufflers must be located in the walls of the two proposed compressor buildings directly outside of the four wall air inlet fans to reduce the sound from the proposed turbine compressor units that escapes through these openings. Each air inlet muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Ventilation Air Inlet Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	4	12	20	23	42	48	45	38	21

14E. The ventilation systems of the two compressor buildings can have a total of twelve roof air discharge hoods with a maximum total area of 363 square feet. Ventilation air discharge mufflers must be located under each ventilation air discharge hood (but above the roof) to reduce the sound from the proposed turbine compressor units that escapes through these openings. Each air discharge muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Ventilation Air Discharge Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	9	17	25	39	46	45	40	25

15. The maximum noise from the lube oil cooler for each turbine compressor unit must not exceed an A-weighted sound level of 50 dBA at 50 feet from the centerline of the cooler with all fans running at maximum speed. Each lube oil cooler (including all fans, motors and drives) must have maximum octave band sound pressure levels (SPL) as follows:

Lube Oil Cooler Maximum SPL at 50 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	54	61	58	51	46	43	39	35	30

16. The maximum noise from the gas cooler for each turbine compressor unit must not exceed an A-weighted sound power level of 87 dBA with all fans running at maximum speed. Each gas cooler (including all fans, motors and drives) must have maximum octave band sound power levels (PWL) as follows:

Compressor Unit Gas Cooler Maximum PWL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	92	93	92	89	84	82	76	70	64

17. All aboveground sections of the unit suction, discharge and bypass lines, and the gas cooler inlet and outlet headers and piping (including the metal pipe supports) of the four proposed turbine compressor units must be acoustically insulated. This acoustic pipe insulation must have minimum Insertion Loss (IL) values as follows:

Piping Acoustic Insulation Minimum IL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	6	12	20	26	26	22

18. The maximum A-weighted sound level from each silenced unit blowdown vent must not exceed 60 dBA at 50 feet.

19. The maximum noise from each ultrasonic meter must not exceed an A-weighted sound level of 80 dBA at 3 feet with maximum octave band sound pressure levels (PWL) as follows:

Ultrasonic Meter Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	70	72	74	75	75	74	73	72	70

20. The wall and roof panels of the measurement building must have a minimum Sound Transmission Class (STC) of 29 and a minimum Noise Reduction Coefficient (NRC) of 0.90. In addition, these panels must have minimum Sound Transmission Loss (TL) values as follows:

Measurement Building Wall and Roof Panel Minimum TL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	2	8	13	18	23	31	38	40	40

21. The doors for the measurement building must be insulated, metal doors with full weather-stripping. Any windows in these doors must be double glazed using minimum 1/4 inch thick glass or acrylic panels separated by a minimum 1/2 inch airspace.

22. Ventilation air inlet acoustic louvers must be located in the walls of the measurement building to reduce the sound from the four ultrasonic meters that escapes through these openings. Each acoustic louver must have minimum Sound Transmission Loss (TL) values as follows:

Ventilation Air Inlet Acoustic Louver Minimum TL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	1	3	4	5	6	7	9	11	12

Model MFLA-4-16 acoustical louvers manufactured by Commercial Acoustics meet these specified minimum octave band TL values.

23. The measurement building can have a maximum 12 inch wide ridge vent.

2.4 PREDICTED MARTS COMPRESSOR STATION SOUND LEVELS

The octave band sound pressure levels and A-weighted sound levels predicted at the nearest NSA (S8) approximately 1000 feet south-southeast of the four proposed turbine compressor units are shown in Table 1.0. Sheets 1 through 5 of this table present the calculations that predict the sound levels from the proposed Solar Titan Model 130S, Solar Mars Model 100S, Solar Taurus Model 70S, and Solar Taurus Model 60S turbine compressor units and the measurement station at this NSA. Detailed line item descriptions are presented on Sheets 6 through 14 of this table. The attached noise control analysis indicates a predicted continuous L_{eq} sound level of 40 dBA at the nearest NSA with a corresponding L_{dn} sound level of 46.4 dBA. At the NSAs approximately 1800 to 3600 feet from the four proposed turbine compressor units, the L_{eq} sound levels from are predicted to range from 25 to 34 dBA, with corresponding L_{dn} sound levels ranging from 31.4 to 40.4 dBA. The predicted L_{dn} sound levels from the four proposed turbine compressor units and the measurement station at the Marts Compressor Station are below 55 dBA at all NSAs around the site.

Table 2.0 presents the sound levels at the NSAs around the site of the proposed station. Shown are:

- the ambient L_d, L_n and L_{dn} sound levels,
- the predicted L_{dn} sound levels from the proposed Solar Titan Model 130S, Solar Mars Model 100S, Solar Taurus Model 70S, and Solar Taurus Model 60S turbine compressor units and the measurement station,

- the predicted total L_{dn} sound levels resulting from summing the L_{dn} sound levels from the proposed Solar Titan Model 130S, Solar Mars Model 100S, Solar Taurus Model 70S, and Solar Taurus Model 60S turbine compressor units and the measurement station with the ambient L_{dn} sound levels, and
- the predicted increase in the ambient L_{dn} sound levels due to the proposed Solar Titan Model 130S, Solar Mars Model 100S, Solar Taurus Model 70S, and Solar Taurus Model 60S turbine compressor units and the measurement station.

At the NSAs, the predicted total L_{dn} sound levels range from 39.2 to 50.4 dBA. These total L_{dn} sound levels are below 55 dBA at all NSAs around the site.

Sincerely yours,
ENVIRONMENTAL NOISE CONTROL

William E. Biker
Principal Engineer
Noise and Vibration Control

TABLE 1.0 Sheet 1 of 14

MARTS COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR
ONE (1) SOLAR TITAN MODEL 130S, ONE (1) SOLAR MARS MODEL 100S,
ONE (1) SOLAR TAURUS MODEL 70S, AND ONE (1) SOLAR TAURUS MODEL 60S
TURBINE COMPRESSOR UNITS AND THE MEASUREMENT STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
1. SPL	92	96	94	97	101	96	88	78	68
2. + DT	32	32	32	32	32	32	32	32	32
3. = PWL	124	128	126	129	133	128	120	110	100
4. – DIL	13	24	31	41	49	46	42	33	24
5. = PWL	111	104	95	88	84	82	78	77	76
6. SPL	82	88	94	95	96	98	101	131	123
7. + DT	32	32	32	32	32	32	32	32	32
8. = PWL	114	120	126	127	128	130	133	163	155
9. – DIL	5	18	33	41	46	50	57	88	81
10. = PWL	109	102	93	86	82	80	76	75	74
11. SPL	82	81	89	86	83	79	80	92	85
12. + DT	32	32	32	32	32	32	32	32	32
13. = PWL	114	113	121	118	115	111	112	124	117
14. – TL	9	15	22	35	41	41	42	42	42
15. = PWL	105	98	99	83	74	70	70	82	75
16. SPL	91	95	93	96	100	95	87	77	67
17. + DT	32	32	32	32	32	32	32	32	32
18. = PWL	123	127	125	128	132	127	119	109	99
19. – DIL	13	24	31	41	49	46	42	33	24
20. = PWL	110	103	94	87	83	81	77	76	75
21. SPL	81	87	93	94	95	97	100	129	121
22. + DT	32	32	32	32	32	32	32	32	32
23. = PWL	113	119	125	126	127	129	132	161	153
24. – DIL	5	18	33	41	46	50	57	87	80
25. = PWL	108	101	92	85	81	79	75	74	73

TABLE 1.0 (cont.) Sheet 2 of 14

MARTS COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR
ONE (1) SOLAR TITAN MODEL 130S, ONE (1) SOLAR MARS MODEL 100S,
ONE (1) SOLAR TAURUS MODEL 70S, AND ONE (1) SOLAR TAURUS MODEL 60S
TURBINE COMPRESSOR UNITS AND THE MEASUREMENT STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
26. SPL	75	74	80	80	83	81	90	88	83
27. + DT	32	32	32	32	32	32	32	32	32
28. = PWL	107	106	112	112	115	113	122	120	115
29. – TL	9	15	22	35	41	41	42	42	42
30. = PWL	98	91	90	77	74	72	80	78	73
31. SPL	91	94	91	95	97	93	87	80	67
32. + DT	32	32	32	32	32	32	32	32	32
33. = PWL	123	126	123	127	129	125	119	112	99
34. – DIL	13	22	29	41	51	46	39	32	25
35. = PWL	110	104	94	86	78	79	80	80	74
36. SPL	79	85	91	92	93	95	98	126	118
37. + DT	32	32	32	32	32	32	32	32	32
38. = PWL	111	117	123	124	125	127	130	158	150
39. – DIL	3	15	31	40	49	50	52	80	78
40. = PWL	108	102	92	84	76	77	78	78	72
41. SPL	82	82	85	87	87	82	90	88	83
42. + DT	32	32	32	32	32	32	32	32	32
43. = PWL	114	114	117	119	119	114	122	120	115
44. – TL	9	15	22	35	41	41	42	42	42
45. = PWL	105	99	95	84	78	73	80	78	73
46. SPL	88	91	88	91	95	87	80	72	64
47. + DT	32	32	32	32	32	32	32	32	32
48. = PWL	120	123	120	123	127	119	112	104	96
49. – DIL	13	22	29	41	51	46	39	32	25
50. = PWL	107	101	91	82	76	73	73	72	71

TABLE 1.0 (cont.) Sheet 3 of 14

MARTS COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR
ONE (1) SOLAR TITAN MODEL 130S, ONE (1) SOLAR MARS MODEL 100S,
ONE (1) SOLAR TAURUS MODEL 70S, AND ONE (1) SOLAR TAURUS MODEL 60S
TURBINE COMPRESSOR UNITS AND THE MEASUREMENT STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
51. SPL	76	82	88	89	90	92	95	120	112
52. + DT	32	32	32	32	32	32	32	32	32
53. = PWL	108	114	120	121	122	124	127	152	144
54. – DIL	3	15	31	40	49	50	52	80	78
55. = PWL	105	99	89	81	73	74	75	72	66
56. SPL	81	81	84	86	86	81	79	78	79
57. + DT	32	32	32	32	32	32	32	32	32
58. = PWL	113	113	116	118	118	113	111	110	111
59. – TL	9	15	22	35	41	41	42	42	42
60. = PWL	104	98	94	83	77	72	69	68	69
61. SPL	92	89	79	71	64	60	55	54	54
62. + DT	8	8	8	8	8	8	8	8	8
63. = PWL	100	97	87	79	72	68	63	62	62
64. + NF	8	8	8	8	8	8	8	8	8
65. = PWL	108	105	95	87	80	76	71	70	70
66. SPL	108	108	107	108	111	104	108	109	103
67. + AT	7	7	7	7	7	7	7	7	7
68. = PWL	115	115	114	115	118	111	115	116	110
69. – DIL	4	12	20	23	42	48	45	38	21
70. = PWL	111	103	94	92	76	63	70	78	89
71. SPL	99	97	95	90	86	84	82	80	77
72. + DT	8	8	8	8	8	8	8	8	8
73. = PWL	107	105	103	98	94	92	90	88	85
74. + NF	9	9	9	9	9	9	9	9	9
75. = PWL	116	114	112	107	103	101	99	97	94

TABLE 1.0 (cont.) Sheet 4 of 14

MARTS COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR
ONE (1) SOLAR TITAN MODEL 130S, ONE (1) SOLAR MARS MODEL 100S,
ONE (1) SOLAR TAURUS MODEL 70S, AND ONE (1) SOLAR TAURUS MODEL 60S
TURBINE COMPRESSOR UNITS AND THE MEASUREMENT STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
76. – DIL	4	12	20	23	42	48	45	38	21
77. = PWL	112	102	92	84	61	53	54	59	73
78. SPL	108	108	107	108	111	104	108	109	103
79. + AT	11	11	11	11	11	11	11	11	11
80. = PWL	119	119	118	119	122	115	119	120	114
81. – DIL	4	12	20	23	42	48	45	38	21
82. = PWL	115	107	98	96	80	67	74	82	93
83. SPL	106	104	102	102	105	98	102	104	98
84. + AT	16	16	16	16	16	16	16	16	16
85. = PWL	122	120	118	118	121	114	118	120	114
86. – DIL	3	9	17	25	39	46	45	40	25
87. = PWL	119	111	101	93	82	68	73	80	89
88. SPL	54	61	58	51	46	43	39	35	30
89. + DT	32	32	32	32	32	32	32	32	32
90. = PWL	86	93	90	83	78	75	71	67	62
91. + NF	6	6	6	6	6	6	6	6	6
92. = PWL	92	99	96	89	84	81	77	73	68
93. PWL	92	93	92	89	84	82	76	70	64
94. + NF	6	6	6	6	6	6	6	6	6
95. = PWL	98	99	98	95	90	88	82	76	70
96. PWL	123	116	108	102	94	92	90	90	96
97. + DT	58	58	59	59	60	61	63	69	76
98. = SPL	65	58	49	43	34	31	27	21	20

TABLE 1.0 (cont.) Sheet 5 of 14

MARTS COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR
ONE (1) SOLAR TITAN MODEL 130S, ONE (1) SOLAR MARS MODEL 100S,
ONE (1) SOLAR TAURUS MODEL 70S, AND ONE (1) SOLAR TAURUS MODEL 60S
TURBINE COMPRESSOR UNITS AND THE MEASUREMENT STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
99. SPL	70	72	74	75	75	74	73	72	70
100. + DT	8	8	8	8	8	8	8	8	8
101. = PWL	78	80	82	83	83	82	81	80	78
102. + NF	6	6	6	6	6	6	6	6	6
103. = PWL	84	86	88	89	89	88	87	86	84
104. – TL	2	8	12	16	19	21	22	23	23
105. = PWL	82	78	76	73	70	67	65	63	61
106. – DT	57	57	58	58	59	60	62	68	75
107. = SPL	25	21	18	15	11	7	3	–5	–14
108. = SPL 40 dBA	65	58	49	43	34	31	27	21	20
109. L_{dn} 46.4 dBA									

* Detailed Line Item Descriptions are listed on Sheets 6 through 14.

