Human Health Risk Assessment Scope for the Holland Board of Public Works (Holland BPW) Proposed New Boiler (Permit to Install Application # 25-07).
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Overview

This paper provides a brief summary of the human health risk assessment elements that have been included for the Holland BPW proposed permit, including a description of the findings of a cumulative risk assessment.

Under the Air Pollution Control Rules, Part 55 of the Natural Resources and Environmental Protection Act, the estimated emissions of the proposed new boiler #10 were evaluated by comparison of the project's modeled maximum ambient air impacts to the applicable health risk-based screening levels. This is the standard and required level of air toxics risk assessment under the New Source Review program, and typically, that is the extent of the risk assessment scope. For the Holland BPW application and review, additional risk assessment steps were also performed, utilizing appropriate environmental modeling tools and risk assessment guidance.

For each of the toxic air contaminants (TACs) that may be emitted from the proposed new boiler #10, the modeled ambient air impacts were determined to be acceptably low. That assessment included a comparison of the impact concentrations to the health risk-based screening levels. The screening levels for each substance are protective against noncancer health effects for all people, including sensitive subpopulations. For each substance which is a carcinogen, the screening levels are protective at a 1-in-one-million lifetime cancer risk, according to the AQD air pollution control rules.

The applicant provided an assessment of the net increase in lead air emissions and deposition impacts, and the multipathway impacts to children's lead exposure and blood lead levels. The results are presented in Holland BPW (2007). The assessment was based on a lead emission rate of 2.17E-05 lb/MMBtu, or approximately 165 lb/yr, which is consistent with the proposed permitted emission rate. That assessment was supplemented by additional analyses of the potential lead impacts (Sills, 2008). All of the assessments focused on the potential impacts to children, who are a particularly susceptible subpopulation. The assessments were done in a "cumulative" approach, in that the potential background levels were accounted for. Multiple pathways of children's lead exposure (food, water, air, soil, and house dust) were accounted for. It is staff's conclusion that the modeled impacts of the proposal's lead emissions are very small and do not pose a public health threat. As one indicator of the magnitude of the impact, the proposed facility change was modeled to result in a net ambient air impact of approximately 0.0002 micrograms per cubic meter (ug/m^3). This can be compared to the National Ambient Air Quality Standard (NAAQS) of 0.15 ug/m^3, and an estimated background level of 0.01 ug/m^3 for this area of the State. The modeled incremental impact is approximately 700 times lower than the NAAQS. Further details are available in the above referenced documents.

The potential impacts of the proposed facility's mercury emissions were also characterized via risk assessment. The applicant provided a human health risk assessment of the proposed facility-wide mercury emissions and impacts to Lake Macatawa fish mercury levels and to the sport anglers who may eat their catch. The results are presented in Holland BPW (2007), and are summarized below.

Additionally, AQD staff evaluated potential concerns for human health risk from the simultaneous exposure to the complex mixture of air toxics in the proposed emissions of the new boiler, in a cumulative risk assessment. That assessment is also described below.

Mercury risk assessment

The potential impacts of the proposed facility's mercury emissions to the local environment were evaluated by the applicant (Holland BPW, 2007; SAFRISK, 2007). Mercury emissions and impacts were evaluated to determine if there are concerns for ambient air impacts, as well as impacts due to deposition, persistence, and bioaccumulation in fish. The estimated incremental impacts to fish mercury levels should be considered in the overall context of the background levels of mercury in Lake Macatawa walleye, which are elevated and have increased over time. The findings of the assessment are summarized as follows.

The mercury emissions of the whole facility including the proposed new boiler were modeled to result in an ambient air impact concentration of 0.000022 micrograms per cubic meter (ug/m^3) of total mercury, annual averaged, in the relatively more impacted area northeast of the facility. This may be compared to the EPA Reference Concentration (RfC) of 0.3 ug/m^3, which is the level that is protective of everyone from any adverse health effects due to direct inhalation over a lifetime of exposure. Thus, the impact is 14,000 times lower than the Reference Concentration. The regional background ambient air level of mercury is estimated as approximately 0.001 ug/m^3.

