Risk Screening
for Onyx Incineration Facility
Sauget, Illinois

September 23, 2003

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This report presents the results of risk screenings that have recently been conducted as part of an evaluation of the Onyx hazardous waste incineration facility in Sauget, Illinois. This evaluation has been conducted to provide additional information relevant to an upcoming permit renewal decision by the State of Illinois.

In this document, the analysis is being referred to as a screening because it has focused only on those pollutants which the U.S. EPA believes at this time to have a likelihood of exceeding accepted levels of cancer risk or chronic toxicity. It also is a screening in the sense that several simplifying assumptions have been made in the process of conducting the assessment, where a more detailed evaluation could result in reductions in the predicted risk. Screening analyses are generally used as a first step in the risk evaluation process, and can be used to determine whether a more detailed risk analysis is called for. At this time, U.S. EPA Region 5 has chosen to focus specifically on the potential health impacts of polychlorinated dibenzodioxins and furans (“PCDD/Fs”) and those toxic/carcinogenic metals being regulated under new U.S. EPA regulations at 40 CFR Part 63 Subpart EEE (i.e., the Hazardous Waste Combustion Maximum Achievable Control Technology or “HWC-MACT” Rule).

The HWC-MACT Rule

The U.S. EPA’s final MACT standards were promulgated on September 30, 1999, increasing control over emissions of hazardous air pollutants at 172 incinerators, cement kilns and lightweight aggregate kilns now operating in the United States. These facilities burn about 80%— approximately 3.3 million tons—of the 4 million tons of hazardous waste being combusted each year. The remaining 15 to 20 percent of waste is burned in industrial boilers and other types of industrial furnaces that will be addressed in a future rulemaking.

The new rule becomes effective for most affected facilities on September 30, 2003, and was issued under the joint authority of the Clean Air Act (CAA) and the Resource Conservation and Recovery Act (RCRA). The final rule ensures that combustion facilities will be able to avoid two potentially different regulatory compliance schemes by integrating the monitoring, compliance testing, and record keeping requirements of the CAA and RCRA into one permit—the Title V CAA permit. The only exception would be potential extra, site-specific permit conditions as needed to protect human health and the environment under a RCRA permit. It is for the purpose of those potential site-specific conditions in that RCRA permit that this risk screening is being conducted.

The new standards are based on the Maximum Achievable Control Technology approach required by the CAA. MACT reflects the maximum degree of hazardous air pollution reduction that can be achieved considering the availability, current use, costs, and non-air environmental impacts of emissions control technologies. The standards limit emissions of dioxins and furans, mercury, semi-volatile metals (cadmium and lead), low-volatile metals (arsenic, beryllium, chromium, and antimony), particulate matter, acid gas emissions (hydrochloric acid and chlorine), hydrocarbons, and carbon monoxide.

Risk Assessment:

The foundation for the risk screening methods described in this report is consistent with well-established chemical risk assessment principles and procedures developed for the regulation of environmental contaminants. Application of these guidelines and principles provides a consistent process for evaluating and documenting potential health risks associated with environmental exposures. The risk assessment process used by federal regulatory agencies and applied in this screening is essentially that described by the National Research Council (NRC 1983), and consists of the following four components:

- Hazard identification, in which the chemical substances of concern in emissions from the facility are identified and data relevant to the toxic properties of these substances are compiled, reviewed, and evaluated;

- Dose-response evaluation, in which the relationship between dose and response is evaluated for each chemical of potential concern to derive toxicity values that can be used to estimate the incidence of adverse effects occurring at different exposure levels;

- Exposure assessment, in which potential exposure pathways are identified and measures of chemical exposure (e.g., concentrations for the various environmental media, or doses) are estimated for the potential exposure pathways, based upon various exposure assumptions and the characteristics of the population receiving the exposure; and,

- Risk characterization, in which numerical estimates of risk are calculated for each substance by each potential route of exposure using the toxicity information and the exposure estimates.