TABLE 1.0 (cont.) Sheet 6 of 14

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

1. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Titan Model 130S turbine. These data were supplied by Solar Turbines Incorporated.

2. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Titan Model 130S turbine.

3. Unmuffled exhaust PWL of one (1) Solar Titan Model 130S turbine.

4. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Titan Model 130S turbine (Noise Control Measure/Specification No. 1).

5. Muffled exhaust PWL of one (1) Solar Titan Model 130S turbine; result of lines 1 through 4.

6. Unmuffled intake SPL at 50 feet of one (1) Solar Titan Model 130S turbine. These data were supplied by Solar Turbines Incorporated.

7. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Titan Model 130S turbine.

8. Unmuffled intake PWL of one (1) Solar Titan Model 130S turbine.

9. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Titan Model 130S turbine (Noise Control Measure/Specification No. 6).

10. Muffled intake PWL of one (1) Solar Titan Model 130S turbine; result of lines 6 through 9.

11. Casing SPL at 50 feet of one (1) Solar Titan Model 130S turbine. These data were supplied by Solar Turbines Incorporated.

12. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Titan Model 130S turbine.

13. Casing PWL of one (1) Solar Titan Model 130S turbine.

TABLE 1.0 (cont.)

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

14. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

15. PWL of compressor building radiated casing noise from one (1) Solar Titan Model 130S turbine; result of lines 11 through 14.

16. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Mars Model 100S turbine. These data were supplied by Solar Turbines Incorporated.

17. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Mars Model 100S turbine.

18. Unmuffled exhaust PWL of one (1) Solar Mars Model 100S turbine.

19. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Mars Model 100S turbine (Noise Control Measure/Specification No. 2).

20. Muffled exhaust PWL of one (1) Solar Mars Model 100S turbine; result of lines 16 through 19.

21. Unmuffled intake SPL at 50 feet of one (1) Solar Mars Model 100S turbine. These data were supplied by Solar Turbines Incorporated.

22. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Mars Model 100S turbine.

23. Unmuffled intake PWL of one (1) Solar Mars Model 100S turbine.

24. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Mars Model 100S turbine (Noise Control Measure/Specification No. 7).

25. Muffled intake PWL of one (1) Solar Mars Model 100S turbine; result of lines 21 through 24.

26. Casing SPL at 50 feet of one (1) Solar Mars Model 100S turbine. These data were supplied by Solar Turbines Incorporated.

TABLE 1.0 (cont.)

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

27. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Mars Model 100S turbine.

28. Casing PWL of one (1) Solar Mars Model 100S turbine.

29. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

30. PWL of compressor building radiated casing noise from one (1) Solar Mars Model 100S turbine; result of lines 26 through 29.

31. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

32. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Taurus Model 70S turbine.

33. Unmuffled exhaust PWL of one (1) Solar Taurus Model 70S turbine.

34. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Taurus Model 70S turbine (Noise Control Measure/Specification No. 3).

35. Muffled exhaust PWL of one (1) Solar Taurus Model 70S turbine; result of lines 31 through 34.

36. Unmuffled intake SPL at 50 feet of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

37. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Taurus Model 70S turbine.

38. Unmuffled intake PWL of one (1) Solar Taurus Model 70S turbine.

39. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Taurus Model 70S turbine (Noise Control Measure/Specification No. 8).

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

40. Muffled intake PWL of one (1) Solar Taurus Model 70S turbine; result of lines 36 through 39.

41. Casing SPL at 50 feet of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

42. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Taurus Model 70S turbine.

43. Casing PWL of one (1) Solar Taurus Model 70S turbine.

44. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

45. PWL of compressor building radiated casing noise from one (1) Solar Taurus Model 70S turbine; result of lines 41 through 44.

46. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Taurus Model 60S turbine. These data were supplied by Solar Turbines Incorporated.

47. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Taurus Model 60S turbine.

48. Unmuffled exhaust PWL of one (1) Solar Taurus Model 60S turbine.

49. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Taurus Model 60S turbine (Noise Control Measure/Specification No. 4).

50. Muffled exhaust PWL of one (1) Solar Taurus Model 60S turbine; result of lines 46 through 49.

51. Unmuffled intake SPL at 50 feet of one (1) Solar Taurus Model 60S turbine. These data were supplied by Solar Turbines Incorporated.

52. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Taurus Model 60S turbine.

TABLE 1.0 (cont.)

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

53. Unmuffled intake PWL of one (1) Solar Taurus Model 60S turbine.

54. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Taurus Model 60S turbine (Noise Control Measure/Specification No. 9).

55. Muffled intake PWL of one (1) Solar Taurus Model 60S turbine; result of lines 51 through 54.

56. Casing SPL at 50 feet of one (1) Solar Taurus Model 60S turbine. These data were supplied by Solar Turbines Incorporated.

57. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Taurus Model 60S turbine.

58. Casing PWL of one (1) Solar Taurus Model 60S turbine.

59. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

60. PWL of compressor building radiated casing noise from one (1) Solar Taurus Model 60S turbine; result of lines 56 through 59.

61. Specified maximum SPL at three (3) feet for one (1) air handling unit (Noise Control Measure/Specification No. 14A).

62. Distance Term (DT) to convert maximum air handling unit SPL at three (3) feet to PWL.

63. PWL of one (1) air handling unit.

64. Number Factor (NF) to account for six (6) air handling units.

65. PWL of six (6) air handling units; result of lines 61 through 64.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

66. SPL calculated at the walls of the two compressor buildings with one (1) Solar Titan Model 130S turbine, one (1) Solar Mars Model 100S turbine, one (1) Solar Taurus Model 70S turbine, and one (1) Solar Taurus Model 60S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the building walls.

67. Conversion of SPL in line 66 to represent PWL of turbine casing noise at the six (6) air handling unit penetrations in the compressor building walls.

68. PWL of the turbine casing noise at the six (6) air handling unit penetrations in the compressor building walls.

69. Specified Dynamic Insertion Loss (DIL) of each air handling unit muffler (Noise Control Measure/Specification No. 14B).

70. PWL of the turbine casing noise at the six (6) air handling unit penetrations in the compressor building walls with mufflers; result of lines 66 through 69.

71. Specified maximum SPL for one (1) wall air inlet fan at 3 feet (Noise Control Measure/Specification No. 14C).

72. Distance Term (DT) to convert maximum wall air inlet fan SPL at 3 feet to PWL.

73. PWL of one (1) wall air inlet fan.

74. Number Factor (NF) to account for eight (8) wall air inlet fans.

75. PWL of eight (8) wall air inlet fans.

76. Specified Dynamic Insertion Loss (DIL) of each ventilation air inlet muffler (Noise Control Measure/Specification No. 14D).

77. PWL of eight (8) wall air inlet fans in the compressor building walls with mufflers; result of lines 71 through 76.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

78. SPL calculated at the walls of the two compressor buildings with one (1) Solar Titan Model 130S turbine, one (1) Solar Mars Model 100S turbine, one (1) Solar Taurus Model 70S turbine, and one (1) Solar Taurus Model 60S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the building walls.

79. Conversion of SPL in line 78 to represent PWL of turbine casing noise at the eight (8) wall air inlet fan openings in the compressor building walls.

80. PWL of the turbine casing noise at the eight (8) wall air inlet fan openings in the compressor building walls.

81. Specified Dynamic Insertion Loss (DIL) of each ventilation air inlet muffler (Noise Control Measure/Specification No. 14D).

82. PWL of the turbine casing noise at the eight (8) wall air inlet fan openings in the compressor building walls with mufflers; result of lines 78 through 81.

83. SPL calculated under the roofs of the compressor building with one (1) Solar Titan Model 130S turbine, one (1) Solar Mars Model 100S turbine, one (1) Solar Taurus Model 70S turbine, and one (1) Solar Taurus Model 60S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the roofs of the two compressor buildings.

84. Conversion of SPL in line 83 to represent PWL of turbine casing noise at twelve (12) roof air discharge openings in the roofs of the two compressor buildings.

85. PWL of the turbine casing noise at twelve (12) roof air discharge openings in the roofs of the two compressor buildings.

86. Specified Dynamic Insertion Loss (DIL) of each ventilation air discharge muffler (Noise Control Measure/Specification No. 14E).

87. PWL of the turbine casing noise at twelve (12) roof air discharge openings in the roofs of the two compressor buildings with mufflers; result of lines 83 through 86.

88. Specified maximum SPL at 50 feet from one (1) lube oil cooler with the fan(s) running at maximum speed (Noise Control Measure/Specification No. 15).

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

89. Distance Term (DT) to convert maximum lube oil cooler SPL at 50 feet to PWL.

90. PWL of one (1) lube oil cooler with the fan(s) running at maximum speed.

91. Number Factor for four (4) lube oil coolers.

92. PWL of four (4) lube oil coolers with the fan(s) running at maximum speed; result of lines 88 through 91.

93. Specified maximum PWL of one (1) gas cooler with the fan(s) running at maximum speed (Noise Control Measure/Specification No. 16).

94. Number Factor for four (4) gas coolers.

95. PWL of four (4) gas coolers with the fan(s) running at full speed; result of lines 93 and 94.

96. Total PWL of one (1) Solar Titan Model 130S, one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, and one (1) Solar Taurus Model 60S turbine compressor units; logarithmic sum of lines 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 77, 82, 87, 92, and 95.

97. Distance Term (DT) to convert total PWL to SPL at the nearest NSA (S8) 1000 feet south-southeast of one (1) Solar Titan Model 130S, one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, and one (1) Solar Taurus Model 60S turbine compressor units.

98. Energy equivalent sound level (L_{eq}) at the nearest NSA (S8) 1000 feet south-southeast of one (1) Solar Titan Model 130S, one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, and one (1) Solar Taurus Model 60S turbine compressor units in the two compressor buildings at the Marts Compressor Station; result of lines 96 and 97.

99. Specified maximum SPL at 3 feet from one (1) ultrasonic meter (Noise Control Measure/ Specification No.19).

100. Distance Term (DT) to convert maximum ultrasonic meter SPL at 3 feet to PWL.

101. PWL of one (1) ultrasonic meter.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

102. Number Factor for four (4) ultrasonic meters.

103. PWL of four (4) ultrasonic meters.

104. Composite sound transmission loss (TL) of the measurement building using the specified STC 29 wall and roof panels, the specified doors, the specified ventilation air inlet acoustic louvers and the specified ridge vent (Noise Control Measures/Specifications Nos. 20, 21, 22, and 23).

105. PWL of the four (4) ultrasonic meters in the measurement building; result of lines 99 through 104.

106. Distance Term (DT) to convert PWL of the four (4) ultrasonic meters in the measurement building to SPL at the nearest NSA (S8) 950 feet east-southeast of the four (4) ultrasonic meters in the measurement building.

107. Energy equivalent sound level (L_{eq}) of the four (4) ultrasonic meters in the measurement building at the nearest NSAs (S8) 950 feet east-southeast of the measurement building at the Marts Compressor Station; result of lines 105 and 106.

108. Energy equivalent sound level (L_{eq}) at the nearest NSA (S8) from one (1) Solar Titan Model 130S, one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, and one (1) Solar Taurus Model 60S turbine compressor units in the two compressor buildings and four (4) ultrasonic meters in the measurement building: sum of lines 98 and 107.

109. Day-night sound level (L_{dn}) at the nearest NSA (S8) of one (1) Solar Titan Model 130S, one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, and one (1) Solar Taurus Model 60S turbine compressor units in the two compressor buildings and four (4) ultrasonic meters in the measurement building at the Marts Compressor Station.

TABLE 2.0 Sheet 1 of 2

NOISE QUALITY ANALYSIS FOR THE MARTS COMPRESSOR STATION

Ambient Sound Levels, Predicted Sound Levels from the Four Proposed Turbine Compressor Units and Measurement Station, and Predicted Total Sound Levels

A-Weighted Sound Levels in dBA re 20 microPa

Location/ Description	Distance/ Direction	Existing (1) $L_{eq}(d)$	$L_{eq}(n)$	L_{dn}	Predicted L_{dn} (2)	Total L_{dn} (3)	Noise (4) Increase
P1. Prop Line	2000 ft N	41.3	30.6	41.1	38.4	42.9	1.8
P2. Prop Line	1500 ft E	39.3	34.6	42.1	42.4	45.3	3.2
P3. Prop Line	950 ft SE	35.1	32.7	39.5	47.4	48.1	8.6
S1. Residence	3600 ft NNW	40.0	31.3	40.5	31.4	41.0	0.5
S2. Residence	3000 ft NNW	32.4	30.8	37.5	34.4	39.2	1.7
S3. Residence	1800 ft N	38.2	31.3	39.6	40.4	43.0	3.4
S4. Residence	2000 ft NNE	38.6	32.8	40.7	38.4	42.7	2.0
S5. Residence	2300 ft ENE	43.3	32.9	43.2	37.4	44.2	1.0
S6. Residence	1900 ft E	38.4	33.6	41.1	39.4	43.3	2.2
S7. Residence	1900 ft ESE	37.9	44.1	50.0	39.4	50.4	0.4
S8. Residence	1000 ft SSE	36.6	30.7	38.6	46.4	47.1	8.5
S9. Residence	2800 ft SSW	36.4	31.0	38.7	35.4	40.4	1.7
S10. Residence	2900 ft SW	31.7	31.5	37.9	35.4	39.9	2.0

