TES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

DATE: June 27, 2003

SUBJECT: Further evaluation of Tier 1A metals emissions at the ESSROC Materials Cement Corp. (Logansport, IN) - Exposure to mercury via the fish ingestion pathway

FROM: Mario M. Mangino
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TO: Jae Lee
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At your request, I have reviewed the letter (June 5, 2003) submitted by Horizon Environmental acting as the consultant for ESSROC Cement Corp. on the "Comprehensive Risk Assessment" document for the ESSROC permit review [1]. The Horizon letter describes certain aspects of the fate and transport modeling that were used to estimate the hazard index for mercury from the consumption of locally caught fish. For mercury, the form that contributes the predominant health risk is methylmercury. This form of mercury is generated in waterbodies and wetlands after deposition of elemental mercury from the air or runoff of mercury from soil deposits. Methylmercury exhibits a great capacity to accumulate in aquatic organisms and to magnify its concentration as it moves up the food chain into fish.

Horizon estimated the hazard index for the "high-end" adult and child fish consumers to be 0.95 and 0.74, respectively, for fishing in the Wabash River in the vicinity of the facility. These values exceed the EPA target risk limit of 0.25 for a single metal constituent. This target limit has been recommended by the OSW [2] as an adjustment to the typical hazard index limit of 1.0 for a constituent. This adjustment accounts for the likely presence of multiple metal constituents and the background contribution of metals from other sources in the vicinity of the combustion facility under study.

As pointed out by Horizon, the application of the fate and transport parameters recommended by EPA guidance combined with a conservative estimate of the fish consumption rate could lead to an overestimate of the actual methylmercury hazard index for fish consumption. EPA guidance recommends the use of conservative or high-end fate and transport parameter values when the site-specific values are not available or would be difficult to obtain. In that sense, the EPA guidance applies a screening level analysis which is designed to prevent underestimation of chemical exposure and risk.

Horizon discusses the fish consumption rate as a primary factor contributing to the overestimate of the methylmercury hazard index. However, a closer examination of the fish consumption rate used by Horizon shows that a site-specific adjustment in the default consumption rate was applied by Horizon. In particular, for fishing from the Wabash River, Horizon applied the high-end consumption rate for recreational fishing that was reported from studies of sport fishing in Michigan. This value of 32 grams/day is about 40% of the default consumption rate that the EPA combustion risk guidance uses for a subsistence fisher (i.e., a person who obtains a large amount of the total diet from fish). In addition, Horizon assumed that the local fisher would obtain 25% of total fish from the part of the Wabash River impacted by mercury emissions from ESSROC, with the remainder coming from other sources. This results in an estimate that the local adult fisher would consume about 2800 grams/year of fish from the Wabash River or about 19 fish meals per year. This value is plausible and is not necessarily an overestimate for a high-end fish consumer. Consequently, it is not obvious that the fish consumption rate used by Horizon would lead to an overestimate of the methylmercury hazard index.

Some other parameters which are important for estimating the concentration of methylmercury in fish are described below, along with a comparison of EPA's screening level parameter value compared against other values of the parameter which would be applicable to the ESSROC case. The screening level parameters are contained in EPA's 1998 HHRAP combustion risk guidance [3].

Mercury to Methylmercury Conversion Rate

When inorganic mercury enters waterbodies through direct deposition or by runoff from land erosion, it becomes available for conversion to methylmercury. The conversion rate depends on many factors including dissolved organic carbon and sulfate levels, oxygen level, pH level, and residence time. Data presented in the 1997 Mercury Study Report [4] on deep water lakes indicated that the conversion rate ranges from 5% to about 15%. Because conversion rate data on other waterbodies was not available in the Mercury Study Report, the HHRAP guidance adopted the high-end rate of 15% as the recommended default value for all waterbodies. However, studies on river systems and streams indicate that the likely methylation rates in these waterbodies are significantly lower than those found in lakes. Studies by the U.S. Geological Survey (USGS) on 21 river systems reported that the conversion rate ranged from 1% to 11% with a mean value of about 4.4% [5-6]. Discussion with an EPA scientist from the Athens laboratory confirmed that the USGS studies applied up-to-date methodology. The EPA scientist offered the view that for rivers, a mercury methylation rate of 4% should be used as the average case and 6% should be used as the conservative estimate [7]. Consequently, the HHRAP guidance default value of 15% is likely to be at least a factor of 2.5 times higher than the actual methylation rate that would be expected in the Wabash River.

Bioaccumulation Factor for Methylmercury in Fish

Methylmercury is known to both accumulate in aquatic organisms and to magnify in concentration as the chemical is transported up the food chain from lower trophic level species to higher trophic level species. The level of accumulation and magnification is represented by a Bioaccumulation Factor (BAF) which is the ratio of the methylmercury concentration in the aquatic organism to the methylmercury concentration in the water column. For fish, BAF values are very high, in the range of 1E+05 to 1E+07. The 1997 Mercury Study Report presented data showing that for fish in the highest trophic level (i.e., trophic level 4 - e.g., salmon, trout, bass, walleye) from deep water lakes, the measured BAF ranged from 3.3E+06 to 1.4E+07 with a mean value of 6.8E+06. Because BAF values from other waterbodies were not available in the Mercury Study Report, the HHRAP guidance adopted the mean lake BAF value as the recommended screening default value to cover all waterbodies and all types of fish.

