

APPENDIX D

CALCULATIONS OF HUMAN HEALTH RISK FROM INHALATION OF TOXIC AND CARCINOGENIC SUBSTANCES

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Table D.1 uses EPA reference doses and carcinogenic potency to evaluate the human health risk from inhalation of toxic air pollutants from the proposed project. The first column of Table D.1 lists potential toxic air pollutants emitted from the stack of the proposed project. In the second and third columns, annual tons of pollutant emissions are given for one repowered unit assuming that only coal and only petroleum coke, respectively, were used as fuel. The fourth column is derived by taking the higher of the pollutant emissions in columns 2 and 3 and then converting the units to grams per second, which are the units required as input for the air dispersion modeling. The fifth column indicates maximum annual modeled ground-level concentrations in the ambient air for each of the toxic air pollutants (in units of milligrams per cubic meter), as calculated by the ISCST3 air dispersion model. The sixth column is the EPA reference dose (a no-effect dose set by the EPA for noncarcinogenic compounds) in units of milligrams of the substance taken into the body per kilogram of body weight per day. Based on the assumption that air is inhaled at a rate of 26 yd³ per day by a person weighing 154 lb, the maximum modeled concentrations were converted to doses and compared with the EPA reference doses; the seventh column presents this comparison as the percentage of the EPA reference dose. The eighth column gives the carcinogenic potency in risk per milligram of the substance taken into the body per kilogram of body weight per day. The ninth column is the carcinogenic risk, which is derived from the maximum modeled concentrations (column 5) and the carcinogenic potency (column 8).

Table D.1. Emissions and maximum modeled concentrations of toxic air pollutants resulting from the proposed project compared with EPA reference doses and carcinogenic potency^g

Toxic air pollutant	Predicted emissions by fuel type		Maximum emissions for one unit ^d (g/s)	Maximum modeled concentration ^e (mg/m ³)	EPA reference dose ^f (mg/kg-d)	Percentage of EPA reference dose	Carcinogenic potency ^g (kg-d/mg)	Carcinogenic risk
	Coal ^b (tons/year)	Petroleum coke ^c (tons/year)						
Antimony	1.09×10^{-2}	0	3.14×10^{-4}	1.88×10^{-9}	4×10^{-4}	1.35×10^{-4}		
Arsenic	2.48×10^{-1}	4.37×10^{-2}	7.15×10^{-3}	4.28×10^{-8}	3×10^{-4}	4.08×10^{-3}		
Beryllium	7.51×10^{-3}	2.65×10^{-3}	2.16×10^{-4}	1.3×10^{-9}			8.4	3.11×10^{-9}
Cadmium	3.09×10^{-2}	1.26×10^{-2}	8.9×10^{-4}	2.68×10^{-9}	5.71×10^{-5}	2.67×10^{-3}	6.3	9.6×10^{-9}
Chromium (total): (III)	1.57×10^{-1}	8.33×10^{-3}	4.52×10^{-3}	2.71×10^{-8}	5.71×10^{-7}	1.36		
Chromium (VI)	4.78×10^{-2}	6.15×10^{-3}	1.38×10^{-3}	8.25×10^{-9}			4.2×10^1	9.9×10^{-8}
Cobalt	6.05×10^{-2}	0	1.74×10^{-3}	1.05×10^{-8}	6×10^{-2}	4.97×10^{-6}		
Lead	6.72×10^{-2}	6.74×10^{-1}	1.94×10^{-2}	1.17×10^{-7}	4.29×10^{-4}	7.75×10^{-3}		
Magnesium	6.66	0	1.92×10^{-1}	1.15×10^{-6}				
Manganese	2.97×10^{-1}	1.30×10^{-1}	8.55×10^{-3}	5.1×10^{-8}	1.43×10^{-5}	1.03×10^{-1}		
Mercury (inorganic)	9.72×10^{-2}	2.07×10^{-2}	2.8×10^{-3}	1.68×10^{-8}	8.57×10^{-5}	5.6×10^{-3}		
Nickel	5.39×10^{-2}	1.38	3.97×10^{-2}	2.38×10^{-7}	2×10^{-2}	3.40×10^{-4}		
Selenium	7.87×10^{-1}	7.96×10^{-2}	2.27×10^{-2}	1.36×10^{-7}	5×10^{-3}	7.75×10^{-4}		
Vanadium	2.61×10^{-1}	9.22	2.65×10^{-1}	1.59×10^{-6}	7×10^{-3}	6.5×10^{-3}		
Subtotal carcinogenic risk								1.12×10^{-7}