TABLE 2.0 (cont.) Sheet 2 of 2

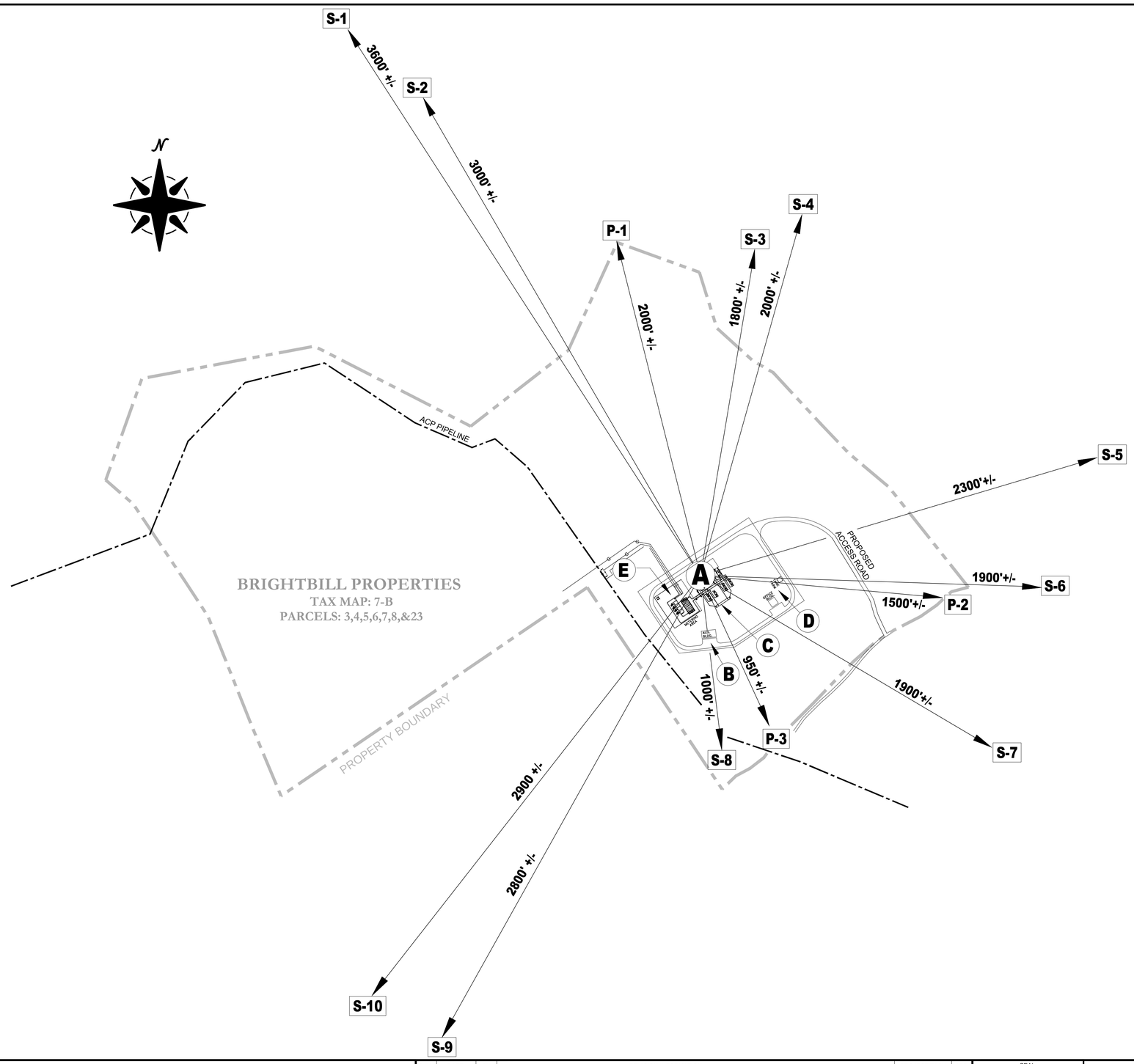
NOISE QUALITY ANALYSIS FOR THE MARTS COMPRESSOR STATION

(1) Ambient daytime and nighttime L_{eq} sound levels measured on 5 January 2015, and calculated ambient L_{dn} sound levels. These ambient sound levels were due to birds, aircraft, dogs barking, water flowing in creeks and roadside ditches, wind blowing through the trees, traffic on County Highways 35/10 and 35/7 and Hollick Run Road, water dripping off houses, the Dominion Transmission Inc. Lightburn Compressor Station, horses neighing at S7, and a cat meowing at S10.

(2) Predicted L_{dn} sound levels from the four proposed Marts Compressor Station turbine compressor units and the measurement station with Noise Control Measures/Specifications Nos. 1 through 23 installed.

(3) Predicted total $L_{dn} = 10 \log (10^{(\text{Ambient } L_{dn}/10)} + 10^{(\text{Predicted } L_{dn}/10)})$.

(4) Predicted increase of the ambient L_{dn} sound levels due to the four proposed Marts Compressor Station turbine compressor units and the measurement station with Noise Control Measures/Specifications Nos. 1 through 23 installed.



LEGEND:

A - COMPRESSOR BUILDINGS
B - AUXILIARY BUILDING
C - GAS COOLERS
D - TANK FARM
E - METERING AREA

P-1	NORTH PROPERTY LINE
P-2	EAST PROPERTY LINE
P-3	SOUTH EAST PROPERTY LINE
S-1	RESIDENCE
S-2	RESIDENCE
S-3	RESIDENCE
S-4	RESIDENCE
S-5	RESIDENCE
S-6	RESIDENCE
S-7	RESIDENCE
S-8	RESIDENCE
S-9	RESIDENCE
S-10	RESIDENCE

GENERAL NOTES AND COMMENTS:

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
C	6/2/15	RRC	REVISED PER CLIENTS COMMENTS		
B	2/9/15	RLR	UPDATE RESIDENCE LOCATIONS		
A	1/15/15	RRC	ISSUED FOR REVIEW		

SEAL

ORIGINAL CONSTRUCTION INFORMATION

PROJECT/TASK:		
DRAWN:	RRC	1/15/15
CHECKED:	DLM	1/15/15
APP. FOR BID:		
APP. FOR CONST.:		
SCALE:	1"=300'	

Atlantic Coast Pipeline, LLC.

445 West Main St. Clarksburg, West Virginia 26301 / Phone: (304) 623-8000

FOR: MARTS COMPRESSOR STATION

TITLE: SOUND STUDY PLOT PLAN

TOWN:	JANE LEW	COUNTY:	LEWIS, WV	GROUP	DWG. NO.	REV.
DIR/FILE:	ACP/SSDwgs/CS1 Sound Study			PD	2079C	C

ENVIRONMENTAL NOISE CONTROL
260 Arbor Street
Lunenburg, MA 01462-1458
(978) 582-9204
Fax (978) 582-7102

11 June 2015

Dominion Transmission, Inc.
445 West Main Street
PO Box 2450
Clarksburg, West Virginia 26302-2450

Attention: Mr. Jay C. Riley

Subject: ENC Report No. 536:
Ambient Sound Survey and Noise Analysis for Installation of Four Turbine Compressor Units and a Measurement and Regulation Station at the Proposed Buckingham Compressor Station for the Atlantic Coast Pipeline Project
ENC Project No. 15-02

Dear Mr. Riley:

Environmental Noise Control (ENC) has conducted an ambient sound survey and a noise analysis of the sound levels due to the installation of one Solar Mars Model 100S, one Solar Taurus Model 70S, one Solar Taurus Model 60S, and one Solar Centaur Model 50S turbine compressor units and a Measurement and Regulation (M&R) station at the proposed Buckingham Compressor Station for the Atlantic Coast Pipeline Project.

1.0 PURPOSE

The purpose of the property line and noise sensitive area (NSA) sound survey was to document the existing ambient sound levels for the environmental report to be submitted for the installation of one Solar Mars Model 100S, one Taurus Model 70S, one Solar Taurus Model 60S, and one Solar Centaur Model 50S turbine compressor units and a M&R station at the proposed Buckingham Compressor Station. Presented below are descriptions of the proposed Buckingham Compressor Station site, the sound survey measurement locations, and the measured ambient sound levels.

1.1 SITE DESCRIPTION

The site of the proposed Buckingham Compressor Station is located north of Route 56/South James River Road in the Town of Wingina, Buckingham County, Virginia. It is planned that the four proposed turbine compressor units will be located in two acoustically insulated compressor buildings with two compressor units in each compressor building. Three ultrasonic meters and two regulator valves will be located in an acoustically insulated M&R building approximately 400 feet

northeast of the compressor buildings. Two gas heaters will be located outside near the M&R building.

The land uses surrounding the proposed site are residential, agricultural and forested areas. The nearest NSAs are residences approximately 1450, 1800, and 2700 feet west-northwest, 1900 feet north-northwest, 3600 feet east-northeast, 3000 and 3100 feet east-southeast, and 2000 and 2100 feet southeast of the two proposed compressor buildings (See the attached plot plan drawing). There are no NSAs within one mile west, southwest or south of the proposed compressor buildings.

1.2 SOUND SURVEY MEASUREMENTS

Sound survey measurements were conducted at the property lines and NSAs on 21 April 2015. Daytime measurements were conducted between 11AM and 1:30 PM and nighttime measurements were conducted between 10 PM and midnight. The weather conditions during the daytime measurements were a temperature of 62 degrees F increasing to 68 degrees F, a relative humidity of 40% decreasing to 30%, clear skies and northwest winds (5 to 9 mph decreasing to 0 to 3 mph). During the nighttime measurements, the weather conditions were a temperature of 65 degrees F decreasing to 55 degrees F, a relative humidity of 50% increasing to 55%, clear skies and calm winds.

Audible sources of daytime ambient sound were wind blowing through the trees, dogs barking, local traffic, birds, insects and airplanes. During the nighttime, audible ambient sound sources were spring peepers, local traffic, dogs barking, airplanes, and whippoorwills.

A resident at NSAs S8 and S9 would not allow measurements to be taken near the properties, so the measured sound levels at the property line location in this direction P3 have been used at these two NSAs. At the property lines and NSAs, the measured daytime ambient L_{eq} sound levels ranged from 39.7 to 47.9 dBA. The measured nighttime ambient L_{eq} sound levels ranged from 25.3 to 35.9 dBA. The calculated ambient L_{dn} sound levels ranged from 39.4 to 46.1 dBA.

2.0 NOISE ANALYSIS OF PROPOSED BUCKINGHAM COMPRESSOR STATION

The proposed Buckingham Compressor Station sound levels will be the sound levels from one Solar Mars Model 100S, one Solar Taurus Model 70S, one Solar Taurus Model 60S, and one Solar Centaur Model 50S turbine compressor units and the M&R station with the noise control materials installed. Presented below are the predicted sound levels from the four proposed turbine compressor units and the M&R station, the noise control measures/specifications necessary to reduce the sound levels from the four proposed compressor units and the M&R station, and the total sound levels predicted after the installation of the four proposed compressor units and the M&R station.

2.1 PREDICTED SOUND LEVELS FROM PROPOSED BUCKINGHAM COMPRESSOR STATION

The proposed Buckingham Compressor Station has been designed so that the continuous sound from one Solar Mars Model 100S, one Solar Taurus Model 70S, one Solar Taurus Model 60S and

one Solar Centaur Model 50S turbine compressor units operating at full rated load and the M&R station will not exceed a day-night sound level (L_{dn}) of 55 dBA at the NSAs around the station. The predicted sound levels from the four proposed turbine compressor units are based upon sound level information provided by the turbine manufacturer (Solar Turbines Incorporated). Minimum dynamic insertion loss (DIL) requirements for the turbine exhaust muffler, turbine air intake cleaners/silencers, and compressor building air handling unit, ventilation air inlet and ventilation air discharge mufflers have been specified. Included are specifications for the minimum sound transmission loss (STC) requirements for the wall and roof panels, and personnel doors of the two compressor buildings. Maximum sound levels for the air handling units, the wall air inlet fans and the lube oil cooler have been specified. Also, specified are the maximum sound power levels for the gas coolers. Insulation minimum insertion loss (IL) values have been specified for the noise control insulations to be used on the turbine exhaust pipes, the turbine air intake ducts, all aboveground compressor unit suction, discharge and bypass lines, and the gas cooler inlet and outlet headers and piping. The maximum sound pressure levels for the three ultrasonic meters, the two operating regulator valves, and the two gas heaters are specified. Also, minimum requirements for the M&R building wall and roof panels, personnel doors, and ventilation air inlet acoustic louvers are included.

2.2 NOISE CONTROL MEASURES/SPECIFICATIONS FOR THE FOUR PROPOSED COMPRESSOR UNITS AND M&R STATION

Implementation of the following noise control measures/specifications is necessary to ensure that the continuous sound from one Solar Mars Model 100S, one Solar Taurus Model 70S, one Solar Taurus Model 60S, and one Solar Centaur Model 50S turbine compressor units and the M&R station will not exceed a day-night sound level (L_{dn}) of 55 dBA at the NSAs.