Screening Technique for This Evaluation

The general model for the risk assessment analysis is contained in the U.S. EPA *Draft Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* ("1998 combustion guidance"). The 1998 combustion guidance outlines a comprehensive procedure for calculating estimated environmental media (e.g., air, soil, vegetables, fish, meat) concentrations, human intake rates, and health risks due to the emission of chemicals from combustion stacks. The basic steps in running the model for each facility may be summarized as follows: a) Identify the chemicals of concern from stack emissions and assign emission rates; b) Collect facility-specific stack data (e.g., stack height, gas exit velocity, building dimensions) and local meteorological data; use this data as inputs for the ISCST3 air dispersion/deposition model; c) Collect data on local land use (residential locations, agricultural locations, major water bodies) and map this data in reference to facility location; d) Combine chemical-specific emission rates with the air dispersion model to calculate chemical-specific air concentrations and deposition rates for multiple receptor points around the facility; e) Combine air concentrations and deposition rates with fate and transport algorithms to calculate chemical concentrations in environmental media (soils, plants, vegetable crops, livestock and fish); f) Combine human intake rates for environmental media (air, soil, plants, vegetable crops, etc.) with estimated chemical concentrations in environmental media to determine chemical doses (i.e., intake per unit time) for each applicable exposure pathway; g) Combine the chemical doses with chemical-specific toxicity factors (e.g., cancer slope factors, Reference Doses) to calculate a Cancer Risk for potentially carcinogenic chemicals and a Hazard Quotient for potentially toxic chemicals; h) Sum the Cancer Risks and Hazard Quotients for each chemical across the applicable exposure pathways; i) Sum the Cancer Risks and Hazard Quotients for each chemical to obtain the total Cancer Risks and Hazard Index for all chemicals.

Because the evaluation of multiple chemicals, multiple exposure pathways, and multiple fate and transport processes is a very challenging computational exercise, a computer software program was utilized to accomplish running the risk assessment model for each facility. For this project, the software system called *Industrial Risk Assessment Protocol - Human Health* (IRAP-h View^{TM}) was used. This software package (abbreviated "IRAP" in this report) was developed by Lakes Environmental Software (Waterloo, Ontario, Canada). IRAP was expressly designed to closely follow the recommendations, chemical-specific parameters, and fate and transport algorithms given in the the U.S. EPA's 1998 combustion guidance. IRAP is a Microsoft Windows application.

The U.S. EPA does not endorse the use of the IRAP software, but recognizes that the developers of IRAP-h made an effort to design a program which would closely follow the recommendations of the 1998 combustion guidance.

The major features of the IRAP system are its ability to: a) guide the user through the step-by-step process recommended in the 1998 combustion guidance; b) simultaneously calculate risk values (cancer risks and hazard quotients) for multiple chemicals emitted from a single source or from multiple sources at multiple locations; c) eliminate the need to perform hand calculations and write multiple interconnected computation spreadsheets; d) import ISC plot files containing the output from the ISCST3 air dispersion/deposition model runs; e) provide a graphical display of the ISC receptor grid mode locations; f) directly import GIS generated land use/land cover data (e.g., residential, farming, and water body locations); g) define the perimeter of water bodies and water sheds using a polygon drawing tool; and h) define an area of concern by selecting the receptor grid nodes that represent the highest ISC modeled air dispersion model values.

__Findings of this screening:__

PCDD/Fs:

Following Onyx's recent installation of an activated carbon injection system at unit 4, the U.S. EPA used the IRAP-h software to evaluate potential risks from emissions of PCDD/F from the Onyx Sauget facility. Using emission information provided by the facility, preliminary calculations predicted that cancer risks would be well below the action level of level of 1 E-5 from this pollutant. Although this result may be further analyzed in the future, the U.S. EPA is not at this time recommending any further reductions in PCDD/F emissions.

Toxic/ Carcinogenic Metals:

The HWC-MACT Rule regulates emission concentrations of the metals arsenic, beryllium, chromium, lead, cadmium, and mercury because of the Agency's findings, as discussed in the preamble of that rule, that these metals present a greater potential threat than others generally emitted from a hazardous waste incinerator. The preamble further concludes that emissions of the other toxic and carcinogenic metals will be adequately restricted via the particulate emission limit contained in that rule (i.e., almost all toxic and carcinogenic metals would be emitted as solid particulate matter, and therefore a limit on particulate matter will serve as an overriding limit on the total emission of all these metals). However, because the HWC-MACT Rule singles out the six metals arsenic, beryllium, chromium, lead, cadmium, and mercury, we have singled them out in this risk screening.

The results of risk assessments conducted for hazardous waste incinerators have typically been compared to a maximum total increased cancer risk target value (from metals) of 1 in 100,000, or 1.0 E-5.   This same value is being used in this screening. In addition, risk assessments for hazardous waste incinerators have also typically calculated a hazard index ("HI") from each metal and compared the results to the number 0.25. This was also done in this risk screening.

The metal Lead is evaluated in a slightly different way in this screening, as a conservative simplification over the commonly used blood uptake models. This evaluation uses an ambient air Lead concentration limit of .09 ug/m3, which is the regulatory Reference Air Concentration in 40 CFR 266 Appendix IV. In addition, this evaluation uses a maximum soil lead concentration incremental increase of 100 mg/kg. This means that no incineration facility should emit lead at a rate which causes an incremental increase in the soil lead concentration of more than 100 mg/kg at the point of highest predicted soil impact. This value is 25 percent of the concentration that is generally considered to be acceptable as the residual soil lead concentration for a Superfund or RCRA corrective action cleanup site. Since there are three units at this facility, the total calculated lead impact on the environment was apportioned 33 % to each unit. The Permittee may desire to apportion emissions differently and still achieve the same limits on impact.

