Supplemental Lead IEUBK Modeling Results for Recent Coal Fired Power Plant Permit to Install Applications
June 16, 2008 (revised August 8, 2008)

Introduction and Background

The Air Quality Division (AQD) has recently evaluated potential concerns for the impacts of lead emissions for permit applications for coal fired power plants (Consumers Energy Karn-Weadock, Holland BPW, Mid-Michigan Energy, and Wolverine Power WCEV). Those AQD evaluations have been based upon assessments performed and submitted by the applicants, or, in the case of Wolverine WCEV, conducted by this author (Sills and Sadoff, 2008). Those assessments involved the use of the EPA (2008a) IEUBK model to estimate the potential impacts to children's blood lead levels (BLLs) due to the proposed permitted lead emission rates, the modeled ambient air impacts, and the atmospheric deposition impacts to residential areas. In each case, the key IEUBK model outputs have been the population average BLL and the percent of children estimated to have BLLs above a specified cutoff level of concern. The scenarios modeled included the background situation with and without the incremental impacts of the proposed facility lead emissions. The Centers for Disease Control (CDC, 1991) established a BLL of 10 micrograms per deciliter (ug/dL) as the Action Level and the criterion for lead poisoning in children. Therefore, the power plant IEUBK assessments all utilized that cutoff level. The Wolverine WCEV assessment (Sills and Sadoff, 2008) additionally utilized a cutoff of 5 ug/dL, because some analyses have shown that children with BLLs of 5 to 10 ug/dL are at notable risk (EPA, 2007a).

EPA (2007a, 2008b) also stated that some analyses (Lanphear et al., 2005) appear to show lead effects on intellectual development in young children with blood lead levels ranging from 2 to 8 ug/dL. The EPA (2008b) Proposed Rule for the National Ambient Air Quality Standard (NAAQS) for lead noted that a BLL of 2 ug/dL may be representative of the lowest population mean level for which there is evidence of a statistically significant association between BLLs and health effects. There is no level of lead exposure that can yet be identified, with confidence, which is clearly not associated with some level of deleterious health effects (EPA, 2008b).

Objectives

This paper is intended to provide supplemental assessment information which may be relevant to the permit review process for these facilities. Specifically, this paper is intended to do the following:

1. show comparisons between the facilities, in terms of the ambient air impacts and BLL impacts;
2. show the background and incremental impact for the percentage of children exceeding BLL cutoff levels of 2 and 5 ug/dL, under the maximum exposure scenario;

3. relate the BLL impacts to the potential impacts on intellectual development (as IQ), and;
4. place the findings in perspective by comparing the BLL impacts to laboratory analytical detection capabilities, and by comparing the modeled media impacts to regulatory values.

Results

The highest modeled ambient air concentrations for residential areas, for the facility lead emissions, are presented in Table 1. The previous IEUBK modeling results are summarized in Table 2. Those include scenarios with and without lead-based house paint in the background situation. The scenarios are designed to estimate the impacts to BLLs with and without the incremental impact of the facility operation and topsoil deposition impacts, after 30 years of operation at the proposed permitted emission rate, for the highest deposition impact in areas which may be residential.

Table 1. Modeled ambient air impacts, NAAQS, and estimated ambient air background lead levels.

Current NAAQS	**Proposed NAAQS (EPA, 2008)**	**Residential area highest ambient air impacts (and estimated background levels) (ug/m^3)**			
		Consumers Energy	**Mid-Michigan Energy**	**Holland BPW (net facility change)**	**Wolverine Power WCEV**
1.5 ug/m^3 (quarterly averaged)	0.1 to 0.3 ug/m^3 (quarterly or monthly)	0.000019, annual avg.	0.0000353, annual avg.	0.000213, annual avg.	0.0001, annual avg.
		(background = 0.01)	(background = 0.01)	(background = 0.01)	(background = 0.00318)

Table 2. Summary of the previous IEUBK modeling results for the subject power plants. Incremental BLL impacts are based on the cumulative (30 year) impacts at the highest impacted residential areas.

Scenario	**Consumers Energy**		**Mid-Michigan Energy**		**Holland BPW**		**Wolverine Power WCEV**		
	Mean BLL	**% above 10 ug/dL**	**Mean BLL**	**% above 10 ug/dL**	**Mean BLL**	**% above 10 ug/dL**	**Mean BLL**	**% above 10 ug/dL**	**% above 5 ug/dL**
Background situation; no facility impacts. Background levels of lead.									
No lead paint	2.905	0.427	2.401	0.120	1.536	0.003	1.674	0.007	0.996
+ lead paint	3.975	2.482	3.495	1.265	2.672	0.249	2.808	0.344	10.976
Background plus cumulative facility impacts after 30 years, highest impacted residential areas									
No lead paint	2.905	0.427	2.404	0.121	1.563	0.004	1.674	0.007	0.997
+ lead paint	3.975	2.483	3.498	1.271	2.695	0.264	2.808	0.344	10.977

The comparison of the modeled ambient air impacts and BLL impacts in Table 1 and 2 indicate that the incremental impacts are all quite low. The supplemental IEUBK modeling was focused on the Holland BPW incremental impacts, because they are relatively higher than the impacts of the other facilities (Tables 1 and 2). Table 3 summarizes the key model inputs and outputs for the Holland BPW supplemental IEUBK modeling.

Table 3. IEUBK key model inputs and outputs for supplemental information on the impacts of the Holland BPW lead emissions. Incremental impacts are based on the cumulative (30 year) impacts at the highest impacted residential area.

Scenario	**Model inputs**					**Model outputs**			
	air lead (ug/m^3)	**soil lead (ppm)**	**dust lead (ppm)**	**drink. water (ug/l)**	**Diet lead (ug/d)**	**Avg. BLL (ug/dL)**	**% above cutoffs: 10 ug/dL**	**5 ug/dL**	**2 ug/dL**
Background situation; no facility impacts. Background levels of lead.									
No lead paint	0.01	21	15.7*	2	5.53 to 7**	1.536	0.003	0.602	28.718
+ lead paint	0.01	21	200*	2	5.53 to 7**	2.672	0.249	9.128	73.125
Background plus net facility impacts after 30 years, highest impacted residential area									
No lead paint	0.01021	21.621	16.1*	2	5.65 to 7.12**	1.563	0.004	0.668	29.996
+ lead paint	0.01021	21.621	200*	2	5.65 to 7.12**	2.695	0.264	9.429	73.720

* In the absence of lead in indoor house paint, the Multiple Source Analysis (MSA) function of the IEUBK model calculates the lead concentration in indoor house dust due to deposition of the air lead and track-in of soil lead. With the assumed presence of lead house paint in good condition, the EPA default estimate for lead in house dust is 200 ppm.

** The dietary lead exposure for the "background" scenarios is based on the IEUBK model default values, which vary according to the child's age; the range of the values for the different ages is given here. For the scenarios that include the cumulative facility impact, 0.12 ug/d was added to the EPA default values for the "background" scenario. The increment of 0.12 ug/d was provided by the applicant, based on a multipathway risk assessment utilizing the EPA (2005) HHRAP model. That assessment provided this estimated incremental exposure due to the ingestion of homegrown produce, due to plant uptake of environmental lead following 30 years of cumulative facility operation and impacts.

The model outputs in Table 3 can be used to estimate the potential *incremental* impact on a population of children hypothetically exposed at the highest impacted residential area, after 30 years of accumulated soil impact from the continuous, maximum permitted emission rate. The incremental impact of the facility is estimated by comparison between the "background" scenario and the "background plus cumulative facility impacts" scenario. This comparison should be done for the "no lead paint" situation, and for the "+ lead paint" situation, separately. These comparisons are shown in Table 4 below.

Table 4. Summary of maximum project-related incremental BLL impacts.

A. Scenario: No lead paint present.
The incremental increase in the average BLL at the highest impacted residential area is (1.563 – 1.536) = 0.027 ug/dL. This represents a 1.76% increase. The increase in the percent of children with BLLs above the cutoff level is as follows: At a cutoff of 10 ug/dL: 0.004 - 0.003 = 0.001% At a cutoff of 5 ug/dL: 0.668 – 0.602 = 0.066% At a cutoff of 2 ug/dL: 29.996 – 28.718 = 1.278%
B. Scenario: Lead paint present in good condition.
The incremental increase in the average BLL at the highest impacted residential area is (2.695 – 2.672) = 0.023 ug/dL. This represents a 0.86% increase. The increase in the percent of children with BLLs above the cutoff level is as follows: At a cutoff of 10 ug/dL: 0.264 – 0.249 = 0.015% At a cutoff of 5 ug/dL: 9.429 – 9.128 = 0.301% At a cutoff of 2 ug/dL: 73.720 – 73.125 = 0.595%