1. A muffler must be installed on the exhaust of the proposed Solar Mars Model 100S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Mars Model 100S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	24	31	41	49	46	42	33	24

2. A muffler must be installed on the exhaust of the proposed Solar Taurus Model 70S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 70S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	22	29	41	51	46	39	32	25

3. A muffler must be installed on the exhaust of the proposed Solar Taurus Model 60S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 60S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	22	29	41	51	46	39	32	25

4. A muffler must be installed on the exhaust of the proposed Solar Centaur Model 50S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Centaur Model 50S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	11	19	27	35	48	44	39	28	21

5. The exhaust pipes of the four proposed turbines must be acoustically insulated from the walls of the compressor buildings to the exhaust muffler inlet flanges (including expansion joints). This acoustic pipe insulation must have minimum Insertion Loss (IL) values as follows:

Turbine Exhaust Pipe Acoustic Insulation Minimum IL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	0	5	10	25	25	20

6. An air cleaner/silencer must be installed on the air intake of the proposed Solar Mars Model 100S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Mars Model 100S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	5	18	33	41	46	50	57	87	80

7. An air cleaner/silencer must be installed on the air intake of the proposed Solar Taurus Model 70S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 70S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	15	31	40	49	50	52	80	78

8. An air cleaner/silencer must be installed on the air intake of the proposed Solar Taurus Model 60S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 60S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	15	31	40	49	50	52	80	78

9. An air cleaner/silencer must be installed on the air intake of the proposed Solar Centaur Model 50S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Centaur Model 50S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	2	14	28	38	45	49	53	78	72

10. The intake ducts of the four proposed turbines must be acoustically insulated from the walls of the compressor buildings to the air intake cleaner outlet flanges (including expansion joints). This acoustic duct insulation must have minimum Insertion Loss (IL) values as follows:

Turbine Intake Duct Acoustic Insulation Minimum IL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	6	12	20	26	26	22

11. The wall and roof panels of the two proposed Buckingham Compressor Station compressor buildings must have a minimum Sound Transmission Class (STC) of 49 and a minimum Noise Reduction Coefficient (NRC) of 0.90. In addition, these panels must have minimum Sound Transmission Loss (TL) values as follows:

Compressor Building Wall and Roof Panel Minimum TL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	9	15	22	38	46	48	52	53	54

12. The personnel doors of the two proposed Buckingham Compressor Station compressor buildings must be insulated, metal doors with full weather-stripping. The STC rating of these doors must be a minimum of 38 as provided by CECO Medallion doors or equal. Any windows in these doors must be double glazed using minimum 1/4 inch thick safety glass or acrylic panels separated by a minimum 1/2 inch airspace.

13. The equipment doors of the two proposed Buckingham Compressor Station compressor buildings must be insulated, metal doors with full weather-stripping.

14. The two proposed Buckingham Compressor Station compressor buildings must have ventilation systems installed to provide adequate cooling of the buildings to allow full load operation of the four proposed turbine compressor units with all doors closed.

14A. The ventilation systems of the two compressor buildings can have a total of six air handling units. The maximum A-weighted sound level from each air handling unit must not exceed 70 dBA at 3 feet when measured outside of each air handling unit in all directions with maximum octave band sound pressure levels (SPL) as follows:

Air Handling Unit Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	92	89	79	71	64	60	55	54	54

14B. Ventilation air inlet mufflers must be located in the air paths between the air handing units and the compressor building wall penetrations to reduce the sound from the proposed turbine compressor units that escapes through these openings. Each air handling unit muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Air Handling Unit Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	4	12	20	23	42	48	45	38	21

14C. The ventilation systems of the two compressor buildings can have a total of eight wall air inlet fans. The maximum A-weighted sound level from each wall air inlet fan must not exceed 90 dBA at 3 feet when measured inside the compressor buildings without the four proposed turbine compressor units operating with maximum octave band sound pressure levels (SPL) as follows:

Wall Air Inlet Fan Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	99	97	95	90	86	84	82	80	77

14D. Ventilation air inlet mufflers must be located in the walls of the two proposed compressor buildings directly outside of the four wall air inlet fans to reduce the sound from the proposed turbine compressor units that escapes through these openings. Each air inlet muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Ventilation Air Inlet Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	4	12	20	23	42	48	45	38	21

14E. The ventilation systems of the two compressor buildings can have a total of twelve roof air discharge hoods with a maximum total area of 363 square feet. Ventilation air discharge mufflers must be located under each ventilation air discharge hood (but above the roof) to reduce the sound from the proposed turbine compressor units that escapes through these openings. Each air discharge muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Ventilation Air Discharge Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	9	17	25	39	46	45	40	25

15. The maximum noise from the lube oil cooler for each turbine compressor unit must not exceed an A-weighted sound level of 50 dBA at 50 feet from the centerline of the cooler with all fans running at maximum speed. Each lube oil cooler (including all fans, motors and drives) must have maximum octave band sound pressure levels (SPL) as follows:

Lube Oil Cooler Maximum SPL at 50 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	54	61	58	51	46	43	39	35	30

16. The maximum noise from the gas cooler for each turbine compressor unit must not exceed an A-weighted sound power level of 87 dBA with all fans running at maximum speed. Each gas cooler (including all fans, motors and drives) must have maximum octave band sound power levels (PWL) as follows:

Compressor Unit Gas Cooler Maximum PWL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	92	93	92	89	84	82	76	70	64

17. All aboveground sections of the unit suction, discharge and bypass lines, and the gas cooler inlet and outlet headers and piping (including the metal pipe supports) of the four proposed turbine compressor units must be acoustically insulated. This acoustic pipe insulation must have minimum Insertion Loss (IL) values as follows:

Piping Acoustic Insulation Minimum IL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	6	12	20	26	26	22

18. The maximum A-weighted sound level from each silenced unit blowdown vent must not exceed 60 dBA at 50 feet.

19. The maximum noise from each ultrasonic meter must not exceed an A-weighted sound level of 80 dBA at 3 feet with maximum octave band sound pressure levels (SPL) as follows:

Ultrasonic Meter Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	70	72	74	75	75	74	73	72	70

20. The maximum noise from each operating regulator valve must not exceed an A-weighted sound level of 85 dBA at 3 feet with maximum octave band sound pressure levels (SPL) as follows:

Regulator Valve Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	96	95	92	87	81	76	74	73	72

21. The wall and roof panels of the M&R building must have a minimum Sound Transmission Class (STC) of 29 and a minimum Noise Reduction Coefficient (NRC) of 0.90. In addition, these panels must have minimum Sound Transmission Loss (TL) values as follows:

M&R Building Wall and Roof Panel Minimum TL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	2	8	13	18	23	31	38	40	40

22. The doors for the M&R building must be insulated, metal doors with full weather-stripping. Any windows in these doors must be double glazed using minimum 1/4 inch thick glass or acrylic panels separated by a minimum 1/2 inch airspace.

23. Ventilation air inlet acoustic louvers must be located in the walls of the M&R building to reduce the sound from the three ultrasonic meters and two operating regulator valves that escapes through these openings. Each acoustic louver must have minimum Sound Transmission Loss (TL) values as follows:

Ventilation Air Inlet Acoustic Louver Minimum TL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	1	3	4	5	6	7	9	11	12

Model MFLA-4-16 acoustical louvers manufactured by Commercial Acoustics meet these specified minimum octave band TL values.

24. The M&R building can have a maximum 12 inch wide ridge roof vent.

25. The maximum noise from each gas heater installed outside near the M&R building must not exceed an A-weighted sound level of 90 dBA at 3 feet with maximum octave band sound pressure levels (SPL) as follows:

Gas Heater Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	111	105	94	87	87	83	82	80	78

2.4 PREDICTED BUCKINGHAM COMPRESSOR STATION SOUND LEVELS

The octave band sound pressure levels and A-weighted sound levels predicted at the nearest NSA (S3) approximately 1450 feet west-northwest of the four proposed turbine compressor units are shown in Table 1.0. Sheets 1 through 5 of this table present the calculations that predict the sound levels from the proposed Solar Mars Model 100S, the Solar Taurus Model 70S, the Solar Taurus Model 60S, and the Solar Centaur Model 50S turbine compressor units and the M&R station at this NSA. Detailed line item descriptions are presented on Sheets 6 through 15 of this table. The attached noise control analysis indicates a predicted continuous L_{eq} sound level of 38 dBA at the nearest NSA with corresponding L_{dn} sound levels of 44.4 dBA. At the NSAs approximately 1800 to

3600 feet from the four proposed turbine compressor units, the L_{eq} sound levels are predicted to range from 29 to 36 dBA, with corresponding L_{dn} sound levels ranging from 35.4 to 42.4 dBA. The predicted L_{dn} sound levels from the four proposed compressor units and the M&R station at the Buckingham Compressor Station are below 55 dBA at all NSAs around the site.

Table 2.0 presents the sound levels at the NSAs around the site of the proposed station. Shown are:

- the ambient L_d, L_n and L_{dn} sound levels,
- the predicted L_{dn} sound levels from the proposed Solar Mars Model 100S, Solar Taurus Model 70S, Solar Taurus Model 60S, and Solar Centaur Model 50S turbine compressor units and the M&R station,
- the predicted total L_{dn} sound levels resulting from summing the L_{dn} sound levels from the proposed Solar Mars Model 100S, Solar Taurus Model 70S, Solar Taurus Model 60S, and Solar Centaur Model 50S turbine compressor units and the M&R station with the ambient L_{dn} sound levels, and
- the predicted increase in the ambient L_{dn} sound levels due to the proposed Solar Mars Model 100S, Solar Taurus Model 70S, Solar Taurus Model 60S, and Solar Centaur Model 50S turbine compressor units and the M&R station.

At the NSAs, the predicted total L_{dn} sound levels range from 42.2 to 47.6 dBA. These total L_{dn} sound levels are below 55 dBA at all NSAs around the site.

Sincerely yours,
ENVIRONMENTAL NOISE CONTROL

William E. Biker
Principal Engineer
Noise and Vibration Control

TABLE 1.0 Sheet 1 of 15

BUCKINGHAM COMPRESSOR STATION COMPONENT NOISE ANALYSIS
FOR ONE (1) SOLAR MARS MODEL 100S, ONE (1) SOLAR TAURUS MODEL 70S,
ONE (1) SOLAR TAURUS MODEL 60S, AND ONE SOLAR CENTAUR MODEL 40S
TURBINE COMPRESSOR UNITS AND THE M&R STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
1. SPL	91	95	93	96	100	95	87	77	67
2. + DT	32	32	32	32	32	32	32	32	32
3. = PWL	123	127	125	128	132	127	119	109	99
4. – DIL	13	24	31	41	49	46	42	33	24
5. = PWL	110	103	94	87	83	81	77	76	75
6. SPL	81	87	93	94	95	97	100	129	121
7. + DT	32	32	32	32	32	32	32	32	32
8. = PWL	113	119	125	126	127	129	132	161	153
9. – DIL	5	18	33	41	46	50	57	87	80
10. = PWL	108	101	92	85	81	79	75	74	73
11. SPL	75	74	80	80	83	81	90	88	83
12. + DT	32	32	32	32	32	32	32	32	32
13. = PWL	107	106	112	112	115	113	122	120	115
14. – TL	9	15	22	35	41	41	42	42	42
15. = PWL	98	91	90	77	74	72	80	78	73
16. SPL	91	94	91	95	97	93	87	80	67
17. + DT	32	32	32	32	32	32	32	32	32
18. = PWL	123	126	123	127	129	125	119	112	99
19. – DIL	13	22	29	41	51	46	39	32	25
20. = PWL	110	104	94	86	78	79	80	80	74
21. SPL	79	85	91	92	93	95	98	126	118
22. + DT	32	32	32	32	32	32	32	32	32
23. = PWL	111	117	123	124	125	127	130	158	150
24. – DIL	3	15	31	40	49	50	52	80	78
25. = PWL	108	102	92	84	76	77	78	78	72

TABLE 1.0 (cont.) Sheet 2 of 15

BUCKINGHAM COMPRESSOR STATION COMPONENT NOISE ANALYSIS
FOR ONE (1) SOLAR MARS MODEL 100S, ONE (1) SOLAR TAURUS MODEL 70S,
ONE (1) SOLAR TAURUS MODEL 60S, AND ONE SOLAR CENTAUR MODEL 40S
TURBINE COMPRESSOR UNITS AND THE M&R STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
26. SPL	82	82	85	87	87	82	90	88	83
27. + DT	32	32	32	32	32	32	32	32	32
28. = PWL	114	114	117	119	119	114	122	120	115
29. – TL	9	15	22	35	41	41	42	42	42
30. = PWL	105	99	95	84	78	73	80	78	73
31. SPL	88	91	88	91	95	87	80	72	64
32. + DT	32	32	32	32	32	32	32	32	32
33. = PWL	120	123	120	123	127	119	112	104	96
34. – DIL	13	22	29	41	51	46	39	32	25
35. = PWL	107	101	91	82	76	73	73	72	71
36. SPL	76	82	88	89	90	92	95	120	112
37. + DT	32	32	32	32	32	32	32	32	32
38. = PWL	108	114	120	121	122	124	127	152	144
39. – DIL	3	15	31	40	49	50	52	80	78
40. = PWL	105	99	89	81	73	74	75	72	66
41. SPL	81	81	84	86	86	81	79	78	79
42. + DT	32	32	32	32	32	32	32	32	32
43. = PWL	113	113	116	118	118	113	111	110	111
44. – TL	9	15	22	35	41	41	42	42	42
45. = PWL	104	98	94	83	77	72	69	68	69
46. SPL	86	88	88	87	94	88	82	70	61
47. + DT	32	32	32	32	32	32	32	32	32
48. = PWL	118	120	120	119	126	120	114	102	93
49. – DIL	11	19	27	35	48	44	39	28	21
50. = PWL	107	101	93	84	78	76	75	74	72

TABLE 1.0 (cont.) Sheet 3 of 15

BUCKINGHAM COMPRESSOR STATION COMPONENT NOISE ANALYSIS
FOR ONE (1) SOLAR MARS MODEL 100S, ONE (1) SOLAR TAURUS MODEL 70S,
ONE (1) SOLAR TAURUS MODEL 60S, AND ONE SOLAR CENTAUR MODEL 40S
TURBINE COMPRESSOR UNITS AND THE M&R STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
51. SPL	75	81	87	88	89	91	94	118	110
52. + DT	32	32	32	32	32	32	32	32	32
53. = PWL	107	113	119	120	121	123	126	150	142
54. – DIL	2	14	28	38	45	49	53	78	72
55. = PWL	105	99	91	82	76	74	73	72	70
56. SPL	81	81	84	86	86	81	79	78	79
57. + DT	32	32	32	32	32	32	32	32	32
58. = PWL	113	113	116	118	118	113	111	110	111
59. – TL	9	15	22	35	41	41	42	42	42
60. = PWL	104	98	94	83	77	72	69	68	69
61. SPL	92	89	79	71	64	60	55	54	54
62. + DT	8	8	8	8	8	8	8	8	8
63. = PWL	100	97	87	79	72	68	63	62	62
64. + NF	8	8	8	8	8	8	8	8	8
65. = PWL	108	105	95	87	80	76	71	70	70
66. SPL	104	102	104	106	106	102	108	106	102
67. + AT	7	7	7	7	7	7	7	7	7
68. = PWL	111	109	111	113	113	109	115	113	109
69. – DIL	4	12	20	23	42	48	45	38	21
70. = PWL	107	97	91	90	71	61	70	75	88
71. SPL	99	97	95	90	86	84	82	80	77
72. + DT	8	8	8	8	8	8	8	8	8
73. = PWL	107	105	103	98	94	92	90	88	85
74. + NF	9	9	9	9	9	9	9	9	9
75. = PWL	116	114	112	107	103	101	99	97	94
76. – DIL	4	12	20	23	42	48	45	38	21