Mercury air emissions can be expected to disperse and undergo long-range transport, with some amounts of deposition to the ground and surface waters as the plume travels. Locations closer to the emission source generally receive more deposition impact than sites further away. The Holland BPW facility is located within the Lake Macatawa watershed, very near Lake Macatawa. And, Lake Macatawa is known to already have relatively high levels of mercury in walleye. Therefore, impacts to Lake Macatawa were the focus of the deposition modeling study.

For the deposition modeling study, it was assumed that the facility would operate for 30 years. The mercury emissions from the new boiler were assumed to occur continuously at the proposed permitted emission rate. The mercury emissions and impacts were modeled for the entire Holland BPW facility after the proposed facility changes (SAFRISK, 2007), and for just the net change in the facility resulting from replacing boiler #3 with new boiler #10 (Holland BPW, 2007). The fraction of mercury in air emissions which may deposit to the ground or surface waters is expected to undergo "environmental fate" processes, such as runoff and bioaccumulation. The modeling study utilized state-of-the-art EPA models for those deposition and environmental fate processes. The modeling provided estimates of the facility's impacts to mercury levels in Lake Macatawa water and fish, and potential exposure to sport anglers who eat their catch. The modeling also estimated mercury exposure for children that may live near the facility and who may be exposed by breathing the air, contacting the soil, and eating food from their gardens, as well as eating fish from Lake Macatawa.

The results of the modeling were compared to the available data on existing levels, and to certain criteria levels for environmental protection. The criteria for environmental protection include 1.3 nanograms per liter (ng/l) for surface water, and 0.35 parts per million (ppm; also called milligrams per kilogram, mg/kg) for fish tissue. The surface water mercury level of 1.3 ng/l is the MDEQ water quality standard. That is the level that is protective for avian wildlife. The surface water level that is protective for people who catch and eat sportfish is actually somewhat less restrictive: 1.8 ng/l. The mercury fish tissue level of 0.35 ppm is the value utilized by MDEQ to help determine if surface waters are supporting all designated uses, particularly sportfish consumption. That value was derived based on the level of exposure associated with eating fish and the health protective exposure level. That level of 0.35 ppm is somewhat more restrictive than the 0.5 ppm criterion which is utilized by the Michigan Department of Community Health as a trigger to advise restricted consumption of sportfish. The results of the modeling of facility impacts, and a comparison to the existing levels and criteria levels, are summarized in Table 1 below.

Table 1. Holland BPW mercury impact estimates for Lake Macatawa, and comparison to existing levels and criteria levels.

Emissions modeled	**Emission rate (lb/yr)**	**Water mercury level (ng/l)**			**Fish mercury level (ppm)**		
		Incremen-tal impact	**Existing level**	**Criteria level**	**Incremental impact**	**Existing level**	**MDEQ comparison value**
Whole facility after proposed changes	16.4	0.036	No data	1.3	0.0041	0.57	0.35
Proposed net change only	6.3	0.0095	No data	1.3	0.0011	0.57	0.35

As indicated in Table 1, the existing mercury level in fish (0.57 ppm in walleye, 2005) in Lake Macatawa is already higher than the criterion of 0.35 ppm. It should also be noted that walleye data from 1987, 1995, and 2005 indicate that the mercury level has an increasing trend of 4% per year. This conclusion is based on a comparison of levels as well as the sizes of fish, since mercury levels also generally increase as fish get older and larger. The reasons for the increasing trend are not known. Elevated fish mercury levels are known to occur at many locations in the State, and in some, there is an increasing or decreasing trend, often with no apparent explanation. MDEQ sampled Lake Macatawa walleye and largemouth bass for mercury analysis again in May 2008; the results may be available in late 2008. The modeling also estimated that the additional exposure to mercury due to total facility emissions, for the most exposed people living near the source and eating fish from Lake Macatawa, would be 0.8% of the EPA health protective exposure level.

The model results summarized in Table 1 indicate that the incremental impacts of the net facility change proposed, and of the whole facility after the proposed change, are relatively small in comparison to the available data on existing fish levels in Lake Macatawa and environmental protection criteria. However, situations such as this with known elevated fish mercury levels, and an increasing temporal trend, warrant concerns and caution regarding the approvability of additional mercury loadings. The MDEQ authority and practice under the AQD new source review program is to make case-by-case risk management decisions regarding mercury air emission sources and impacts, to help ensure protection of public health and the environment. Staff believes that the mercury impacts of the proposed modified facility are small and has initially determined that they meet the requirements of the applicable regulations for health protection, pending public comment and a determination by the permit decision-maker.

After the mercury impact analysis summarized in Table 1 was completed, the applicant agreed to a 37% lower mercury emission rate from boiler #10 (5.33 lb/yr) than originally proposed (8.41 lb/yr). That lower emission rate is specified in the current proposed permit conditions. Therefore, the facility impact estimates in Table 1 may be somewhat overestimated. The applicant performed re-modeling of the impacts based on the lower proposed mercury emission rate. However, but the results of that reassessment (SAFRISK, 2008; received by MDEQ November 13, 2008) were not available to MDEQ staff in time to review and verify for this report. MDEQ staff will continue to assess the findings of the re-modeling.

Cumulative risk assessment overview

The cumulative risk assessment “additivity assessment” approach utilized was a screening-level approach described in Sills et al. (2008). The focus of the assessment was the modeled maximum ambient air impact for each substance. As noted previously, the maximum ambient air impact of each individual air toxic substance was compared to the applicable health risk-based screening level. In the “additivity assessment”, all those substances which had an impact that was at least 1% of the screening level (i.e., a hazard quotient (HQ) of at least 0.01, or a cancer risk of at least 0.01 in one million) were initially assumed to act additively for the purposes of evaluating potential cumulative noncancer and cancer effects. Further details of the additivity assessment are provided below, for noncarcinogenic and carcinogenic effects.

Cumulative noncarcinogenicity risk assessment

The applicant provided the updated modeling results for air toxics on November 14, 2008, for new boiler #10, based on the highest emission rate for the proposed fuel types for each substance (NTH, 2008). That report was checked by AQD Staff for accuracy. All modeled ambient air impacts were lower than the applicable AQD health risk-based air toxics screening levels. For the cumulative noncarcinogenicity assessment, hazard quotients for the substances were derived and summed. The hazard quotient (HQ) for a substance is calculated by the environmental level of concern (i.e., the ambient air impact) divided by the health-protective benchmark level (i.e., the Initial Threshold Screening Level (ITSL)). The total hazard index (HI) is the sum of all HQs, regardless of whether or not the substances have a common target organ or toxic effect. This is a very conservative screening-level approach. The screening step of excluding from the additivity step all substances with HQ values of < 0.01 reduced the list of substances to those in Table 2 below.

Table 2. Additivity assessment of noncancer risk[1]

Substance	% of ITSL[2]	HQ[3]	Comments
Acrolein	18.95% (of the annual ITSL)	0.1895	The annual ITSL resulted in the higher % of ITSL than the 1-hr ITSL, and was utilized here.
Hydrogen chloride	12.21%	0.1221	
Manganese	1.43%	0.0143	
Methyl hydrazine	1.43%	0.0143	
Phosphorus	5.90%	0.059	
Naphthalene	2.58%	0.0258	
Silver	1.75%	0.0175	
Mercury	0.0053%	0.000053	See note #4.
Lead	0.14%	0.0014	See note #5.
TOTAL	**-**	**Total = 0.46 ~ 0.5**	**Total HI = 0.5** (see note #6)

1. This includes all substances with noncancer HQs of 0.01 or greater.
2. 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.
3. The Hazard Quotient (HQ) is the value resulting from dividing the exposure level by the health risk-based protective screening level (the ITSL).
4. For mercury, the applicant (Holland BPW (2007), Appendix H, Table 5-1) provided the modeled ambient air concentrations (with annual averaging time) for three forms of mercury. These were added together by Staff for simplicity to expedite this Table 2 assessment process, and the resulting total mercury level was divided by the EPA Reference Concentration (RfC) for elemental mercury (0.3 ug/m^3). The resulting HQ is for inhalation-only exposure; multipathway exposure and risk is addressed in Holland BPW (2007) and SAFRISK (2007). The HQ presented here is well below the 0.01 criterion for inclusion, but is presented here for clarity and completeness.
5. For lead, the modeled net ambient air impact of the project was 0.000213 ug/m^3 (annual averaging time) (Holland BPW, 2007). Lead is not classified as a toxic air contaminant, therefore there is no ITSL. EPA (2008) revised the National Ambient Air Quality Standard (NAAQS) for lead from 1.5 to 0.15 ug/m^3. The new standard has a rolling 3-month averaging time. For the purposes of this additivity assessment, the modeled ambient air impact (annual averaged) was compared to the NAAQS without attempting to reconcile the differences in the averaging times. The HQ presented here is well below the 0.01 criterion for inclusion, but is presented here for clarity and completeness.
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 target organ or critical effect.

