

Addendum: Wolverine Clean Energy Venture (WCEV) Mercury Risk Assessment and Cumulative Risk Assessment (PTI Application # 317-07)

September 17, 2008

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The purpose of this addendum report is to provide additional information which supplements two previous assessment reports (Sills, 2008a, 2008b). Specifically, additional modeling of the proposed facility emissions and impacts was provided, which involved the following:

- A. Mercury emissions and dispersion modeling, and risk assessment:
 - 1. There was a correction to the mercury emission rates from the CFB boilers, resulting in a 16% increase in emissions.
 - 2. There was an addition of recently available 2007 meteorological data, along with the previously utilized 2005 and 2006 meteorological data.

- B. Cumulative risk assessment
 - 1. There were changes in some of the dispersion modeling results, primarily reflecting an accounting for stack parameters during startup/shutdown periods.
 - 2. There was an addition of recently available 2007 meteorological data, along with the previously utilized 2005 and 2006 meteorological data.

Further details of these modeling aspects, and their impacts on the previously developed risk assessment report findings, are provided below.

A. Mercury deposition impacts

The applicant (WCEV, 2007) submitted a mercury deposition impact assessment for four local water bodies. They utilized meteorological data for 2005 and 2006 in that modeling assessment of mercury emissions from the CFB1 and CFB2 boilers. In September 2008, it was discovered that the mercury emission rate estimate should have been 16% greater. The corrected mercury emission rates and modeled maximum ambient air impacts were provided by Yanochko (2008a). Accordingly, the applicant provided a revised mercury deposition impact assessment for CFB1 and CFB2 mercury emissions, utilizing the corrected mercury emission rates and the 2005 and 2006 meteorology data. (FTC&H, 2008a). AQD requested that the applicant also include the 2007 meteorological data in that assessment. Subsequently, FTC&H (2008b) submitted a revised mercury deposition impact assessment, based on the average of the modeled dispersion with 2005-2007 meteorological data. That assessment (FTC&H, 2008b) provided estimates of the incremental impacts of the CFB boiler mercury emissions.

Previously, AQD provided a summary of the WCEV (2007) mercury deposition modeling impacts (Sills, 2008a). The impacts to Swan Lake were relatively greater than the impacts to the other modeled lakes. Also, Sills (2008a) evaluated some potential alternative reasonable assumptions for the deposition impact modeling, which determined which particular set of assumptions would result in the highest estimated incremental

impact to Swan Lake fish mercury levels. It should be noted that the applicant's modeling of mercury deposition and fish impacts utilized a conservative assumption that 100% of the emitted mercury was in the form of reactive gaseous mercury (RGM; Hg^{+2}). RGM has a greater tendency for local deposition to nearby water bodies than the other mercury forms that are generally believed to be present in power plant emissions (elemental mercury vapor and particle-bound divalent mercury). The other assumptions utilized by the applicant were reasonable.

The revised mercury impact modeling based on the dispersion modeling results (2005-2007; FTC&H (2008b)) for Swan Lake were replicated and confirmed by this author. The dispersion modeling results were also utilized by this author for mercury impact modeling utilizing the set of reasonable alternative assumptions which had resulted in the highest incremental impact to Swan Lake fish mercury levels (Sills, 2008a).

The results of the series of mercury deposition modeling may be summarized as follows. WCEV (2007) reported that the highest incremental fish mercury impact estimate was for Swan Lake at 0.003 mg/kg (ppm). Sills (2008a) confirmed that result, and also provided an estimate of 0.005 mg/kg utilizing alternative estimates for the background mercury deposition rate as described in WCEV (2007). Sills (2008a) indicated that utilizing the set of alternative reasonable assumptions which resulted in the highest incremental impact to Swan Lake (model run # "L") resulted in an incremental fish mercury impact estimate of 0.006 mg/kg. Utilizing the corrected (16% higher) mercury emission rate for the CFB boilers and the 2005-2007 meteorological data, FTC&H (2008b) reported that the highest incremental fish mercury impact was for Swan Lake, at 0.004 mg/kg. This author replicated that result, and also derived an estimate of 0.006 mg/kg utilizing alternative estimates for the background mercury deposition rate as described in WCEV (2007). This author also repeated model run "L" utilizing the set of alternative reasonable assumptions which resulted in the highest incremental impact to Swan Lake. That modeling resulted in an estimated impact of 0.007 mg/kg. It should be noted that model run "L" utilized a conservative assumption that 100% of the mercury emitted is in the RGM form, and other alternative assumptions which may be considered reasonable and which resulted in the highest impact estimate (Sills, 2008a).