TABLE 1.0 (cont.) Sheet 4 of 15

BUCKINGHAM COMPRESSOR STATION COMPONENT NOISE ANALYSIS
FOR ONE (1) SOLAR MARS MODEL 100S, ONE (1) SOLAR TAURUS MODEL 70S,
ONE (1) SOLAR TAURUS MODEL 60S, AND ONE SOLAR CENTAUR MODEL 40S
TURBINE COMPRESSOR UNITS AND THE M&R STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
77. = PWL	112	102	92	84	61	53	54	59	73
78. SPL	104	102	104	106	106	102	108	106	102
79. + AT	11	11	11	11	11	11	11	11	11
80. = PWL	115	113	115	117	117	113	119	117	113
81. – DIL	4	12	20	23	42	48	45	38	21
82. = PWL	111	101	95	94	75	65	74	79	92
83. SPL	102	98	99	100	101	96	102	101	97
84. + AT	16	16	16	16	16	16	16	16	16
85. = PWL	118	114	115	116	117	112	118	117	113
86. – DIL	3	9	17	25	39	46	45	40	25
87. = PWL	115	105	98	91	78	66	73	77	88
88. SPL	54	61	58	51	46	43	39	35	30
89. + DT	32	32	32	32	32	32	32	32	32
90. = PWL	86	93	90	83	78	75	71	67	62
91. + NF	6	6	6	6	6	6	6	6	6
92. = PWL	92	99	96	89	84	81	77	73	68
93. PWL	92	93	92	89	84	82	76	70	64
94. + NF	6	6	6	6	6	6	6	6	6
95. = PWL	98	99	98	95	90	88	82	76	70
96. PWL	121	114	107	101	94	91	89	88	95
97. – DT	61	62	62	63	64	65	68	76	87
98. = SPL	60	52	45	38	30	26	21	12	8
99. SPL	70	72	74	75	75	74	73	72	70
100. + DT	8	8	8	8	8	8	8	8	8

TABLE 1.0 (cont.) Sheet 5 of 15

BUCKINGHAM COMPRESSOR STATION COMPONENT NOISE ANALYSIS
FOR ONE (1) SOLAR MARS MODEL 100S, ONE (1) SOLAR TAURUS MODEL 70S,
ONE (1) SOLAR TAURUS MODEL 60S, AND ONE SOLAR CENTAUR MODEL 40S
TURBINE COMPRESSOR UNITS AND THE M&R STATION

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

		OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*		31.5	63	125	250	500	1000	2000	4000	8000
101. = PWL		78	80	82	83	83	82	81	80	78
102. + NF		5	5	5	5	5	5	5	5	5
103. = PWL		83	85	87	88	88	87	86	85	83
104. SPL		96	95	92	87	81	76	74	73	72
105. + AT		18	18	18	18	18	18	18	18	18
106. = PWL		114	113	110	105	99	94	92	91	90
107. + NF		3	3	3	3	3	3	3	3	3
108. = PWL		117	116	113	108	102	97	95	94	93
109. PWL		117	116	113	108	102	97	96	95	93
110. – TL		2	8	12	16	19	21	22	23	23
111. = PWL		115	108	101	92	83	76	74	72	70
112. SPL		111	105	94	87	87	83	82	80	78
113. + DT		8	8	8	8	8	8	8	8	8
114. = PWL		119	113	102	95	95	91	90	88	86
115. + NF		3	3	3	3	3	3	3	3	3
116. = PWL		122	116	105	98	98	94	93	91	89
117. PWL		123	117	106	99	98	94	93	91	89
118. – DT		63	63	63	64	65	68	71	80	92
119. = SPL		60	54	43	35	33	26	22	11	–3
120. = SPL	38 dBA	63	56	47	40	35	29	25	15	8
121. L_{dn}	44.4 dBA									

* Detailed Line Item Descriptions are listed on Sheets 6 through 15.

TABLE 1.0 (cont.)

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5

1. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Mars Model 100S turbine. These data were supplied by Solar Turbines Incorporated.

2. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Mars Model 100S turbine.

3. Unmuffled exhaust PWL of one (1) Solar Mars Model 100S turbine.

4. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Mars Model 100S turbine (Noise Control Measure/Specification No. 1).

5. Muffled exhaust PWL of one (1) Solar Mars Model 100S turbine; result of lines 1 through 4.

6. Unmuffled intake SPL at 50 feet of one (1) Solar Mars Model 100S turbine. These data were supplied by Solar Turbines Incorporated.

7. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Mars Model 100S turbine.

8. Unmuffled intake PWL of one (1) Solar Mars Model 100S turbine.

9. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Mars Model 100S turbine (Noise Control Measure/Specification No. 6).

10. Muffled intake PWL of one (1) Solar Mars Model 100S turbine; result of lines 6 through 9.

11. Casing SPL at 50 feet of one (1) Solar Mars Model 100S turbine. These data were supplied by Solar Turbines Incorporated.

12. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Mars Model 100S turbine.

13. Casing PWL of one (1) Solar Mars Model 100S turbine.

TABLE 1.0 (cont.) Sheet 7 of 15

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

14. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

15. PWL of compressor building radiated casing noise from one (1) Solar Mars Model 100S turbine; result of lines 11 through 14.

16. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

17. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Taurus Model 70S turbine.

18. Unmuffled exhaust PWL of one (1) Solar Taurus Model 70S turbine.

19. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Taurus Model 70S turbine (Noise Control Measure/Specification No. 2).

20. Muffled exhaust PWL of one (1) Solar Taurus Model 70S turbine; result of lines 16 through 19.

21. Unmuffled intake SPL at 50 feet of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

22. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Taurus Model 70S turbine.

23. Unmuffled intake PWL of one (1) Solar Taurus Model 70S turbine.

24. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Taurus Model 70S turbine (Noise Control Measure/Specification No. 7).

25. Muffled intake PWL of one (1) Solar Taurus Model 70S turbine; result of lines 21 through 24.

26. Casing SPL at 50 feet of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

TABLE 1.0 (cont.)

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

27. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Taurus Model 70S turbine.

28. Casing PWL of one (1) Solar Taurus Model 70S turbine.

29. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

30. PWL of compressor building radiated casing noise from one (1) Solar Taurus Model 70S turbine; result of lines 26 through 29.

31. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Taurus Model 60S turbine. These data were supplied by Solar Turbines Incorporated.

32. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Taurus Model 60S turbine.

33. Unmuffled exhaust PWL of one (1) Solar Taurus Model 60S turbine.

34. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Taurus Model 60S turbine (Noise Control Measure/Specification No. 3).

35. Muffled exhaust PWL of one (1) Solar Taurus Model 60S turbine; result of lines 31 through 34.

36. Unmuffled intake SPL at 50 feet of one (1) Solar Taurus Model 60S turbine. These data were supplied by Solar Turbines Incorporated.

37. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Taurus Model 60S turbine.

38. Unmuffled intake PWL of one (1) Solar Taurus Model 60S turbine.

39. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Taurus Model 60S turbine (Noise Control Measure/Specification No. 8).

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

40. Muffled intake PWL of one (1) Solar Taurus Model 60S turbine; result of lines 36 through 39.

41. Casing SPL at 50 feet of one (1) Solar Taurus Model 60S turbine. These data were supplied by Solar Turbines Incorporated.

42. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Taurus Model 60S turbine.

43. Casing PWL of one (1) Solar Taurus Model 60S turbine.

44. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

45. PWL of compressor building radiated casing noise from one (1) Solar Taurus Model 60S turbine; result of lines 41 through 44.

46. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Centaur Model 50S turbine. These data were supplied by Solar Turbines Incorporated.

47. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Centaur Model 50S turbine.

48. Unmuffled exhaust PWL of one (1) Solar Centaur Model 50S turbine.

49. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Centaur Model 50S turbine (Noise Control Measure/Specification No. 4).

50. Muffled exhaust PWL of one (1) Solar Centaur Model 50S turbine; result of lines 46 through 49.

51. Unmuffled intake SPL at 50 feet of one (1) Solar Centaur Model 50S turbine. These data were supplied by Solar Turbines Incorporated.

52. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Centaur Model 50S turbine.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

53. Unmuffled intake PWL of one (1) Solar Centaur Model 50S turbine.

54. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Centaur Model 50S turbine (Noise Control Measure/Specification No. 9).

55. Muffled intake PWL of one (1) Solar Centaur Model 50S turbine; result of lines 51 through 54.

56. Casing SPL at 50 feet of one (1) Solar Centaur Model 50S turbine. These data were supplied by Solar Turbines Incorporated.

57. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Centaur Model 50S turbine.

58. Casing PWL of one (1) Solar Centaur Model 50S turbine.

59. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 11, 12, and 13).

60. PWL of compressor building radiated casing noise from one (1) Solar Centaur Model 50S turbine; result of lines 56 through 59.

61. Specified maximum SPL at three (3) feet for one (1) air handling unit (Noise Control Measure/Specification No. 14A).

62. Distance Term (DT) to convert maximum air handling unit SPL at three (3) feet to PWL.

63. PWL of one (1) air handling unit.

64. Number Factor (NF) to account for six (6) air handling units.

65. PWL of four (4) air handling units; result of lines 61 through 64.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

66. SPL calculated at the walls of the two compressor buildings with one (1) Solar Mars Model 100S turbine, one (1) Solar Taurus Model 70S turbine, one (1) Solar Taurus Model 60S turbine, and one (1) Solar Centaur Model 50S turbine operating. This is based upon the amount of sound absorption provided by the compressor walls and roof, and upon the distance from the turbines to the building walls.

67. Conversion of SPL in line 66 to represent PWL of turbine casing noise at the six (6) air handling unit penetrations in the compressor building walls.

68. PWL of the turbine casing noise at the six (6) air handling unit penetrations in the compressor building walls.

69. Specified Dynamic Insertion Loss (DIL) of each air handling unit muffler (Noise Control Measure/Specification No. 14B).

70. PWL of the turbine casing noise at the six (6) air handling unit penetrations in the compressor building walls with mufflers; result of lines 66 through 69.

71. Specified maximum SPL for one (1) wall air inlet fan at 3 feet (Noise Control Measure/Specification No. 14C).

72. Distance Term (DT) to convert maximum wall air inlet fan SPL at 3 feet to PWL.

73. PWL of one (1) wall air inlet fan.

74. Number Factor (NF) to account for eight (8) wall air inlet fans.

75. PWL of four (4) wall air inlet fans.

76. Specified Dynamic Insertion Loss (DIL) of each ventilation air inlet muffler (Noise Control Measure/Specification No. 14D).

77. PWL of eight (8) wall air inlet fans in the compressor building walls with mufflers; result of lines 71 through 76.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

78. SPL calculated at the walls of the two compressor buildings with one (1) Solar Mars Model 100S turbine, one (1) Solar Taurus Model 70S turbine, one (1) Solar Taurus Model 60S turbine, and one (1) Solar Centaur Model 50S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the building walls.

79. Conversion of SPL in line 78 to represent PWL of turbine casing noise at the eight (8) wall air inlet fan openings in the compressor building walls.

80. PWL of the turbine casing noise at the eight (8) wall air inlet fan openings in the compressor building walls.

81. Specified Dynamic Insertion Loss (DIL) of each ventilation air inlet muffler (Noise Control Measure/Specification No.14D).

82. PWL of the turbine casing noise at the eight (8) wall air inlet fan openings in the compressor building walls with mufflers; result of lines 78 through 81.

83. SPL calculated under the roofs of the two compressor buildings with one (1) Solar Mars Model 100S turbine, one (1) Solar Taurus Model 70S turbine, one (1) Solar Taurus Model 60S turbine, and one (1) Solar Centaur Model 50S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the roofs of the two compressor buildings.

84. Conversion of SPL in line 83 to represent PWL of turbine casing noise at twelve (12) roof air discharge openings in the roofs of the two compressor buildings.

85. PWL of the turbine casing noise at twelve (12) roof air discharge openings in the roofs of the two compressor buildings.

86. Specified Dynamic Insertion Loss (DIL) of each ventilation air discharge muffler (Noise Control Measure/Specification No. 14E).

87. PWL of the turbine casing noise at twelve (12) roof air discharge openings in the roofs of the two compressor buildings with mufflers; result of lines 83 through 86.

88. Specified maximum SPL at 50 feet from one (1) lube oil cooler with the fan(s) running at maximum speed (Noise Control Measure/Specification No. 15).

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

89. Distance Term (DT) to convert maximum lube oil cooler SPL at 50 feet to PWL.

90. PWL of one (1) lube oil cooler with the fan(s) running at maximum speed.

91. Number Factor for four (4) lube oil coolers.

92. PWL of four (4) lube oil coolers with the fan(s) running at maximum speed; result of lines 88 through 91.

93. Specified maximum PWL of one (1) gas cooler with the fan(s) running at maximum speed (Noise Control Measure/Specification No. 16).

94. Number Factor for four (4) gas coolers.

95. PWL of four (4) gas coolers with the fan(s) running at full speed; result of lines 93 and 94.

96. Total PWL of one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, one (1) Solar Taurus Model 60S, and one (1) Solar Centaur Model 50S turbine compressor units; logarithmic sum of lines 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 65, 70, 77, 82, 87, 92, and 95.