Table D.1. Continued

Toxic air pollutant	Predicted emissions by fuel type		Maximum emissions for one unit ^d (g/s)	Maximum modeled concentration ^e (mg/m ³)	EPA reference dose ^f (mg/kg-d)	Percentage of EPA reference dose	Carcinogenic potency ^g (kg-d/mg)	Carcinogenic risk
	Coal ^b (tons/year)	Petroleum coke ^c (tons/year)						
Dioxins/furans								
2,3,7,8-TCDD	0	0	0	0			1.16×10^5	0
Total TCDD	2.38×10^{-7}	1.83×10^{-7}	6.85×10^{-9}	4.11×10^{-14}			1.16×10^5	1.36×10^{-9}
Total PeCDD	4.27×10^{-7}	3.29×10^{-7}	1.23×10^{-8}	7.35×10^{-14}			5.8×10^4	1.22×10^{-9}
Total HxCDD	1.82×10^{-6}	1.40×10^{-6}	5.25×10^{-8}	3.14×10^{-13}			4.55×10^{-3}	4.08×10^{-16}
Total HpCDD	6.05×10^{-6}	4.66×10^{-6}	1.74×10^{-7}	1.05×10^{-12}			1.16×10^3	3.46×10^{-10}
Total OCDD	1.74×10^{-5}	1.34×10^{-5}	5.0×10^{-7}	3.0×10^{-12}			1.16×10^2	1.0×10^{-10}
2,3,7,8-TCDF	0	0	0	0			1.16×10^5	0
Total TCDF	1.51×10^{-6}	1.16×10^{-6}	4.34×10^{-8}	2.61×10^{-13}			1.16×10^4	8.65×10^{-10}
Total PeCDF	2.93×10^{-6}	2.25×10^{-6}	8.4×10^{-8}	5.01×10^{-13}			5.8×10^4	8.4×10^{-9}
Total HxCDF	7.69×10^{-6}	5.91×10^{-6}	2.21×10^{-7}	1.33×10^{-12}			1.16×10^4	4.4×10^{-9}
Total HpCDF	2.66×10^{-5}	2.04×10^{-5}	7.7×10^{-7}	4.59×10^{-12}			1.16×10^3	1.52×10^{-9}
Total OCDF	8.29×10^{-5}	6.38×10^{-5}	2.39×10^{-6}	1.43×10^{-11}			1.16×10^2	4.74×10^{-10}
Subtotal carcinogenic risk								1.87×10^{-8}