Consideration of "background" levels of air toxics can help to lend perspective to the source impacts. This is limited by the relative lack of ambient air monitoring data, although some source-specific data were obtained several years ago near a Holland facility other than Holland BPW. The EPA 1999 National Scale Air Toxics Assessment (NATA) provides estimates of hazardous air pollutant concentrations, based on emission estimates and dispersion modeling. The emissions inventory for NATA would have included the existing Holland BPW facility. The NATA estimates were developed for risk management considerations and not for direct regulatory applications, and are now somewhat dated (1999). They may still serve as the best available general guide to the background air toxics concentrations and risk levels for cumulative risk assessment. Information was obtained from the EPA's NATA website (http://www.epa.gov/ttn/atw/nata1999/) and from Palma and Strum (2005). For noncancer effects, the focus of the available summary information is on the cumulative hazard indices (HIs) for respiratory and for neurological effects. The counties of Michigan have median (across census tracts) respiratory HIs ranging from less than 1 to the 5-30 range. Ottawa County (the location of Holland BPW) is in the 2-3 range. The Risk Maps available at the NATA website indicate that the respiratory HI for the Holland area is approximately 3-4.5, predominantly due to on-road emission sources, and specifically, acrolein concentrations. It may be noted that the acrolein HQ value was based on the EPA Reference Concentration (RfC), which was based on a rodent study and incorporated an uncertainty factor of 1000. This helps to indicate the lack of precision, and considerable uncertainty, in the RfC, HQ, and HI values. The NATA-based neurological HI for the Holland area is approximately 0.05 to 5.

As shown in Table 2, the Total HI for the Holland BPW project is 0.5. This does not raise particular concerns for the potential cumulative impacts of the complex mixture, for the project alone or in consideration of potential "background" air toxics concentrations based on the limited information described above.

Some of the criteria pollutants emitted by the Holland BPW project (SO_2, NO_x, and PM-10) are respiratory tract irritants. The EPA does not evaluate cumulative exposures and risks for the criteria pollutants. Impacts that result in total ambient air levels that are lower than the NAAQS are considered to be health protective. The AQD modeling assessment for criteria pollutants (Mason, 2008) found that the particulate (PM-10) source impacts were 1.4 ug/m^3 (24 hr averaging time) and 0.21 ug/m^3 (annual averaging time); these were not above thresholds for significant impacts, and were well below allowable increments for the prevention of significant deterioration. SO_2 and NO_x were not modeled, because the proposed facility modifications would result in a net reduction of emissions for these criteria pollutants.

Some of the Table 2 substances are central nervous system (CNS) toxicants (manganese, mercury, and lead). Although the HQ values for these substances do not indicate a concern, individually or cumulatively, these HQs address only inhalation exposure. As indicated previously, the multipathway impacts, exposures, and risks of mercury and lead are discussed in detail elsewhere. Although it is possible that some level of lead and mercury exposures, in general, could have cumulative multipathway effects on the CNS, the detailed assessments indicate that the facility incremental impacts are very small and do not pose a significant risk. Those assessments also indicate that the "background" exposure sources (for mercury, due to fish consumption; for lead, due to oral exposure to house paint containing lead) may be substantial. These potential exposure situations do not indicate that the Holland BPW project emissions and impacts would be reasonably anticipated to pose a significant cumulative risk for CNS effects alone, in combination, or in the aggregate including potential background sources.

Carcinogenic effects

As with the assessment of noncarcinogenic effects, this additivity assessment utilized a screening criterion of 1% of the screening level to help focus the assessment on the substances that may make a substantive impact on the total risk. The modeled ambient air impacts for new boiler #10 were provided by NTH (2008), with confirmation of the results by AQD as previously noted. The screening levels utilized were the Initial Risk Screening Levels (IRSLs), which are the ambient air concentrations that are each associated with an upper-bound cancer risk estimate of 1-in-one-million (i.e., 1E-06) to an individual with a lifetime of continuous exposure. Therefore, Table 3 includes only the emitted carcinogenic substances with a modeled maximum ambient air impact that is associated with a risk level of at least 1% of the IRSL (i.e., a risk of at least 0.01-in-one-million, or 0.01E-06). The results are presented in Table 3.