As indicated previously, the mercury deposition impact modeling focused on the mercury emissions for only the CFB boilers. As indicated by the dispersion modeling results (Yanochko, 2008a), mercury emissions also occur from three other emission units. As indicated in Sills (2008a), a focus on the CFB boiler emissions may be acceptable because the great majority of the facility-wide mercury emissions are from those units. That issue was revisited utilizing the corrected mercury emission rates for the CFB boilers (Yanochko, 2008a), with accounting for the proposed permit limits for the hrs/year operation of the other emission units (4,000 hrs/yr for the auxiliary boiler; 500 hrs/yr for the black start generator; and, 500 hrs/yr for the fire pump). That assessment resulted in an estimate that 97.6% of the facility-wide mercury emissions were attributable to the CFB boilers. That finding supports the approach of focusing the mercury deposition impact assessment on the CFB boiler emissions. The inclusion of the emissions and impacts of the other emission units would not be expected to have any

significant effect on the deposition impact modeling results, particularly since the key modeling results (the incremental fish mercury impacts) were very small and therefore appeared in the model output with only one significant figure.

AQD also noted that the CFB boiler startup and shutdown conditions may be expected to have lower heat input, lower exit velocity, and higher mercury maximum ambient air impact levels, compared to normal operating conditions. AQD modeling (by Jim Haywood) indicates that those startup/shutdown conditions, if present *continuously* for all the modeled years, would result in maximum ambient air impacts (with annual averaging time) that are approximately 1.7 times greater than the modeled impacts based on normal operating conditions. However, the proposed permit conditions allow for startup and shutdown conditions to occur no more than 12 total times per year, for a duration of no more than 8 hours (shutdown) or 24 hours (startup). If it is assumed that the maximum permitted startup/shutdown frequency and duration occurs, with normal operating conditions the remainder of the year (i.e., no down-time), then the time-weighted average model result for the maximum ground level concentration [$2.86\text{E-}3$ (ug/m³)/(lb/hr)] is only 1.6% greater than the model result for normal operating conditions [$2.815\text{E-}3$ (ug/m³)/(lb/hr)]. This indicates that the focus on the stack conditions during normal operating conditions does not result in a significant underestimation of the long-term mercury impacts. It should also be noted that the modeled maximum ambient air concentration for mercury ($4.24\text{E-}5$ ug/m³, annual averaged; Haywood (2008)) is 7,075 times lower than the EPA Reference Concentration (RfC) for mercury, indicating that the mercury emissions do not pose a significant inhalation risk during normal or startup/shutdown operating conditions.

B. Cumulative risk assessment

The previous assessment of potential concerns for cumulative exposures and risks (Sills, 2008b) was re-visited, due to the availability of updated ambient air impact modeling. The final version of the updated air toxics dispersion modeling is Haywood (2008b). The updated modeling was based on 2005-2007 meteorological data (previously it had included 2005-2006), and also was reflective of startup and shutdown conditions for the modeling of impacts of air toxics with averaging times of 24 hours or less. As noted above, startup and shutdown conditions are estimated to have lower heat input, lower exit velocity, and higher maximum ambient air impacts, compared to normal operating conditions. The results of the noncarcinogenicity additivity assessment based on the updated ambient air impact assessment are presented in Table 1.