Table D.1. Continued

Toxic air pollutant	Predicted emissions by fuel type		Maximum emissions for one unit ^d (g/s)	Maximum modeled concentration ^e (mg/m ³)	EPA reference dose ^f (mg/kg-d)	Percentage of EPA reference dose	Carcinogenic potency ^g (kg-d/mg)	Carcinogenic risk
	Coal ^b (tons/year)	Petroleum coke ^c (tons/year)						
Polynuclear aromatics								
Biphenyl	1.03×10^{-3}	0	2.96×10^{-5}	1.78×10^{-10}	5×10^{-2}	1.02×10^{-7}		
Acenaphthene	3.09×10^{-4}	6.05×10^{-4}	1.74×10^{-5}	1.05×10^{-10}	6×10^{-2}	4.97×10^{-8}		
Acenaphthylene	1.51×10^{-4}	3.56×10^{-4}	1.03×10^{-5}	6.2×10^{-11}	3×10^{-2}	5.85×10^{-8}		
Anthracene	1.27×10^{-4}	1.78×10^{-4}	5.1×10^{-6}	3.07×10^{-11}	3×10^{-1}	2.93×10^{-9}		
Benzo(a)anthracene	4.84×10^{-5}	1.83×10^{-4}	5.3×10^{-6}	3.16×10^{-11}			6.1×10^{-1}	5.5×10^{-12}
Benzo(a)pyrene	2.30×10^{-5}	1.04×10^{-4}	2.99×10^{-6}	1.8×10^{-11}			6.1	3.13×10^{-11}
Benzo(b,j, or k)fluoranthene	6.66×10^{-5}	3.24×10^{-4}	9.3×10^{-6}	5.6×10^{-11}			6.1×10^{-1}	9.75×10^{-12}
Benzo(g,h,i)perylene	1.63×10^{-5}	1.07×10^{-4}	3.08×10^{-6}	1.85×10^{-11}			6.1×10^{-3}	3.22×10^{-14}
Chrysene	6.05×10^{-5}	5.68×10^{-4}	1.64×10^{-5}	9.8×10^{-11}			6.1×10^{-3}	1.71×10^{-13}
Fluoranthene	4.30×10^{-4}	9.27×10^{-4}	2.67×10^{-5}	1.60×10^{-10}	4×10^{-2}	1.14×10^{-7}		
Fluorene	5.51×10^{-4}	1.14×10^{-3}	3.28×10^{-5}	1.97×10^{-10}	4×10^{-2}	1.41×10^{-7}		
Indeno(1,2,3-cd)pyrene	5.10×10^{-3}	1.04×10^{-4}	2.99×10^{-6}	1.8×10^{-11}			6.1×10^{-1}	3.13×10^{-12}
Naphthalene	7.87×10^{-3}	5.82×10^{-2}	1.68×10^{-3}	1.01×10^{-8}	4×10^{-2}	7.2×10^{-6}		
Phenanthrene	1.63×10^{-3}	7.12×10^{-3}	2.05×10^{-4}	1.23×10^{-9}	3×10^{-2}	1.17×10^{-6}		
Pyrene	1.20×10^{-4}	2.17×10^{-3}	6.3×10^{-5}	3.75×10^{-10}	3×10^{-2}	3.57×10^{-7}		
5-methyl chrysene	1.33×10^{-5}	0	3.83×10^{-7}	2.3×10^{-12}			4.1×10^{-1}	2.69×10^{-13}

Table D.1. Continued

Toxic air pollutant	Predicted emissions by fuel type		Maximum emissions for one unit ^d (g/s)	Maximum modeled concentration ^e (mg/m ³)	EPA reference dose ^f (mg/kg-d)	Percentage of EPA reference dose	Carcinogenic potency ^g (kg-d/mg)	Carcinogenic risk
	Coal ^b (tons/year)	Petroleum coke ^c (tons/year)						
Acetaldehyde	3.45×10^{-1}	0	9.9×10^{-3}	5.95×10^{-8}			7.7×10^{-3}	1.31×10^{-10}
Acetophenone	9.08×10^{-3}	0	2.61×10^{-4}	1.57×10^{-9}	5.71×10^{-6}	7.85×10^{-3}		
Acrolein	1.76×10^{-1}	0	5.05×10^{-3}	3.04×10^{-8}	5.71×10^{-6}	1.52×10^{-1}		
Benzene	7.87×10^{-1}	7.45×10^{-3}	2.27×10^{-2}	1.36×10^{-7}			2.9×10^{-2}	1.13×10^{-9}
Benzyl chloride	4.24×10^{-1}	0	1.22×10^{-2}	7.3×10^{-8}			1.7×10^{-1}	3.56×10^{-9}
bis(2-ethylhexyl)phthalate	4.42×10^{-2}	0	1.27×10^{-3}	7.6×10^{-9}			1.4×10^{-2}	3.05×10^{-11}
Bromoform	2.36×10^{-2}	0	6.8×10^{-4}	4.07×10^{-9}			3.85×10^{-3}	4.48×10^{-12}
Carbon disulfide	7.87×10^{-2}	0	2.27×10^{-3}	1.36×10^{-8}	2×10^{-1}	1.94×10^{-6}		
2-Chloroacetophenone	4.24×10^{-3}	0	1.22×10^{-4}	7.3×10^{-10}	8.57×10^{-6}	2.44×10^{-3}		
Chlorobenzene	1.33×10^{-2}	0	3.83×10^{-4}	2.3×10^{-9}	5.71×10^{-3}	1.15×10^{-5}		
Chloroform	3.57×10^{-2}	0	1.03×10^{-3}	6.15×10^{-9}			8.05×10^{-2}	1.42×10^{-10}
Cumene	3.21×10^{-3}	0	9.25×10^{-5}	5.55×10^{-10}	2.57×10^{-3}	6.2×10^{-6}		
Cyanide	1.51	0	4.34×10^{-2}	2.61×10^{-7}	2×10^{-2}	3.72×10^{-4}		
Subtotal carcinogenic risk							4.99×10^{-9}	

Table D.1. Continued

Toxic air pollutant	Predicted emissions by fuel type		Maximum emissions for one unit ^d (g/s)	Maximum modeled concentration ^e (mg/m ³)	EPA reference dose ^f (mg/kg-d)	Percentage of EPA reference dose	Carcinogenic potency ^g (kg-d/mg)	Carcinogenic risk
	Coal ^b (tons/year)	Petroleum coke ^c (tons/year)						
2,4-Dinitrotoluene	1.69×10^{-4}	0	4.86×10^{-6}	2.92×10^{-11}	2×10^{-3}	4.17×10^{-7}		
Dimethyl sulfate	2.91×10^{-2}	0	8.35×10^{-4}	5.0×10^{-9}			4.1×10^{-1}	5.9×10^{-10}
Ethyl benzene	5.69×10^{-2}	0	1.64×10^{-3}	9.8×10^{-9}	2.86×10^{-1}	9.8×10^{-7}		
Ethyl chloride	2.54×10^{-2}	0	7.3×10^{-4}	4.38×10^{-9}	2.86	4.38×10^{-8}		
Ethylene dichloride	2.42×10^{-2}	0	6.95×10^{-4}	4.18×10^{-9}			9.1×10^{-2}	1.09×10^{-10}
Ethylene dibromide	7.26×10^{-4}	0	2.09×10^{-5}	1.25×10^{-10}			7.7×10^{-1}	2.76×10^{-11}
Formaldehyde	1.45×10^{-1}	0	4.17×10^{-3}	2.5×10^{-8}			4.55×10^{-2}	3.25×10^{-10}
Hexane	4.06×10^{-2}	0	1.17×10^{-3}	7.0×10^{-9}	5.71×10^{-2}	3.51×10^{-6}		
Isophorone	3.51×10^{-1}	0	1.01×10^{-2}	6.05×10^{-8}			9.5×10^{-4}	1.65×10^{-11}
Methyl bromide	9.69×10^{-2}	0	2.79×10^{-3}	1.67×10^{-8}	1.43×10^{-3}	3.34×10^{-4}		
Methyl chloride	3.21×10^{-1}	0	9.25×10^{-3}	5.55×10^{-8}			6.3×10^{-3}	1.0×10^{-10}
Methyl ethyl ketone	2.36×10^{-1}	0	6.8×10^{-3}	4.07×10^{-8}	2.86×10^{-1}	4.07×10^{-6}		
Methyl hydrazine	1.03×10^{-1}	0	2.96×10^{-3}	1.78×10^{-8}			1.1	5.6×10^{-9}
Methyl methacrylate	1.21×10^{-2}	0	3.48×10^{-4}	2.09×10^{-9}	8×10^{-2}	7.45×10^{-7}		
Methyl tertbutyl ether	2.19×10^{-2}	0	6.3×10^{-4}	3.78×10^{-9}	8.57×10^{-1}	1.26×10^{-7}		
Methylene chloride	1.76×10^{-1}	0	5.05×10^{-3}	3.04×10^{-8}			1.64×10^{-3}	1.43×10^{-11}
Phenol	9.69×10^{-3}	0	2.79×10^{-4}	1.67×10^{-9}	6×10^{-1}	7.95×10^{-8}		