Since the 1997 Mercury Study Report, the EPA has compiled and analyzed a larger body of data on the measured BAF values for fish in multiple trophic levels and from different types of waterbodies in the U.S. The data analysis is presented in the EPA's Water Quality Criterion document on methylmercury [8]. The table below shows the recommended BAF values for trophic 3 and trophic level 4 fish in lakes and rivers.

Water Body System	Trophic level 3 BAF	Trophic level 4 BAF
Lake	1.3E+06	6.8E+06
River	1.6E+06	2.5E+06

Note that the recommended BAF value for trophic level 4 fish in river systems is less than ½ of the value for lake systems. In addition, for a high-end consumer of river fish in Indiana, it is not likely that all of the fish harvest could be derived from the "game fish" category of trophic level 4. It is more realistic that the fish harvest would be divided about equally between the two trophic types. In that case, the effective BAF becomes:

$$BAF_{effective} = [(1.6E{+}06)/2] + [(2.5E{+}06)/2] = 2.1E{+}06$$

Consequently, the HHRAP guidance default BAF value of 6.8E+06 is likely to be a factor of 2.7 to 3.2 times higher than the actual BAF value that would be expected for the Wabash River.

Combination of Factors on Estimated Hazard Index

The two factors discussed above would both be expected to effect the estimated methylmercury concentration in fish in a linear fashion. For example, if the actual BAF value for methylmercury in the Wabash River was 50% of the default value used by Horizon, then the estimated fish concentration would be 50% lower. In this case, adjustments in both factors would have a combined effect on the estimated fish concentration of methylmercury. Consequently, using the recommendations described above, the predicted methylmercury hazard index values would change as follows:

High-end Adult Fisher:

HI = 0.95 x (River methylation rate/default rate) x (River BAF/default BAF)

HI = 0.95 x (6/15) x (2.5E+06/6.8E+06) = 0.14

High-end Child Fisher:

HI = 0.74 x (River methylation rate/default rate) x (River BAF/default BAF)

HI = 0.74 x (6/15) x (2.5E+06/6.8E+06) = 0.11

The general conclusion from the above is that appropriate site-specific adjustments to the fate and transport parameters for methylmercury could result in estimated hazard index values below 0.25.

References

[1] Horizon Environmental (2003) *Comprehensive Risk Assessment for the Cement Kiln Operations at the Essroc Cement Corporation in Logansport, Indiana*; Horizon Environmental Corporation; Grand Rapids, MI.

[2] U.S. EPA (1994) *Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities* (EPA 530-R-94-021; April 1994); Office of Solid Waste; Washington, DC.

[3] U.S. EPA (1998) *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA530-D-98-001A; July 1998); *Volume 2; Appendix A: Chemical-Specific Data* (EPA530-D-98-001B); Office of Solid Waste; Washington, DC.

[4] U.S. EPA (1997) *Mercury Study Report to Congress. Volume III: Fate and Transport of Mercury in the Environment* (EPA-452/R-97-005); Office of Air Quality Planning and Standards; Office of Research and Development; Washington, DC.

[5] USGS (1999) *A National Pilot Study of Mercury Contamination of Aquatic Ecosystems along Multiple Gradients*; Krabbenhoft, D.P., Wiener, J.G., Brumbaugh, W.G., Olson, M.L., DeWild, J.F., Sabin, T.J.; U.S. Geological Survey Toxic Substances Hydrology Program -- Volume 2 of 3: *Contamination of Hydrologic Systems and Related Ecosystems, Water Resources Investigations* Report 99-4018B; http://toxics.usgs.gov/pubs/wri99-4018/Volume2/sectionB/2301_Krabbenhoft/pdf/2301_Krabbenhoft.pdf.

[6] USGS (2001) *A National Pilot Study of Mercury Contamination of Aquatic Ecosystems Along Multiple Gradients: Bioaccumulation in Fish*; Brumbaugh, W.G., Krabbenhoft, D.P. Helsel, D.R., Wiener, J.G., Echols, K.R.; U.S. Geological Survey Biological Science Report; September 2001 (USGS/BRD/BSR-2001-0009, iii+25pp) http://www.cerc.cr.usgs.gov/pubs/center/pdfDocs/BSR2001-0009.pdf.

[7] U.S. EPA (2003) "Methyl mercury in various waterbodies"; Presentation to EPA Combustion Technical Assistance Team (June 19, 2003); Dr. Robert Ambrose; Office of Research and Development; National Exposure Research Laboratory; Athens, GA.

[8] U.S. EPA (2001) *Water Quality Criterion for the Protection of Human Health: Methylmercury* (Final); (EPA-823-R-01-00); Office of Science and Technology; Office of Water, Washington, DC.

Please contact me if any clarification is needed on the material presented above.

cc: Harriet Croke
Gary Victorine

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