As indicated in Table 1 (footnote #6), the Total HI may be derived as a conservative screening step, without distinguishing between the differences in target organs/effects of substances. The Total HI from the updated assessment is not significantly greater than that from the previous assessment. As indicated in Table 1, most of the substances have a target organ/effect of irritation or respiratory effects. The updated assessment does not raise particular concerns due to the magnitude of the Total HI (= 1.738) or the irritation/respiratory HI (= 1.47).

Table 1. Additivity assessment of noncarcinogenic air toxics: previous and updated assessments

Substance	Applicant's HQ ¹ (previous assessment by Sills (2008b))	AQD's HQ ² (previous assessment by Sills (2008b))	AQD's HQ ² (updated assessment)	Target organ / effect ³
Acrolein	0.02	0.024	0.03	Irritation
HCl	0.58	0.058	0.022	Irritation; respiratory
HF	0.22	0.229	0.342	Irritation; respiratory
Methyl hydrazine	-	-	0.118	Recently developed ITSL (5/15/08); irrit., resp., liver, hematology, dec. body wt., circulatory (angiectasis)
Ammonia	0.015	0.015	0.032	Irritation; respiratory
Sulfuric acid	0.19	0.19	0.356	Respiratory; irritation
Beryllium	0.14	0.14	0.302	Respiratory (subpharyngeal)
Chromium (+6)	0.032	0.036	0.015	Irritation
Cobalt	0.01	0.01	0.019	Respiratory
Manganese	0.13	0.136	0.264	CNS
Selenium	0.018	0.018	0.029	Irritation; respiratory; CNS (headaches); GI
Vanadium	0.14	0.14	0.209	Irritation; respiratory (Vanadate pentoxide ITSL)
Mercury ⁴	0.00012	0.00012	0.00014	CNS; see note #4
Lead ⁵	0.0057	0.001	0.0076	CNS; see note #5
TOTAL	Total HI = 1.475 ~ 1 (see note #6)	Total HI = 0.996 ~ 1 (see note #6)	Total HI = 1.738 ~ 2 (see note #6)	All; see note #6

1. As utilized by Sills (2008b), the applicant (Table 6-17, 12/4/07 update) provided the maximum ambient air impacts and comparisons to AQD screening levels. The Hazard Quotient (HQ) is the value resulting from dividing the maximum ambient air impact by the health risk-based protective benchmark level (the ITSL). ITSL = Initial Threshold Screening Level. The ITSL is the concentration of a substance over a specified averaging time which is protective against noncarcinogenic effects, as derived according to the Air Pollution Control Rules.

2. As utilized by Sills (2008b), these HQs are based on the maximum ambient air impacts from the AQD modeling (Haywood, 2008a).

3. The target organ / effects of "irritation" and "respiratory" may overlap for some substances; "irritation" may include irritation to the eyes, nose, throat, or skin.

4. For mercury, the applicant (WCEV, 2007) provided a modeled maximum ambient air concentration of 3.61E-05 ug/m³ (with annual averaging time) for total mercury. That impact was divided by the EPA Reference Concentration (RfC) for elemental mercury (0.3 ug/m³). The resulting HQ is for inhalation-only exposure; multipathway exposure and risk is addressed in WCEV (2007) and Sills (2008a). The HQs presented here are well below the 0.01 criterion for inclusion, but they are presented here for clarity and completeness.

5. For lead, the previous assessment utilized the AQD modeled ambient air impact for residential areas, 0.0001 ug/m³ (annual averaging time; Sills and Sadoff, 2008). The applicant’s modeled maximum impact was 0.00057 ug/m³ (monthly averaging time; Caudell, 2008). For the updated assessment, the modeled maximum ambient air impact (7.6E-04, monthly average; Haywood, 2008b) was utilized. Lead is not an air toxic, therefore there is no ITSL. The National Ambient Air Quality Standard for lead is currently 1.5 ug/m³. However, EPA (2008) has proposed revising the standard to a value in the range of 0.1 to 0.3 ug/m³, and has solicited comment on an averaging time of monthly or calendar quarter. For the purposes of this additivity assessment, the modeled ambient air impacts listed here were compared to the low-end of the EPA proposed NAAQS range (0.1 ug/m³), without attempting to adjust for the differences in averaging times. The HQs presented here are well below the 0.01 criterion for inclusion, but they are presented here for clarity and completeness. Multipathway lead impacts are addressed in Sills and Sadoff (2008).

6. As a screening step (Sills et al., 2008), the sum of all HQs can provide a “Total Hazard Index (HI)”. This is a conservative screening approach, without the appropriate separation of substances and HQs according to the commonality of the target organ or critical effect.

As noted in Sills (2008b), some of the criteria pollutants emitted by WCEV (SO₂, NO_x, and PM-10) are respiratory tract irritants. Although the EPA does not evaluate cumulative exposures and risks for the criteria pollutants, the total ambient air concentrations for those which are respiratory irritants are summarized in Table 2.

Table 2. WCEV criteria pollutant respiratory irritants and their impacts as percentages of the NAAQS, based on the previous assessment (Haywood, 2008a) and (in parentheses) based on the updated assessment (Haywood, 2008c).

Substance	Total impacts ¹ as % of NAAQS ²		
	3 hr. avg. time (AT)	24 hr AT	Annual AT
SO ₂	8.1% (16.8%)	11.5% (21.2%)	4.8% (9.3%)
NO _x	-	-	9.1% (14.8%)
PM-10	-	85.9% (71.4%)	55.1% (56.1%)

¹ Total impact includes WCEV, other sources, and the area background.

² Based on the AQD Air Dispersion Analysis Summaries by Haywood (2008a, 2008c).

The updated assessment of the cumulative cancer risk estimate based on the updated ambient air impact assessment is presented in Table 3. This indicates that the updated assessment did not result in significant changes from the previous assessment (Sills, 2008b).

Table 3. Additive cancer risk estimates of WCEV project emissions, based on the previous assessment (Sills, 2008b) and the updated modeling results (Haywood, 2008b).

Substance	Risk estimates (plausible upper-bound)		
	Based on applicant's modeled impacts (previous assessment by Sills (2008b))	Based on AQD's modeled impacts (previous assessment by Sills (2008b))	Based on AQD's modeled impacts (Haywood 2008b; updated assessment)
Methyl hydrazine	1.9E-7	1.91E-7	1.8E-8
B(a)P and combined PAHs	2.7E-8	2.7E-8	3.3E-8
Naphthalene	2.4E-8	2.4E-8	2.3E-8
Benzene	1.E-7	1.E-7	1.04E-7
Benzylchloride	1.9E-8	2.E-8	3.2E-8
1,3-butadiene	1.5E-8	1.5E-8 (applicant's value)	1.4E-8
Formaldehyde	1.3E-7	1.38E-7	1.27E-7
Arsenic	2.4E-6	2.49E-6	2.2E-6
Beryllium	4.1E-7	4.25E-7	6.7E-7
Cadmium	2.2E-7	2.23E-7	2.48E-7
Chromium (+6)	3.5E-7	8.43E-7	7.23E-7
Nickel	1.4E-7	1.43E-7	2.15E-7
2,3,7,8-TCDD – TEQ ¹	1.2E-7	1.22E-7	1.96E-7
TOTAL	Total cancer risk = 4.1E-6 ~ 4 in 1 million	Total cancer risk = 4.7E-6 ~ 5 in 1 million	Total cancer risk = 4.6E-6 ~ 5 in 1 million

¹ The applicant evaluated polychlorinated dibenzodioxins and dibenzofurans by utilizing the available emission factors from the EPA AP-42 reference. Those emission factors are for homologous groups (e.g., TCDD) rather than for specific congeners (e.g., 2,3,7,8-TCDD). The applicant applied the highest congener-specific EPA toxic equivalency factors (TEFs) to the emission factors for the homologous groups represented by those congeners, since congener-specific emission factors were not available (FTC&H, 2007; Yanocho, 2008b). This is a very conservative approach.

References

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