This analysis begins by calculating the potential cancer risk and potential HI for each of the metals for each of the three stacks (Unit 2, Unit 3, and Unit 4) created by an assumed emission rate of 1.0 grams/second. The results are presented for the area of maximum exposure to a theoretical individual ("MEI") in Table 1. Note that for lead, the value in the Risk column on Table 1 is the predicted max soil concentration at the MEI from that unit, and the value in the HQ column is the predicted maximum air concentration at the MEI.

Table 1 – Calculated Risks and Hazard Indices at the MEI location resulting from an emission of 1.0 gram/second

	Stack 2				Stack 3				Stack 4			
	Adult		Child		Adult		Child		Adult		Child	
	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Arsenic	2.25e-03	6.76	1.05e-03	16.2	2.51e-03	8.33	1.17e-03	19.9	2.27e-04	1.19	1.71e-04	4.48
Beryllium	2.81e-02	5.08	3.31e-02	31.4	3.49e-02	6.32	4.12e-02	39.1	1.06e-02	2.02	1.42e-02	13.7
Cadmium	3.87e-02	0.17	1.33e-02	36.7	4.81e-02	0.16	1.66e-02	0.35	1.58e-02	0.02	5.52e-03	0.04
Chrome, Hex	3.17e-02	0.58	1.37e-02	1.25	3.91e-02	0.72	1.68e-02	1.55	4.49e-03	0.09	3.19e-03	0.3
Lead	4.98e+03	0.8	4.98e+03	0.8	6.19e+03	0.76	6.19e+03	0.76	3.57e+03	0.9	3.57e+03	0.9
Mercuric Cl	0.00e+00	113	0.00e+00	377	0.00e+00	115	0.00e+00	385	0.00e+00	85.7	0.00e+00	288
Mercury	NA	0.46	NA	1.02	NA	0.44	NA	0.98	NA	0.5	NA	0.11
Methyl Hg	NA	11.6	NA	27.6	NA	11.9	NA	28.3	NA	8.56	NA	20.8
Total Hg	NA	125.6	NA	405.6	NA	127.3	NA	414.3	NA	94.3	NA	309.7

Note that for Lead, the value in the Risk column is the predicted max soil concentration at the MEI, and the value in the HQ column is the predicted maximum air concentration at the MEI.

Because there are four carcinogenic metals being emitted from three different stacks, a decision was made for the purpose of this analysis to partition an acceptable risk of 1 E-6 to each individual metal from each individual stack, and then to calculate acceptable emission rate for each metal from each stack (for a total of twelve metal/stack emission rate values) which would not exceed that risk value. Although this summation could theoretically result in a total risk of 1.2 E-5 (i.e., 4 x 3 x 1 E-06) if all stacks were emitting all metals at the full regulatory limit proposed under this screening at all times, the likelihood of this maximum operating condition is very small.

In light of the above, a proportion was set up for each metal/stack value to the proposed maximum cancer risk of 1 E-6, as follows (using arsenic from stack 2 as an example) using the highest risk for each metal (i.e., adult or child)

$$\frac{\textbf{EL-As2}}{\text{1.0 gram/second As}} = \frac{\text{1.0 E-06}}{\text{2.25 E-03}}$$

And solving for **EL-As2** (i.e., the proposed Emission Limit for Arsenic from stack #2)

$$\textbf{EL-As2} = \frac{\text{1 E-06 g/s}}{\text{2.25 E-03}}$$

$$\textbf{EL-As2} = \text{4.44 E-4 g/sec} \quad \text{(= 1.6 g/hour)}$$

Similarly, proportions were set up for mercury for the highest calculated total mercury HI from each stack, to develop a proposed emission limit based on a HI of 0.25 for each metal for each stack (as before, assuming that the situation of all three stacks emitting a metal at the maximum rate simultaneously is not likely). Lead emissions were evaluated by comparing the predicted MEI soil concentrations and predicted MEI ambient air concentrations, at a 1 gram/sec emission rate, to the target values of 100 mg/kg and .09 ug/m3, respectively, and reducing the emission rate as necessary to achieve the target values. Each of the three units was apportioned 1/3 of the total (e.g., 33 mg/kg soil) when possible emission limits were calculated.

All of the above HI and cancer risk information was then put into Table 2, to assemble a list of potential emission limits for consideration in the RCRA permit:

Table 2 - