Air Emissions Risk Analysis

Prepared for
Great River Energy

Elk River, Sherburne County

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RISK ANALYSIS SUMMARY

1.0 Introduction

An Air Emissions Risk Analysis (AERA) was conducted for the Great River Energy Elk River Station located in Sherburne County, Minnesota. Major components of the risk analysis include: emission calculations, air dispersion modeling, estimating potential incremental human health risks for inhalation and indirect exposure (consumption of locally grown garden), and a qualitative analysis that includes a discussion on uncertainty for the quantitative risk estimates and identifies issues for which public health impacts cannot be easily quantified.

The procedures used in conducting the AERA were based on screening procedures identified in the Minnesota Pollution Control Agency (MPCA) guidance documents and/or information posted to their website (http://www.pca.state.mn.us/air/aera.html).

- General guidance per the March 2004 (Version 1.0) AERA guide.
- Emission estimates per the "Emissions Estimating Guidance" (March 2006).
- Risk estimates using the MPCA's Risk Assessment Screening Spreadsheet (RASS; Version 20060829) to estimate potential incremental human health chronic and acute inhalation and multimedia risks.

The AERA process is designed to identify those sources, source groups, chemicals and associated exposure pathways that clearly do not pose unacceptable risks or hazards to the public as a result of their emissions. In this document, "risk" generally refers to estimated cancer risks and the potential for noncancer health effects. Noncancer health effects are described using a hazard quotient (HQ) for a single chemical or a hazard index (HI; the sum of HQs) for all noncancer chemical exposures. In the AERA process, "quantitative analysis" specifically refers to the estimation of cancer risks and hazard indices using the RASS.

In general terms, risk analysis is a comparison of the toxicity of a chemical with the exposure to that chemical, and regardless of how risks are expressed, risks remain dependent on toxicity and exposure. To alter either one alters the risk. Therefore, an accurate assessment of risk requires thorough knowledge of the existing information concerning the toxicity of the chemical associated with the specific route of exposure, predicted intake, absorption, metabolism, excretion, tissue accumulation and species variation. Because of the limitation inherent in the risk assessment process it is very important to recognize that the risk characterization described in this or any AERA cannot predict actual health outcomes such as cancer. In other words, this or any AERA does not provide an estimate of actual risk to a real person.

Only one risk concept is evaluated in this analysis: the Maximum Exposed Individual (MEI). The MEI concept assumes that all maximum modeled air concentrations occur at one location. For chronic (long-term) risks, the MEI concept assumes that a person is present at the location of maximum modeled air concentrations and is outdoors continuously for a lifetime (24 hours per day, 365 days per year, for 70 years). For acute (1-hour) risks, the MEI concept assumes that a person can be present at the location of maximum modeled air concentrations for an hour.

The MEI concept is designed to more likely overestimate potential risks than underestimate risk and provides a worst-case exposure scenario and an upper bound (near 100^{th} percentile) estimate of potential incremental health risks. The MEI concept is to be used as a screening tool to determine if more detailed analyses or the inclusion of other exposure concepts such as the Modified Central Tendency Exposure (MCTE) are warranted.

Two risk calculations are provided in this analysis. Risk estimates for the MEI scenario are calculated for the existing facility (pre-project) and for the post-project facility and provide the potential incremental risks for the project.

2.0 Emission Calculations

The chemicals evaluated in this AERA are primarily associated with the combustion of fuel oil, natural gas, and refuse-derived fuel. The chemical list is provided in Table 1.

Emissions were calculated in a conservative manner. Sources for emission factors included AP-42, EPA Combustion Turbines Emissions Database v.5, manufacturers guarantees, stack test data, and EPA TANKS 4.0.9d. The details of the emission calculations are provided electronically in the "emission calculation spreadsheet".

2.1 Peaking Turbine

Manufacturer's worst-case scenario information was used for criteria emission factors. AP-42 emission factors were used for hazardous air pollutant (HAP) emission calculations. In addition, non-AP-42 HAP pollutants found in the EPA Combustion Turbines Emissions Database v.5 were added to the turbine emissions. The turbine emissions are currently calculated using 8,760 hours per year, which provides for a conservatively high emissions scenario. Great River Energy anticipates annual needs of only 76 hours of fuel oil operation and 800 hours of natural gas operation; however, final permitted hours of operation will be determined through the air permitting process.

2.2 Refuse-Derived Fuel Burner

Emissions from the refuse-derived fuel (RDF) burner were based on historical stack test averages plus one standard deviation. The emission calculations are detailed in the "emission calculation" spreadsheet. The one exception to this emission calculation approach was for dioxins/furans.

For dioxins/furans the AERA evaluated the permit limit of 30 ng/DSCM (nanograms per dry standard cubic meter) total PCDD/PCDF on a 2,3,7,8-TCDD equivalents basis. Speciating the permit limit into the various 2,3,7,8-substituted isomers required an assessment of the available stack testing data. This data assessment included validating dioxin/furan congener concentrations in each sample. After the data validation step was completed, the next steps involved deriving an average composition to be applied to the permit limit of 30 ng/DSCM total PCDD/PCDF. First, the valid concentration for each 2,3,7,8-substituted isomer in a sample was divided by the Total PCDD/PCDF concentration reported for that sample. This provides a percent composition of each valid isomer in a sample. The average composition across the data set was then calculated for each 2,3,7,8-substituted isomer (Table 2). A memorandum detailing this analysis is available upon request.

Table 1. Chemical list for the Air Emissions Risk Analysis (AERA) conducted for the Great River Energy Elk River Station, Sherburne County, Minnesota.

PM	
PM_{10}	
CO	
SO_2	
NOx	
H_2SO_4 Mist	
VOC	
VOCs	**Metals and Semivolatiles**
1,3-Butadiene	Aluminum
2,2,4-Trimethylpentane	Arsenic
Acetaldehyde	Barium
Acrolein	Beryllium
Benzene	Boron
Carbon tetrachloride	Cadmium
Chlorobenzene	Calcium
Chloroform	Chromium
Dichlorobenzene	Cobalt
Ethyl benzene	Copper
Ethylene dichloride	Iron
Formaldehyde	Lead
Hexane	Magnesium
Hydrochloric acid	Manganese
Methylene chloride	Mercury
Naphthalene	Molybdenum
N-Nitrosodimethylamine (NDMA)	Nickel
N-Nitrosomorpholine (NMOR)	Selenium
Propylene oxide	Silver
Tetrachloroethylene	Sodium
Toluene	Strontium
Trichloroethylene	Tin
Trimethoxyamphetamines (TMA)	Vanadium
Vinyl chloride	Zinc
Vinylidene chloride	Chloride
Xylenes	Sulfate
	Semivolatiles
	Dioxins/Furans (as 2,3,7,8-TCDD equivalent)
	PAH (Total)

Table 2. Average composition of dioxin/furan congeners from stack test data at the Great River Energy RDF plant in Elk River, Minnesota, and derivation of a 2,3,7,8-TCDD equivalents for the existing permit limit.

Dioxin/Furan Congener	Average Composition	Concentration @ 30 ng/DSCM [ng/DSCM]	TEF (DF) WHO2005	TEQ Calculation [ng/DSCM]
2,3,7,8-TCDD	0.13%	0.039	1	0.039
1,2,3,7,8-Dioxin penta	0.38%	0.113	1	0.113
1,2,3,4,7,8-Dioxin, hexa	0.48%	0.145	0.1	0.015
1,2,3,6,7,8-Dioxin, hexa	0.76%	0.228	0.1	0.023
1,2,3,7,8,9-Dioxin, hexa	0.60%	0.179	0.1	0.018
1,2,3,4,6,7,8-Dioxin, hepta	6.53%	1.960	0.01	0.020
Dioxin, octa	13.93%	4.178	0.0003	0.001
2,3,7,8-TCDF	0.00%	0.000	0.1	0.000
1,2,3,7,8-Dibenzofuran, penta	0.88%	0.263	0.03	0.008
2,3,4,7,8-Dibenzofuran, penta	1.19%	0.357	0.3	0.107
1,2,3,4,7,8-Dibenzofuran, hexa	1.56%	0.469	0.1	0.047
1,2,3,6,7,8-Dibenzofuran, hexa	1.61%	0.483	0.1	0.048
1,2,3,7,8,9-Dibenzofuran, hexa	0.53%	0.159	0.1	0.016
2,3,4,6,7,8-Dibenzofuran, hexa	2.08%	0.625	0.1	0.063
1,2,3,4,6,7,8-Dibenzofuran, hepta	8.03%	2.409	0.01	0.024
1,2,3,4,7,8,9-Dibenzofuran, hepta	1.16%	0.349	0.01	0.003
Dibenzofuran, octa	4.53%	1.359	0.0003	0.000
TEQDF-WHO2005 [ND= 1/2 DL]				**0.54**

3.0 Air Dispersion Modeling

Detailed air dispersing modeling was conducted with the AERMOD model for the AERA. The building inputs used for the BPIP analysis are the same as those submitted to the MPCA on April 1, 2002. The receptor grid had 25 meter spacing along the property boundary, 50 meter spaced Cartesian grid out to 500 meters, and a 200 meter polar grid with a radius of 4 km. Five years of meteorological data were obtained from the MPCA.

A one gram/second emission rate modeling run was conducted, and post-processing then used the emission rates from the existing (pre-project) facility and then from the post-project facility to estimate maximum air concentrations for 1-hour, monthly, and annual averaging periods. The electronic modeling files (input and output) are provided with this submittal.

The maximum off-property air concentrations for each modeled pollutant were obtained from the air dispersion modeling (maximum hourly, monthly, annual). These maximum air concentrations were input to the RASS and used to estimate potential incremental human health risks for the existing facility (pre-project) and the post-project facility.

4.0 Quantitative Risk Estimates Using the MPCA RASS

Estimated risks for the existing (pre-project) facility (Table 3), the post-project facility (Table 4), and the project-only risks (Table 5) are presented below. As identified in Table 5, potential incremental human health risks for the project are below the Minnesota Department of Health guidelines of 1E-05 for cancer (one cancer per 100,000 people) and 1.0 for noncancer (chronic, acute).

Risk driver pollutants for the project-only incremental multipathway risks are as follows:

- Cancer (farmer): dioxins/furans, 3E-04; PAHs (total), 6E-05.
  - For comparison, the project only dioxin/furan risk for a resident = 2E-06.
  - For comparison, the project only PAH (total) risk for a resident = 2E-07.
- Noncancer chronic: no risk drivers; all chemicals with HQs less than 0.1.
- Noncancer acute: Nitrogen dioxide (NO_2); HQ = 0.30.

Maximum estimated air concentrations occur at, or only a short distance from, the property boundary. Potential incremental risks for a farmer are calculated but there is currently no farming occurring at the Elk River Station property boundary. The current trend in the Elk River area is for farmland to be converted to residential land use. An assessment of reasonably foreseeable future land use indicates it is highly unlikely for new farms to be located in an urban area such as Elk River. The potential farmer risks in Table 5 are below the MDH guideline.

Conservatism in the analysis that leads to overestimates of potential risk include the following:

- Use of the MEI concept; maximum outdoor exposure (24 hours/day, 365 days/year; 70 years). This is an exposure that does not occur in an actual population.
- Assuming that all maximum modeled air concentrations occur at one location, and that a person lives at that location. Air dispersion modeling identifies that the maximum air concentrations for the risk driver pollutants occur at different locations and risk at specific receptor locations are lower than the maximum risks presented in Tables 3, 4, and 5.
- Potential metal emissions from the RDF ash handling silo are assumed to be 100% bioavailable. This is a conservative assumption and provides for an overestimate of potential risks.
- Worst case emission factors were used for the combustion turbine and these factors are predominantly from fuel oil. In addition, turbine operations were assumed for 8,760 hours per year. The operating scenario in conjunction with using worst case emission factors from fuel oil results in an analysis that essentially assumes the turbine will burn fuel oil. This operating is not expected to occur for the combustion turbine.
- Evaluating total PAHs as a group. The toxicity value for benzo(a)pyrene (BaP) is assigned to total PAHs in RASS. BaP is typically only a small percent of total PAHs. By assuming the total PAHs are as toxic as BAP overestimates the potential risks from PAHs.

Table 3. Estimated potential incremental risk for the existing (pre-project) facility at the Great River Energy Elk River Station, Sherburne County, Minnesota; Maximum Exposed Individual concept.

[Existing Facility; Pre-project]

Air Toxics Screen [1]												
Total Inhalation Screening Hazard Indices and Cancer Risks				Total Indirect Pathway Screening Hazard Indices and Cancer Risks				Total Multipathway Screening Hazard Indices and Cancer Risks				
Acute	Subchronic Noncancer	Chronic Non-cancer	Cancer	Farmer Non-cancer [2]	Farmer Cancer [2]	Resident Non-cancer	Resident Cancer	Farmer Non-cancer [2]	Farmer Cancer [2]	Resident Non-cancer	Resident Cancer	
2.4E-01	1.5E-02	7.5E-02	7E-06	1.1E-04	2E-03		6E-06	7.5E-02	2E-03	7.5E-02	1E-05	
1.0E+00	1.0E+00	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	<<< Acceptable Level
OK	OK	OK	OK	OK	REFINE		OK	OK	REFINE	OK	OK	<<<OK or Not?

[1] Cancer risks rounded to one significant figure per U.S. EPA guidance (1989; 2005).

[2] Farmer risks are reported but farming is not a current land use at the Elk River Station property boundary. Reasonably foreseeable future land use indicates it is highly unlikely for a farmer to be located at the property boundary.

Table 4. Estimated potential incremental risk for the post-project facility at the Great River Energy Elk River Station, Sherburne County, Minnesota; Maximum Exposed Individual concept.

[Post-project]

Air Toxics Screen [1]												
Total Inhalation Screening Hazard Indices and Cancer Risks				Total Indirect Pathway Screening Hazard Indices and Cancer Risks				Total Multipathway Screening Hazard Indices and Cancer Risks				
Acute	Subchronic Noncancer	Chronic Non-cancer	Cancer	Farmer Non-cancer [2]	Farmer Cancer [2]	Resident Non-cancer	Resident Cancer	Farmer Non-cancer [2]	Farmer Cancer [2]	Resident Non-cancer	Resident Cancer	
6.1E-01	2.0E-02	9.9E-02	7E-06	2.2E-04	2E-03		7E-06	9.9E-02	2E-03	9.9E-02	1E-05	
1.0E+00	1.0E+00	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	<<< Acceptable Level
OK	OK	OK	OK	OK	REFINE		OK	OK	REFINE	OK	OK	<<<OK or Not?

[1] Cancer risks rounded to one significant figure per U.S. EPA guidance (1989; 2005).

[2] Farmer risks reported but farming is not a current land use at the Elk River Station property boundary. Reasonably foreseeable future land use indicates it is highly unlikely for a farmer to be located at the property boundary.

Table 5. Estimated potential incremental risk for the peaking plant (project only) proposed to be located at the Great River Energy Elk River Station, Sherburne County, Minnesota; Maximum Exposed Individual concept [1]

[Turbine Project Only]

Air Toxics Screen [1]												
Total Inhalation Screening Hazard Indices and Cancer Risks				Total Indirect Pathway Screening Hazard Indices and Cancer Risks				Total Multipathway Screening Hazard Indices and Cancer Risks				
Acute	Subchronic Noncancer	Chronic Non-cancer	Cancer	Farmer Non-cancer [2]	Farmer Cancer [2]	Resident Non-cancer	Resident Cancer	Farmer Non-cancer [2]	Farmer Cancer [2]	Resident Non-cancer	Resident Cancer	
3.7E-01	4.2E-03	2.4E-02	8.E-07	1.2E-04	3.E-04		1.E-06	2.4E-02	3.E-04	2.4E-02	2.E-06	
1.0E+00	1.0E+00	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	1.0E+00	1.0E-05	<<< Acceptable Level
OK	OK	OK	OK	OK	OK		OK	OK	OK	OK	OK	<<<OK or Not?

[1] Cancer risks rounded to one significant figure per U.S. EPA guidance (1989; 2005).

[2] Farmer risks reported but farming is not a current land use at the Elk River Station property boundary. Reasonably foreseeable future land use indicates it is highly unlikely for a farmer to be located at the property boundary.

In summary, estimated potential incremental risks from the proposed project are below the MDH guidelines. Based on the available information, adverse impacts to human health are not expected to be associated with potential emissions from the proposed project.

The details of the risk results are provided in the electronic versions of the RASS. A separate RASS file is submitted for the existing facility (pre-project) and the post-project facility.

For perspective, the reader should note that background cancer risk for males in Minnesota is 1 in 2 (0.5; 5E-01) regardless of where one lives in the state (MDH 2000); 50,000 cancer cases in a population of 100,000 people. Accounting for potential incremental resident cancer risk of 3E-08 from the project (one per 100,000,000 people) the number of cancer cases would remain at 50,000 because the potential incremental cancer risk from the project is very small. In other words, the additional incremental cancer risk is insignificant compared to background cancer risk. It is also important to understand that that the actual cancer risk, when compared to the estimated cancer risks in this AERA, are probably less than the calculated value and may be as low as zero.

5.0 Qualitative Screening Analysis

This discussion is part of Form AERA-02.

6.0 References

MDH 2000. Minnesota Department of Health, Statement of Need and Reasonableness (draft), Proposed Permanent Rules Relating to Health Risk Values, Minnesota Rules, Parts 4717.800 to 4717.8600. Page. 10. October 2000.

MPCA 2004. Air Emission Risk Analysis (AERA) Guidance. Version 1.0. Minnesota Pollution Control Agency, 520 Lafayette Road, St. Paul. March 2004.

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U.S. EPA 2005. Human health risk assessment protocol for hazardous waste combustion facilities. Final. (HHRAP). EPA 530-R-05-006. September 2005.