<u>Discussion</u>

The Lead Panel of the EPA Clean Air Scientific Advisory Committee (CASAC, 2007) noted that IQ decrements of 1-2 IQ points or more would be of great concern, as EPA considers the level of health protection of potential NAAQS revisions. The American Academy of Pediatrics recommended that EPA consider the goal of preventing a rise in BLL that is predicted to be associated with an incremental increase estimated to decrease IQ by 1 point (EPA, 2008b; p. 29241). EPA has proposed a reduction in the lead NAAQS to a level of between 0.1-0.3 ug/m^3; 0.1 ug/m^3 has an estimated degree of air-related impact on the population mean IQ loss of less than 1 point to around 2 points, based upon the steeper set of concentration-response estimates (EPA, 2008b; p. 29243). EPA has proposed to conclude that an air-related population mean IQ loss within the range of 1-2 IQ points could be significant from a public health perspective, and that a standard level should be selected to provide protection from impacts in excess of that range (EPA, 2008b; p. 29242).

Although there is uncertainty about the concentration-response (C-R) function between BLL and IQ loss, project-related incremental increases in the average BLL can be related to potential impacts on IQ utilizing a set of C-R functions (EPA, 2007b). EPA (2007b; pp. 4-1 to 4-5) described three particular concentration-response functions and analytical procedures. Those can be applied here, to relate the calculated average BLL as “concurrent” lead levels to the associated IQ decrements. The results are summarized in Table 5.

Table 5. Estimated lead-related IQ deficits for Table 3 average BLLs associated with background conditions with and without Holland BPW impacts.

EPA 2007(b) C-R function:	**Log-linear function with cutpoint**		**Log-linear function with low-exposure linearization**		**Two-piece linear function**	
Scenario:	No lead paint	+ lead paint	No lead paint	+ lead paint	No lead paint	+ lead paint
Background IQ loss:	-1.159	-2.654	-3.859	-5.354	-0.697	-1.213
Background + maximum project impact IQ loss:	-1.206	-2.677	-3.906	-5.377	-0.709	-1.223
Incremental IQ impact:	-0.047	-0.023	-0.047	-0.023	-0.012	-0.010

The incremental impacts to the average BLL associated with the Holland BPW proposal, as shown in Table 3, are therefore estimated to be associated with IQ decrements of 0.047 points or less. It should again be noted that the scenarios modeled represent the highest impacted residential area, after 30 years of accumulated impact due to the proposed maximum permitted emission rate. Other locations, and lesser actual emission rates, would result in lower potential BLL and IQ impacts.

The above estimated incremental BLL impacts can also be placed in perspective by considering the analytical capability of BLL measurement. In risk assessment, there is a primary focus on using the available models to calculate potential impacts on exposure and risk. However, it is also of interest to note how the estimated exposure impacts relate to the capabilities of actual clinical measurements. The following information was obtained by personal communications with the Michigan Department of Community Health (MDCH; Scott, 2008; Dupler, 2008). Children's BLL data are generated as ug/dL values, as either whole integers or with tenths (e.g., 5, or, 5.1 ug/dL). Due to the variability of collection devices, and to a lesser extent due to the fluctuation of analytical instruments, BLL data should not be presented with more accuracy than tenths of ug/dL. The level of detection of the MDCH lab is 2 ug/dL; they do not report values less than that level. As MDCH compiles BLL data reported from various laboratories, they report the compiled data after rounding off to the nearest integer (e.g., 5.1 becomes rounded to 5 ug/dL). In general, the accuracy of the data may be to (+/- 1 ug/dL) at relatively lower BLL levels. It may be difficult to discern a change in a child's BLL of less than 0.5 ug/dL.

The significance of the estimated impacts can also be evaluated by comparison to the available and relevant standards, criteria or guidance. As indicated in Table 1, the residential area highest ambient air impact of the Holland BPW proposal (and the other proposed power plants) is well below the current and proposed NAAQS for lead. The NAAQS are human health-based, with an intention to ensure adequate public health protection against the neurodevelopmental effects of lead to children. The background plus incremental impacts to topsoil (see Table 3, model inputs) are well below the EPA (1994a) and MDEQ soil cleanup standard of 400 ppm, which was also derived based on the protection of children from neurodevelopmental effects of lead. When operated with the recommended default values, the IEUBK model predicts that no more than 5% of children exposed to 400 ppm in soil will have BLLs exceeding the CDC Action Level of 10 ug/dL (EPA, 1994a, 1998a, 2005). EPA (1994b) stated that the protection level most often used in practice is a maximum 5% risk of BLL above 10 ug/dL for children in a given household. Regarding the acceptable incremental impact of a lead air emission source, guidance from EPA Region 6 (1998a) provides a recommended target level of 100 ppm in soil and 0.2 ug/m^3 in air. Under the regulations for the burning of hazardous waste in boilers and industrial furnaces ("BIF rules"), the emissions and feed rate limits for lead air emissions from facilities are based on an acceptable ambient air impact of 0.15 ug/m^3 (quarterly average) or 0.09 ug/m^3 (annual average) to be protective of inhalation exposure, with site-specific evaluation of deposition impacts (EPA, 2001). All of the incremental and cumulative impacts of the proposed power plant emissions summarized in Tables 1-3 are well below the benchmarks noted in this paragraph. These examples are intended to indicate that regulatory approaches have established acceptable impact levels rather than "no-impact" policies; the modeled impacts of the Holland BPW facility are relatively small in comparison to those regulatory levels.

In a previous impact assessment for lead air emissions for the Select Steel facility (Sills, 1998), the ambient air impact (0.00454 ug/m^3), soil impact (14 ppm), increase in average BLL (0.1 ug/dL, or no change, in three scenarios), and increase in the percent of children exceeding 10 ug/dL (from 0.04% to 0.05%, from 0.87% to 0.97%, and no change, in three scenarios) were all substantially higher than the present case. Those incremental impacts to BLLs were characterized as "very small", and showing "little or no differences" (Sills, 1998). The EPA Office of Civil Rights evaluated that assessment, and found that it was reasonable and conscientious (EPA, 1998b). Further, EPA (1998b) found that, "Based on the available information concerning the releases, the additional deposits of lead in soil from Select Steel are likely to have a *de minimis* incremental effect on local mean lead levels and the incidence of elevated levels."

Although the Holland BPW facility is already existing, with historical and current lead emissions, the lead impact assessment focused on only the net increase in lead emissions due to the proposed replacement of the existing boiler unit (#3) with the new boiler unit (#10) (Holland BPW, 2007). There are several reasons for the appropriateness of that approach. First, the routine risk assessment approach by the AQD Air Toxics Unit under the Air Pollution Control Rules is to evaluate the impacts of a proposed new or modified process, not entire facilities. Secondly, the general area is not known to be a site of soil lead contamination which might warrant a more holistic accounting of facility emissions and utilization of a site-specific background soil lead value in the IEUBK modeling. Thirdly, the past actual lead emission rate (78 lb/yr) is relatively low in comparison to the future potential lead emission rate (251 lb/yr) (Holland BPW, 2007). Fourthly, the modeled deposition impacts for the future potential emission scenario were 7.4 to 9.9 times greater than for the past actual scenario, depending on the meteorological year modeled (2003-2005) (Mason, 2007). Therefore, the future facility deposition impacts were adequately accounted for by focusing on the net increase in the facility's lead emissions.

The proposed new boiler (#10) of Holland BPW (2007) would primarily burn coal. The impact assessment (Holland BPW, 2007) is based on net facility impacts including the potential lead emission rate for the new boiler (1.88E-02 lb/hr). However, the proposal is to allow for that boiler a replacement of up to 10% of the heat input of coal with any of the following alternative fuels: sewage sludge, petcoke, waste wood, and tire derived fuel (TDF). The applicant (Jaros, 2007) indicated that the lead emission rates for only waste wood and TDF combustion would be greater than that for coal. Using those emission rate values for alternative fuels, and 1.88E-02 lb/hr for coal, a worst-case estimate of lead emissions would involve the combustion of 80% coal, 10% wood waste, and 10% TDF. That is calculated to be associated with an overall lead emission rate (2.76E-02) which is 47% greater than the lead emission rate of 1.88E-02 lb/hr. That potential scenario and emission rate difference raises uncertainty in the impact calculations, but it does not suggest that the overall findings and conclusions of the present assessment based on the coal-associated lead emission rate are incorrect.

As previously noted, there is no documented "threshold" of lead exposure below which no adverse effects could occur. Therefore, it is challenging for agencies to develop regulatory criteria or standards, based on a combination of risk assessment information and risk management decisions. The importance of such decisions is highlighted when one considers that the endpoint of concern is the neurobehavioral development of children, and the fact that many children already have elevated BLLs (primarily due to lead-based paint, among other causes) (MCLPPCC, 2007).

Conclusion

The above information supports a conclusion by the author that the proposed incremental lead impacts of the Holland BPW facility and the other power plants discussed herein, are very small, are not in the realm of clinically detectable BLLs, do not appear to be injurious to human health by a practical interpretation of that term, and may be considered approvable by regulatory environmental agencies.

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