Table 3. Additivity assessment of cancer risk

Substance	**% of IRSL**	**Lifetime cancer risk estimate (plausible upper-bound)**	**Comments**
Arsenic	58.76%	0.5876E-06	
Benzene	21.19%	0.2119E-06	
Benzyl chloride	1.%	0.01E-06	
Beryllium	1.50%	0.015E-06	
Bis (2-ethylhexyl) phthalate	1.89%	0.0189E-06	
Cadmium	8.46%	0.0846E-06	
Chromium (+6)	27.28%	0.2728E-06	
1,4-dichlorobenzene	15.81%	0.1581E-06	
Formaldehyde	27.75%	0.2775E-06	
Nickel	3.96%	0.0396E-06	
Naphthalene	10.95%	0.1095E-06	
Total dioxins and furans	2.90%	0.029E-06	Conservatively estimated, based on emission factors for dioxin/furan chemical groups (homologues).
Carcinogenic PAHs	2.96%	0.0296E-06	Includes benzo(a)pyrene and the other 6 carcinogenic PAHs additively.
TOTAL	-	**Total cancer risk = 1.8E-06 ~ 2-in-1-million**	

The background total cancer risk estimates provided by EPA's NATA study indicate that the air toxics levels in counties in Michigan pose an estimated median (across census tracts) cancer risk ranging from the 0-1 in one million range to the 50-75 in one million range. Ottawa County is in the 25 to 50 in one million range.

There are no AQD rules or criteria for the acceptability of total (cumulative) cancer risk, for ambient air background levels or for source impacts. In the opinion of the author, the total cancer risk estimate associated with the Holland BPW project does not raise particular concerns for cumulative cancer risk.

Alternative fuels

The proposed new boiler (#10) of Holland BPW would primarily burn coal. However, the proposed permit conditions allow for that boiler to replace up to a specific percentage of coal (based on heat input) with the following alternative fuels: sewage sludge (20%), petcoke (50%), waste wood (30%), and tire derived fuel (TDF; 30%). The applicant (NTH, 2008) provided modeled ambient air impact estimates based on the highest emission rate for each substance with the combustion of any of these fuels (at 100%). Therefore, the above cumulative risk assessments are conservative; cumulative risks based on actual fuel mixtures would be lower.

References:

EPA. 2008. National Ambient Air Quality Standards for Lead. Final Rule. 73 FR No. 219, pp. 66964-67062. November 12, 2008.

Holland BPW. 2007. Permit to Install Application for Installation of a New Circulating Fluidized Bed Boiler at Holland Board of Public Works James DeYoung Facility, Holland, Michigan. PTI application # 25-07. (Appendix H: Human Health Risk Assessment for Mercury and Lead.)

Mason, D. 2008. Air Dispersion Modeling Summary: Holland Board of Public Works. MDEQ-AQD. Completed on July 2, 2008.

NTH. 2008. Holland BPW – New CFB Boiler (Unit #10) Toxic Air Contaminant Modeling Results, Revised 11/14/2008. Received by AQD, 11/14/08.

Palma, T. and M. Strum. 2005. 1999 National Scale Air Toxics Assessment (NATA) National Scale Assessment. For the Air Toxics Implementation Workshop, March 30, 2005. EPA, Office of Air Quality Planning and Standards.

SAFRISK, LC. 2007. Human Health Risk Assessment. Holland Board of Public Works. July 2007.

SAFRISK, LC. 2008. Human Health Risk Assessment in Support of a Proposed Air Use Permit For a New Circulating Fluidized Bed Boiler at Holland Board of Public Works

James DeYoung Generating Plant, Holland, MI. October 2006 (revised October 2008). Received by MDEQ November 13, 2008.

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

Sills, R., M.L. Hultin and M. Depa. 2008. General Approach for the Screening-Level Risk Assessment of Air Toxics Mixtures and Cumulative Risk Assessment. MDEQ-AQD. May 29, 2008.