97. Distance Term (DT) to convert total PWL to SPL at the nearest NSA (S3) 1450 feet west-northwest of one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, one (1) Solar Model 60S, and one (1) Solar Centaur Model 50S turbine compressor units.

98. Energy equivalent sound level (L_{eq}) at the nearest NSA (S3) 1450 feet west-northwest of one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, one (1) Solar Taurus Model 60S, and one (1) Solar Centaur Model 50S turbine compressor units in the two compressor buildings at the Buckingham Compressor Station; result of lines 96 and 97.

99. Specified maximum SPL at 3 feet from one (1) ultrasonic meter (Noise Control Measure/ Specification No. 19).

100. Distance Term (DT) to convert maximum ultrasonic meter SPL at 3 feet to PWL.

101. PWL of one (1) ultrasonic meter.

102. Number Factor for three (3) ultrasonic meters.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

103. PWL of three (3) ultrasonic meters.

104. Specified maximum SPL at 3 feet from one (1) operating regulator valve (Noise Control Measure/Specification No. 20).

105. Conversion of SPL in line 104 to represent the PWL of one (1) operating regulator valve.

106. PWL of one (1) operating regulator valve.

107. Number Factor (NF) to account for two (2) operating regulator valves.

108. PWL of two (2) operating regulator valves.

109. PWL of three (3) ultrasonic meters and two (2) operating regulator valves.

110. Composite sound transmission loss (TL) of the M&R building using the specified STC 29 wall and roof panels, the specified doors, the specified ventilation air inlet acoustic louvers and the specified roof vent (Noise Control Measures/Specifications Nos . 21, 22, 23, and 24).

111. PWL of the three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building; result of lines 99 through 114.

112. Specified maximum SPL at 3 feet of one (1) gas heater (Noise Control Measure/ Specification No. 25).

113. Distance Term (DT) to convert maximum gas heater SPL at 3 feet to PWL.

114. PWL of one (1) gas heater.

115. Number Factor for two (2) gas heaters.

116. PWL of two (2) gas heaters; result of lines 112 through 115.

117. Total PWL of three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building and two gas heaters; logarithmic sum of lines 111 and 116.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 5 (cont.)

118. Distance Term (DT) to convert total PWL of the three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building and two gas heaters to SPL at the nearest NSA (S3) 1700 feet west-northwest of three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building and two gas heaters.

119. Energy equivalent sound level (L_{eq}) at the nearest NSA (S3) 1700 feet west-northwest of three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building and two gas heaters at the Buckingham Compressor Station; result of lines 117 and 118.

120. Energy equivalent sound level (L_{eq}) at the nearest NSA (S3) of one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, one (1) Solar Taurus Model 60S, and one (1) Solar Centaur Model 50S turbine compressor units in the two compressor buildings, three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building, and two gas heaters at the Buckingham Compressor Station; sum of lines 98 and 119.

121. Day-night sound level (L_{dn}) at the nearest NSA (S3) of one (1) Solar Mars Model 100S, one (1) Solar Taurus Model 70S, one (1) Solar Taurus Model 60S, and one (1) Solar Centaur Model 50S turbine compressor units in the two compressor buildings, three (3) ultrasonic meters and two (2) operating regulator valves in the M&R building, and two gas heaters at the Buckingham Compressor Station.

TABLE 2.0 Sheet 1 of 2

NOISE QUALITY ANALYSIS FOR THE BUCKINGHAM COMPRESSOR STATION

Ambient Sound Levels, Predicted Sound Levels from the Four Proposed Turbine Compressor Units and the M&R Station, and Predicted Total Sound Levels

A-Weighted Sound Levels in dBA re 20 microPa

Location/ Description	Distance/ Direction	Existing (1) $L_{eq}(d)$	$L_{eq}(n)$	L_{dn}	Predicted L_{dn} (2)	Total L_{dn} (3)	Noise (4) Increase
P1. Prop Line	1150 ft WNW	41.9	29.4	41.1	46.4	47.5	6.4
P2. Prop Line	1000 ft ENE	42.4	27.4	41.1	52.4	52.7	11.6
P3. Prop Line	1900 ft SE	43.0	33.9	43.4	42.4	45.9	2.5
P4. Prop Line	400 ft SW	40.7	25.9	39.4	56.4	56.5	17.1
S1. Residence	2700 ft WNW	47.5	29.7	45.9	37.4	46.4	0.5
S2. Residence	1800 ft WNW	47.9	25.3	46.0	42.4	47.6	1.6
S3. Residence	1450 ft WNW	46.4	25.3	44.6	44.4	47.5	2.9
S4. Residence	1900 ft NNW	43.9	31.8	43.2	42.4	45.8	2.6
S5. Residence	3600 ft ENE	39.8	32.9	41.2	35.4	42.2	1.0
S6. Residence	3000 ft ESE	46.2	35.9	46.1	38.4	46.8	0.7
S7. Residence	3100 ft ESE	39.7	35.4	42.7	37.4	43.9	1.2
S8. Residence	2000 ft SE	43.0	33.9	43.4	42.4	45.9	2.5
S9. Residence	2100 ft SE	43.0	33.9	43.4	41.4	45.5	2.1

TABLE 2.0 (cont.) Sheet 2 of 2

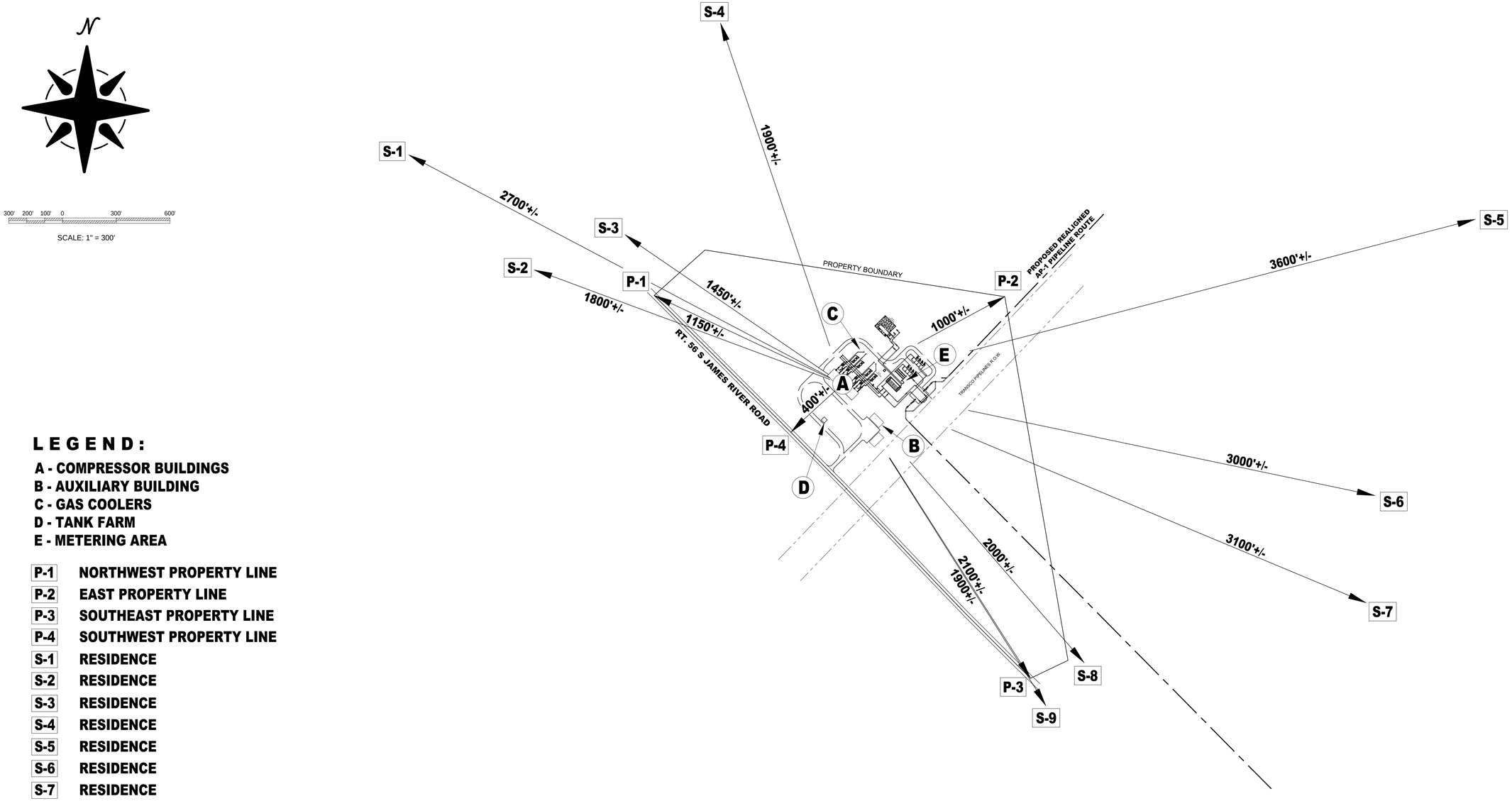
NOISE QUALITY ANALYSIS FOR THE BUCKINGHAM COMPRESSOR STATION

(1) Ambient daytime and nighttime L_{eq} sound levels measured on 21 April 2015, and calculated ambient L_{dn} sound levels. These ambient sound levels were due wind blowing through the trees, dogs barking, local traffic, birds, insects, airplanes, spring peepers and whippoorwills.

(2) Predicted L_{dn} sound levels from the four proposed Buckingham Compressor Station turbine compressor units and the M&R station with Noise Control Measures/Specifications Nos. 1 through 25 installed.

(3) Predicted total $L_{dn} = 10 \log (10^{(\text{Ambient } L_{dn}/10)} + 10^{(\text{Predicted } L_{dn}/10)})$.

(4) Predicted increase of the ambient L_{dn} sound levels due to the four proposed Buckingham Compressor Station turbine compressor units and the M&R station with Noise Control Measures/Specifications Nos. 1 through 25 installed.



LEGEND:

- A - COMPRESSOR BUILDINGS
- B - AUXILIARY BUILDING
- C - GAS COOLERS
- D - TANK FARM
- E - METERING AREA

P-1	NORTHWEST PROPERTY LINE
P-2	EAST PROPERTY LINE
P-3	SOUTHEAST PROPERTY LINE
P-4	SOUTHWEST PROPERTY LINE
S-1	RESIDENCE
S-2	RESIDENCE
S-3	RESIDENCE
S-4	RESIDENCE
S-5	RESIDENCE
S-6	RESIDENCE
S-7	RESIDENCE
S-8	RESIDENCE
S-9	RESIDENCE

GENERAL NOTES AND COMMENTS:

SYM.	DATE	BY	REVISION INFORMATION	PROJECT/TASK	APP.
B	6/9/2015	RRC	REVISED PER CLIENTS COMMENTS		
A	6/4/2015	RRC	ISSUED FOR REVIEW		

SEAL

I3 Engineering and Consulting, LLC
INTEGRITY • INITIATIVE • INNOVATION

DRAWN:	RRC	6/4/2015
CHECKED:	DLM	6/4/2015
APP. FOR BID:		
APP. FOR CONST.:		
SCALE:	1" = 300'	

Atlantic Coast Pipeline, LLC

445 West Main St. Clarksburg, West Virginia 26301 / Phone: (304) 623-8000

TITLE: BUCKINGHAM COMPRESSOR STATION SOUND STUDY PLOT PLAN

DISTRICT:	COUNTY: BUCKINGHAM	STATE: VA	GROUP	DWG. NO.	REV.
DIR/FILE: DOM/ACP/Sound Study Drawings/CS2 Buckingham SS			PD	2083C	B

ENVIRONMENTAL NOISE CONTROL
260 Arbor Street
Lunenburg, MA 01462-1458
(978) 582-9204
Fax (978) 582-7102

11 June 2015

Dominion Transmission, Inc.
445 West Main Street
PO Box 2450
Clarksburg, West Virginia 26302-2450

Attention: Mr. Jay C. Riley

Subject: ENC Report No.537:
Ambient Sound Survey and Noise Analysis for Installation of Three Turbine Compressor Units at the Proposed Northampton Compressor Station for the Atlantic Coast Pipeline Project
ENC Project No. 15-03

Dear Mr. Riley:

Environmental Noise Control (ENC) has conducted an ambient sound survey and a noise analysis of the sound levels due to the installation of one Solar Taurus Model 70S, one Solar Centaur Model 50S, and one Solar Centaur Model 40S turbine compressor units at the proposed Northampton Compressor Station for the Atlantic Coast Pipeline Project.

1.0 PURPOSE

The purpose of the property line and noise sensitive area (NSA) sound survey was to document the existing ambient sound levels for the environmental report to be submitted for the installation of one Solar Taurus Model 70S, one Solar Centaur Model 50S, and one Solar Centaur Model 40S turbine compressor units at the proposed Northampton Compressor Station. Presented below are descriptions of the proposed Northampton Compressor Station site, the sound survey measurement locations and the measured ambient sound levels.

1.1 SITE DESCRIPTION

The site of the proposed Northampton Compressor Station is located on the south side of Route 662/Forest Road in Pleasant Hill Township, Northampton County, North Carolina. It is planned that the three proposed turbine compressor units will be located in one acoustically insulated compressor building.

The land uses surrounding the site of the proposed compressor station are residential, agricultural, industrial and forested areas. There is a closed Georgia Pacific Corp. lumber mill approximately

one mile west-northwest of the proposed compressor station. The nearest NSAs are residences approximately 850 feet north-northwest and 1700 feet northeast of the proposed compressor building (See the attached plot plan drawing). There are no NSAs within one mile east, south or west of the proposed compressor building.