Table D.1. Concluded

Toxic air pollutant	Predicted emissions by fuel type		Maximum emissions for one unit ^d (g/s)	Maximum modeled concentration ^e (mg/m ³)	EPA reference dose ^f (mg/kg-d)	Percentage of EPA reference dose	Carcinogenic potency ^g (kg-d/mg)	Carcinogenic risk
	Coal ^b (tons/year)	Petroleum coke ^c (tons/year)						
Tetrachloroethylene	2.60×10^{-2}	0	7.5×10^{-4}	4.49×10^{-9}			2.03×10^{-3}	2.6×10^{-12}
Toluene	1.45×10^{-1}	0	4.17×10^{-3}	2.5×10^{-8}	1.14×10^{-1}	6.25×10^{-6}		
1,1,1-Trichloroethane	1.21×10^{-2}	0	3.48×10^{-4}	2.09×10^{-9}	2.86×10^{-1}	2.09×10^{-7}		
Styrene	1.51×10^{-2}	0	4.34×10^{-4}	2.61×10^{-9}	2.86×10^{-1}	2.6×10^{-7}		
Xylenes	2.24×10^{-2}	0	6.45×10^{-4}	3.87×10^{-9}	2	5.5×10^{-8}		
Vinyl acetate	4.60×10^{-3}	0	1.33×10^{-4}	7.95×10^{-10}	5.71×10^{-2}	3.97×10^{-7}		
Acid gases								
HCl	3.63×10^1	3.19	1.05	6.25×10^{-6}	5.71×10^{-3}	3.14×10^{-2}		
HF	6.08	1.48	1.75×10^{-1}	1.05×10^{-6}	7×10^{-4}	4.28×10^{-2}		
Subtotal carcinogenic risk							6.75×10^{-9}	
Total carcinogenic risk							1.42×10^{-7}	

^aAbbreviations: Cr = chromium; HCl = hydrogen chloride; HF = hydrogen fluoride; mg/kg-d = milligram/(kilogram-day); HpCDD = heptachlorodibenzodioxin; HpCDF = heptachlorodibenzofuran; HxCDD = hexachlorodibenzodioxin; HxCDF = hexachlorodibenzofuran; OCDD = octachlorodibenzodioxin; OCDF = octachlorodibenzofuran; PeCDD = pentachlorodibenzodioxin; PeCDF = pentachlorodibenzofuran; TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin; TCDF = tetrachlorodibenzofuran.

^bEmissions per unit if only coal were used.

^cEmissions per unit if only petroleum coke were used.

^dEmissions per unit for the greater of 100% coal used or 100% petroleum coke used.

^eMaximum annual ground-level concentration in the ambient air.

^fEPA reference dose (a no-effect dose for noncarcinogenic compounds) in milligrams of the substance taken into the body per kilogram of body weight per day.

^gCarcinogenic potency in risk per milligram of the substance taken into the body per kilogram of body weight per day.

Source: Data taken from: <http://www.epa.gov/reg3hwmn/risk/riskmenu.htm> (accessed July 17, 1998).