1.2 SOUND SURVEY MEASUREMENTS

Sound survey measurements were conducted at the property lines and NSAs on 23 April 2015. Daytime measurements were conducted between 11:30 AM and 2:30 PM, and nighttime measurements were conducted between 10 and 11:30 PM. The weather conditions during the daytime measurements were a temperature of 68 degrees F, a relative humidity of 30%, clear skies and light north winds (0 to 4 mph). During the nighttime measurements, the weather conditions were a temperature of 53 degrees F decreasing to 44 degrees F, a relative humidity of 65% increasing to 85%, clear skies and light north winds (0 to 4 mph).

Audible sources of daytime ambient sound were wind blowing through the trees, dogs barking, airplanes, a train, and traffic on Route 301. During the nighttime, the audible ambient sound sources were airplanes, spring peepers, insects, owls, dogs barking, and wind blowing through the trees.

At the property lines and NSAs, the measured daytime ambient L_{eq} sound levels ranged from 38.0 to 42.8 dBA. The measured nighttime ambient L_{eq} sound levels ranged from 25.9 to 29.9 dBA. The calculated ambient L_{dn} sound levels ranged from 37.8 to 41.5 dBA.

2.0 NOISE ANALYSIS OF PROPOSED NORTHAMPTON COMPRESSOR STATION

The proposed Northampton Compressor Station sound levels will be the sound levels from one Solar Taurus Model 70S, one Solar Centaur Model 50S, and one Solar Centaur Model 40S turbine compressor units with the noise control materials installed. Presented below are the predicted sound levels from the three proposed turbine compressor units, the noise control measures/specifications necessary to reduce the sound levels from the three proposed turbine compressor units, and the total sound levels predicted after the installation of the three proposed turbine compressor units.

2.1 PREDICTED SOUND LEVELS FROM THE PROPOSED NORTHAMPTON COMPRESSOR STATION

The proposed Northampton Compressor Station has been designed so that the continuous sound from one Solar Taurus Model 70S, one Solar Centaur Model 50S, and one Solar Centaur Model 40S turbine compressor units operating at full rated load will not exceed a day-night sound level (L_{dn}) of 55 dBA at the NSAs around the station. The predicted sound levels from the three proposed turbine compressor units are based upon sound level information provided by the turbine manufacturer (Solar Turbines Incorporated). Minimum dynamic insertion loss (DIL) requirements for the turbine exhaust mufflers, turbine air intake cleaners/silencers, and compressor building air handling unit, ventilation air inlet and ventilation air discharge mufflers have been specified. Specifications for minimum sound transmission loss (STC) requirements for the compressor

building wall and roof panels, and personnel doors are included. Maximum sound levels for the air handling units, the wall air inlet fans and the lube oil coolers have been specified. Also specified, are the maximum sound power levels for the gas coolers. Insulation minimum insertion loss (IL) values have been specified for the noise control insulations to be used on the turbine exhaust pipes, the turbine air intake ducts, all aboveground compressor unit suction, discharge and bypass lines, and the gas cooler inlet and outlet headers and piping.

2.2 NOISE CONTROL MEASURES/SPECIFICATIONS FOR THE THREE PROPOSED COMPRESSOR UNITS

Implementation of the following noise control measures/specifications is necessary to ensure that the continuous sound from one Solar Taurus Model 70S, one Solar Centaur Model 50S, and one Solar Centaur Model 40S turbine compressor units will not exceed a day-night sound level (L_{dn}) of 55 dBA at the NSAs.

1. A muffler must be installed on the exhaust of the proposed Solar Taurus Model 70S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 70S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	13	22	29	41	51	46	39	32	25

2. A muffler must be installed on the exhaust of the proposed Solar Centaur Model 50S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Centaur Model 50S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	11	19	27	35	48	44	39	28	21

3. A muffler must be installed on the exhaust of the proposed Solar Centaur Model 40S turbine. This turbine exhaust muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Centaur Model 40S Turbine Exhaust Muffler Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	11	19	27	35	48	44	39	28	21

4. The exhaust pipes of the three proposed turbines must be acoustically insulated from the building wall to the exhaust muffler inlet flanges (including expansion joints). This acoustic pipe insulation must have minimum Insertion Loss (IL) values as follows:

Turbine Exhaust Pipe Acoustic Insulation Minimum IL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	0	5	10	25	25	20

5. An air cleaner/silencer must be installed on the air intake of the proposed Solar Taurus Model 70S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Taurus Model 70S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	15	31	40	49	50	52	80	78

6. An air cleaner/silencer must be installed on the air intake of the proposed Solar Centaur Model 50S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Centaur Model 50S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	2	14	28	38	45	49	53	78	72

7. An air cleaner/silencer must be installed on the air intake of the proposed Solar Centaur Model 40S turbine. This turbine air intake cleaner/silencer must have minimum Dynamic Insertion Loss (DIL) values as follows:

Solar Centaur Model 40S Turbine Air Intake Cleaner/Silencer Minimum DIL in dB

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
dB	2	14	28	38	45	49	53	78	72

8. The intake ducts of the three proposed turbines must be acoustically insulated from the building wall to the air intake cleaner outlet flanges (including expansion joints). This acoustic duct insulation must have minimum Insertion Loss (IL) values as follows:

Turbine Intake Duct Acoustic Insulation Minimum IL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	6	12	20	26	26	22

9. The wall and roof panels of the proposed Northampton Compressor Station compressor building must have a minimum Sound Transmission Class (STC) of 49 and a minimum Noise Reduction Coefficient (NRC) of 0.90. In addition, these panels must have minimum Sound Transmission Loss (TL) values as follows:

Compressor Building Wall and Roof Panel Minimum TL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	9	15	22	38	46	48	52	53	54

10. The proposed Northampton Compressor Station compressor building personnel doors must be insulated, metal doors with full weather-stripping. The STC rating of these doors must be a minimum of 38 as provided by CECO Medallion doors or equal. Any windows in these doors must be double glazed using minimum 1/4 inch thick safety glass or acrylic panels separated by a minimum 1/2 inch airspace.

11. The proposed Northampton Compressor Station compressor building equipment doors must be insulated, metal doors with full weather-stripping.

12. The proposed Northampton Compressor Station compressor building must have a ventilation system installed to provide adequate cooling of the building to allow full load operation of the three proposed turbine compressor units with all doors closed.

12A. The compressor building ventilation system can have a maximum of four air handling units. The maximum A-weighted sound level from each air handling unit must not exceed 70 dBA at 3 feet when measured outside of each air handling unit in all directions with maximum octave band sound pressure levels (SPL) as follows:

Air Handling Unit Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	92	89	79	71	64	60	55	54	54

12B. Ventilation air inlet mufflers must be located in the air paths between the air handing units and the compressor building wall penetrations to reduce the sound from the three proposed turbine compressor units that escapes through these openings. Each air handling unit muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Air Handling Unit Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	4	12	20	23	42	48	45	38	21

12C. The compressor building ventilation system can have a maximum of four wall air inlet fans. The maximum A-weighted sound level from each wall air inlet fan must not exceed 90 dBA at 3 feet when measured inside the compressor building without the three proposed turbine compressor units operating with maximum octave band sound pressure levels (SPL) as follows:

Wall Air Inlet Fan Maximum SPL at 3 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	99	97	95	90	86	84	82	80	77

12D. Ventilation air inlet mufflers must be located in the walls of the proposed compressor building directly outside of the four wall air inlet fans to reduce the sound from the three proposed turbine compressor units that escapes through these openings. Each air inlet muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Ventilation Air Inlet Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	4	12	20	23	42	48	45	38	21

12E. The compressor building ventilation system can have a maximum of nine roof air discharge hoods with a maximum total area of 272 square feet. Ventilation air discharge mufflers must be located under each ventilation air discharge hood (but above the roof) to reduce the sound from the three proposed turbine compressor units that escapes through these openings. Each air discharge muffler must have minimum Dynamic Insertion Loss (DIL) values as follows:

Ventilation Air Discharge Muffler Minimum DIL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	3	9	17	25	39	46	45	40	25

13. The maximum noise from the lube oil cooler for each turbine compressor unit must not exceed an A-weighted sound level of 50 dBA at 50 feet from the centerline of the cooler with all fans running at maximum speed. Each lube oil cooler (including

all fans, motors and drives) must have maximum octave band sound pressure levels (SPL) as follows:

Lube Oil Cooler Maximum SPL at 50 feet in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	54	61	58	51	46	43	39	35	30

14. The maximum noise from the gas cooler for each turbine compressor unit must not exceed an A-weighted sound power level of 87 dBA with all fans running at maximum speed. Each gas cooler (including all fans, motors and drives) must have maximum octave band sound power levels (PWL) as follows:

Compressor Unit Gas Cooler Maximum PWL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	92	93	92	89	84	82	76	70	64

15. All aboveground sections of the unit suction, discharge and bypass lines, and gas cooler inlet and outlet headers and piping (including the metal pipe supports) of the three proposed turbine compressor units must be acoustically insulated. This acoustic pipe insulation must have minimum Insertion Loss (IL) values as follows:

Piping Acoustic Insulation Minimum IL in dB
Octave Band Center Frequency in Hz

	31.5	63	125	250	500	1000	2000	4000	8000
dB	0	0	0	6	12	20	26	26	22

16. The maximum A-weighted sound level from each silenced unit blowdown vent must not exceed 60 dBA at 50 feet.

2.3 PREDICTED NORTHAMPTON COMPRESSOR STATION SOUND LEVELS

The octave band sound pressure levels and A-weighted sound levels predicted at the nearest NSA (S1) approximately 850 feet north-northwest of the three proposed turbine compressor units are shown in Table 1.0. Sheets 1 through 4 of this table present the calculations that predict the sound levels from the proposed Solar Taurus Model 70S, Solar Centaur Model 50S, and Solar Centaur Model 40S turbine compressor units at this NSA. Detailed line item descriptions are presented on Sheets 5 through 11 of this table. The attached noise control analysis indicates a predicted continuous L_{eq} sound level of 39 dBA at the nearest NSA with a corresponding L_{dn} sound level of 45.4 dBA. At the other NSA approximately 1700 feet from the three proposed turbine compressor units, the L_{eq} sound level is predicted to be 31 dBA with a corresponding L_{dn} sound level of 37.4

dBA. The predicted L_{dn} sound levels from the three proposed turbine compressor units at the Northampton Compressor Station are below 55 dBA at all NSAs around the site.

Table 2.0 presents the sound levels at the NSAs around the site of the proposed station. Shown are:

- the ambient L_d, L_n and L_{dn} sound levels,
- the predicted L_{dn} sound levels from the proposed Solar Taurus Model 70S, Solar Centaur Model 50S, and Solar Centaur Model 40S turbine compressor units,
- the predicted total L_{dn} sound levels resulting from summing the L_{dn} sound levels from the proposed Solar Taurus Model 70S, Solar Centaur Model 50S, and Solar Centaur Model 40S turbine compressor units with the ambient L_{dn} sound levels, and
- the predicted increase in the ambient L_{dn} sound levels due to the proposed Solar Taurus Model 70, Solar Centaur Model 50S, and Solar Centaur Model 40S turbine compressor units.

At the NSAs, the predicted total L_{dn} sound levels are 41.2 and 46.2 dBA. The total L_{dn} sound levels are below 55 dBA at all NSAs around the site.

Sincerely yours,
ENVIRONMENTAL NOISE CONTROL

William E. Biker
Principal Engineer
Noise and Vibration Control

TABLE 1.0

NORTHAMPTON COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR ONE (1) SOLAR TAURUS MODEL 70S, ONE (1) SOLAR CENTAUR MODEL 50S, AND ONE (1) SOLAR CENTAUR MODEL 40S TURBINE COMPRESSOR UNITS

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
1. SPL	91	94	91	95	97	93	87	80	67
2. + DT	32	32	32	32	32	32	32	32	32
3. = PWL	123	126	123	127	129	125	119	112	99
4. – DIL	13	22	29	41	51	46	39	32	25
5. = PWL	110	104	94	86	78	79	80	80	74
6. SPL	79	85	91	92	93	95	98	126	118
7. + DT	32	32	32	32	32	32	32	32	32
8. = PWL	111	117	123	124	125	127	130	158	150
9. – DIL	3	15	31	40	49	50	52	80	78
10. = PWL	108	102	92	84	76	77	78	78	72
11. SPL	82	82	85	87	87	82	90	88	83
12. + DT	32	32	32	32	32	32	32	32	32
13. = PWL	114	114	117	119	119	114	122	120	115
14. – TL	9	15	22	35	40	41	41	41	41
15. = PWL	105	99	95	84	79	73	81	79	74
16. SPL	86	88	88	87	94	88	82	70	61
17. + DT	32	32	32	32	32	32	32	32	32
18. = PWL	118	120	120	119	126	120	114	102	93
19. – DIL	11	19	27	35	48	44	39	28	21
20. = PWL	107	101	93	84	78	76	75	74	72
21. SPL	75	81	87	88	89	91	94	118	110
22. + DT	32	32	32	32	32	32	32	32	32
23. = PWL	107	113	119	120	121	123	126	150	142
24. – DIL	2	14	28	38	45	49	53	78	72
25. = PWL	105	99	91	82	76	74	73	72	70

TABLE 1.0 (cont.) Sheet 2 of 11

NORTHAMPTON COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR ONE (1) SOLAR TAURUS MODEL 70S, ONE (1) SOLAR CENTAUR MODEL 50S, AND ONE (1) SOLAR CENTAUR MODEL 40S TURBINE COMPRESSOR UNITS

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
26. SPL	81	81	84	86	86	81	79	78	79
27. + DT	32	32	32	32	32	32	32	32	32
28. = PWL	113	113	116	118	118	113	111	110	111
29. – TL	9	15	22	35	40	41	41	41	41
30. = PWL	104	98	94	83	78	72	70	69	70
31. SPL	84	92	88	90	89	88	81	72	66
32. + DT	32	32	32	32	32	32	32	32	32
33. = PWL	116	124	120	122	121	120	113	104	98
34. – DIL	11	19	27	35	48	44	39	28	21
35. = PWL	105	105	93	87	73	76	74	76	77
36. SPL	75	81	87	88	89	91	94	117	109
37. + DT	32	32	32	32	32	32	32	32	32
38. = PWL	107	113	119	120	121	123	126	149	141
39. – DIL	2	14	28	38	45	49	53	78	72
40. = PWL	105	99	91	82	76	74	73	71	69
41. SPL	81	81	84	86	86	81	79	78	79
42. + DT	32	32	32	32	32	32	32	32	32
43. = PWL	113	113	116	118	118	113	111	110	111
44. – TL	9	15	22	35	40	41	41	41	41
45. = PWL	104	98	94	83	78	72	70	69	70
46. SPL	92	89	79	71	64	60	55	54	54
47. + DT	8	8	8	8	8	8	8	8	8
48. = PWL	100	97	87	79	72	68	63	62	62
49. + NF	6	6	6	6	6	6	6	6	6
50. = PWL	106	103	93	85	78	74	69	68	68

TABLE 1.0 (cont.) Sheet 3 of 11

NORTHAMPTON COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR ONE (1) SOLAR TAURUS MODEL 70S, ONE (1) SOLAR CENTAUR MODEL 50S, AND ONE (1) SOLAR CENTAUR MODEL 40S TURBINE COMPRESSOR UNITS

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
51. SPL	103	101	104	106	105	100	105	103	100
52. + AT	6	6	6	6	6	6	6	6	6
53. = PWL	109	107	110	112	111	106	111	109	106
54. – DIL	4	12	20	23	42	48	45	38	21
55. = PWL	105	95	90	89	69	58	66	71	85
56. SPL	99	97	95	90	86	84	82	80	77
57. + DT	8	8	8	8	8	8	8	8	8
58. = PWL	107	105	103	98	94	92	90	88	85
59. + NF	6	6	6	6	6	6	6	6	6
60. = PWL	113	111	109	104	100	98	96	94	91
61. – DIL	4	12	20	23	42	48	45	38	21
62. = PWL	109	99	89	81	58	50	51	56	70
63. SPL	103	101	104	106	105	100	105	103	100
64. + AT	8	8	8	8	8	8	8	8	8
65. = PWL	111	109	112	114	113	108	113	111	108
66. – DIL	4	12	20	23	42	48	45	38	21
67. = PWL	107	97	92	91	71	60	68	73	87
68. SPL	100	97	98	99	99	94	99	97	94
69. + AT	14	14	14	14	14	14	14	14	14
70. = PWL	114	111	112	113	113	108	113	111	108
71. – DIL	3	9	17	25	39	46	45	40	25
72. = PWL	111	102	95	88	74	62	68	71	83
73. SPL	54	61	58	51	46	43	39	35	30
74. + DT	32	32	32	32	32	32	32	32	32
75. = PWL	86	93	90	83	78	75	71	67	62

TABLE 1.0 (cont.)

NORTHAMPTON COMPRESSOR STATION COMPONENT NOISE ANALYSIS FOR ONE (1) SOLAR TAURUS MODEL 70S, ONE (1) SOLAR CENTAUR MODEL 50S, AND ONE (1) SOLAR CENTAUR MODEL 40S TURBINE COMPRESSOR UNITS

Sound Pressure Levels (SPL) in dB re 20 microPa
Sound Power Levels (PWL) in dB re 10^{-12} watts

	OCTAVE BAND CENTER FREQUENCIES IN Hz								
Description*	31.5	63	125	250	500	1000	2000	4000	8000
76. + NF	5	5	5	5	5	5	5	5	5
77. = PWL	91	98	95	88	83	80	76	72	67
78. PWL	92	93	92	89	84	82	76	70	64
79. + NF	5	5	5	5	5	5	5	5	5
80. = PWL	97	98	97	94	89	87	81	75	69
81. PWL	118	111	105	99	92	89	87	86	91
82. – DT	56	56	57	57	57	58	60	64	71
83. = SPL 39 dBA	62	55	48	42	35	31	27	22	20
84. L_{dn} 45.4 dBA									

* Detailed Line Item Descriptions are listed on Sheets 5 through 11.

TABLE 1.0 (cont.) Sheet 5 of 11

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4

1. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

2. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Taurus Model 70S turbine.

3. Unmuffled exhaust PWL of one (1) Solar Taurus Model 70S turbine.

4. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Taurus Model 70S turbine (Noise Control Measure/Specification No. 1).

5. Muffled exhaust PWL of one (1) Solar Taurus Model 70S turbine; result of lines 1 through 4.

6. Unmuffled intake SPL at 50 feet of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

7. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Taurus Model 70S turbine.

8. Unmuffled intake PWL of one (1) Solar Taurus Model 70S turbine.

9. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Taurus Model 70S turbine (Noise Control Measure/Specification No. 5).

10. Muffled intake PWL of one (1) Solar Taurus Model 70S turbine; result of lines 6 through 9.

11. Casing SPL at 50 feet of one (1) Solar Taurus Model 70S turbine. These data were supplied by Solar Turbines Incorporated.

12. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Taurus Model 70S turbine.

13. Casing PWL of one (1) Solar Taurus Model 70S turbine.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4 (cont.)

14. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 9, 10, and 11).

15. PWL of compressor building radiated casing noise from one (1) Solar Taurus Model 70S turbine; result of lines 11 through 14.

16. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Centaur Model 50S turbine. These data were supplied by Solar Turbines Incorporated.

17. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Centaur Model 50S turbine.

18. Unmuffled exhaust PWL of one (1) Solar Centaur Model 50S turbine.

19. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Centaur Model 50S turbine (Noise Control Measure/Specification No. 2).

20. Muffled exhaust PWL of one (1) Solar Centaur Model 50S turbine; result of lines 16 through 19.

21. Unmuffled intake SPL at 50 feet of one (1) Solar Centaur Model 50S turbine. These data were supplied by Solar Turbines Incorporated.

22. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Centaur Model 50S turbine.

23. Unmuffled intake PWL of one (1) Solar Centaur Model 50S turbine.

24. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Centaur Model 50S turbine (Noise Control Measure/Specification No. 6).

25. Muffled intake PWL of one (1) Solar Centaur Model 50S turbine; result of lines 21 through 24.

26. Casing SPL at 50 feet of one (1) Solar Centaur Model 50S turbine. These data were supplied by Solar Turbines Incorporated.

TABLE 1.0 (cont.) Sheet 7 of 11

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4 (cont.)

27. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Centaur Model 50S turbine.

28. Casing PWL of one (1) Solar Centaur Model 50S turbine.

29. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 9, 10, and 11).

30. PWL of compressor building radiated casing noise from one (1) Solar Centaur Model 50S turbine; result of lines 26 through 29.

31. Unmuffled exhaust sound pressure levels (SPL) at 50 feet and 90 degrees to stack axis of one (1) Solar Centaur Model 40S turbine. These data were supplied by Solar Turbines Incorporated.

32. Distance Term (DT) to convert turbine exhaust SPL at 50 feet to turbine exhaust sound power levels (PWL) of one (1) Solar Centaur Model 40S turbine.

33. Unmuffled exhaust PWL of one (1) Solar Centaur Model 40S turbine.

34. Specified Dynamic Insertion Loss (DIL) of the turbine exhaust muffler for the Solar Centaur Model 40S turbine (Noise Control Measure/Specification No. 3).

35. Muffled exhaust PWL of one (1) Solar Centaur Model 40S turbine; result of lines 31 through 34.

36. Unmuffled intake SPL at 50 feet of one (1) Solar Centaur Model 40S turbine. These data were supplied by Solar Turbines Incorporated.

37. Distance Term (DT) to convert turbine intake SPL at 50 feet to turbine intake PWL of one (1) Solar Centaur Model 40S turbine.

38. Unmuffled intake PWL of one (1) Solar Centaur Model 40S turbine.

39. Specified Dynamic Insertion Loss (DIL) of the turbine intake air cleaner/silencer for the Solar Centaur Model 40S turbine (Noise Control Measure/Specification No. 7).

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4 (cont.)

40. Muffled intake PWL of one (1) Solar Centaur Model 40S turbine; result of lines 36 through 39.

41. Casing SPL at 50 feet of one (1) Solar Centaur Model 40S turbine. These data were supplied by Solar Turbines Incorporated.

42. Distance Term (DT) to convert turbine casing SPL at 50 feet to turbine casing PWL of one (1) Solar Centaur Model 40S turbine.

43. Casing PWL of one (1) Solar Centaur Model 40S turbine.

44. Composite sound transmission loss (TL) of compressor building walls, roof and doors using the specified STC 49 wall and roof panels, the specified STC 38 personnel doors and the specified equipment doors (Noise Control Measures/Specifications Nos. 9, 10, and 11).

45. PWL of compressor building radiated casing noise from one (1) Solar Centaur Model 40S turbine; result of lines 41 through 44.

46. Specified maximum SPL at three (3) feet for one (1) air handling unit (Noise Control Measure/Specification No. 12A).

47. Distance Term (DT) to convert maximum air handling unit SPL at three (3) feet to PWL.

48. PWL of one (1) air handling unit.

49. Number Factor (NF) to account for four (4) air handling units.

50. PWL of four (4) air handling units; result of lines 46 through 49.

51. SPL calculated at the walls of the compressor building with one (1) Solar Taurus Model 70S turbine, one (1) Solar Centaur Model 50S turbine, and one (1) Solar Centaur Model 40S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the building walls.

52. Conversion of SPL in line 51 to represent PWL of turbine casing noise at the four (4) air handling unit penetrations in the compressor building walls.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4 (cont.)

53. PWL of the turbine casing noise at the four (4) air handling unit penetrations in the compressor building walls.

54. Specified Dynamic Insertion Loss (DIL) of each air handling unit muffler (Noise Control Measure/Specification No. 12B).

55. PWL of the turbine casing noise at the four (4) air handling unit penetrations in the compressor building walls with mufflers; result of lines 51 through 54.

56. Specified maximum SPL for one (1) wall air inlet fan at 3 feet (Noise Control Measure/Specification No. 12C).

57. Distance Term (DT) to convert maximum wall air inlet fan SPL at 3 feet to PWL.

58. PWL of one (1) wall air inlet fan.

59. Number Factor (NF) to account for four (4) wall air inlet fans.

60. PWL of four (4) wall air inlet fans.

61. Specified Dynamic Insertion Loss (DIL) of each ventilation air inlet muffler (Noise Control Measure/Specification No. 12D).

62. PWL of four (4) wall air inlet fans in the compressor building walls with mufflers; result of lines 56 through 61.

63. SPL calculated at the walls of the compressor building with one (1) Solar Taurus Model 70S turbine, one (1) Solar Centaur Model 50S turbine, and one (1) Solar Centaur Model 40S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the building walls.

64. Conversion of SPL in line 63 to represent PWL of turbine casing noise at the four (4) wall air inlet fan openings in the compressor building walls.

65. PWL of the turbine casing noise at the four (4) wall air inlet fan openings in the compressor building walls.

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4 (cont.)

66. Specified Dynamic Insertion Loss (DIL) of each ventilation air inlet muffler (Noise Control Measure/Specification No.12D).

67. PWL of the turbine casing noise at the four (4) wall air inlet fan openings in the compressor building walls with mufflers; result of lines 63 through 66.

68. SPL calculated under the roof of the compressor building with one (1) Solar Taurus Model 70S turbine, one (1) Solar Centaur Model 50S turbine, and one (1) Solar Centaur Model 40S turbine operating. This is based upon the amount of sound absorption provided by the compressor building walls and roof, and upon the distance from the turbines to the building roof.

69. Conversion of SPL in line 68 to represent PWL of turbine casing noise at nine (9) roof air discharge openings in the compressor building roof.

70. PWL of the turbine casing noise at nine (9) roof air discharge openings in the compressor building roof.

71. Specified Dynamic Insertion Loss (DIL) of each ventilation air discharge muffler (Noise Control Measure/Specification No. 12E).

72. PWL of the turbine casing noise at nine (9) roof air discharge openings in the compressor building roof with mufflers; result of lines 68 through 71.

73. Specified maximum SPL at 50 feet from one (1) lube oil cooler with the fan(s) running at maximum speed (Noise Control Measure/Specification No. 13).

74. Distance Term (DT) to convert maximum lube oil cooler SPL at 50 feet to PWL.

75. PWL of one (1) lube oil cooler with the fan(s) running at maximum speed.

76. Number Factor for three (3) lube oil coolers.

77. PWL of three (3) lube oil coolers with the fan(s) running at maximum speed; result of lines 73 through 76.

78. Specified maximum PWL of one (1) gas cooler with the fan(s) running at maximum speed (Noise Control Measure/Specification No. 14).

Detailed Line Item Descriptions
To Support Noise Analysis on Sheets 1 through 4 (cont.)

79. Number Factor for three (3) gas coolers.

80. PWL of three (3) gas coolers with the fan(s) running at maximum speed; result of lines 78 and 79.

81. Total PWL of one (1) Solar Taurus Model 70S, one (1) Solar Centaur Model 50S and one (1) Solar Centaur Model 40S turbine compressor units; logarithmic sum of lines 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 62, 67, 72, 77, and 80.

82. Distance Term (DT) to convert total PWL to SPL at the nearest NSAs (S1) 850 feet north-northwest of one (1) Solar Taurus Model 70S, one (1) Solar Centaur Model 50S, and one (1) Solar Centaur Model 40S turbine compressor units.

83. Energy equivalent sound level (L_{eq}) at the nearest (S1) 850 feet north-northwest of one (1) Solar Taurus Model 70S, one (1) Solar Centaur Model 50S, and one (1) Solar Centaur Model 40S turbine compressor units in the compressor building at the Northampton Compressor Station; result of lines 81 and 82.

84. Day-night sound level (L_{dn}) at the nearest NSAs (S1) 850 feet north-northwest of one (1) Solar Taurus Model 70S, one (1) Solar Centaur Model 50S, and one (1) Solar Centaur Model 40S turbine compressor units in the compressor building at the Northampton Compressor Station.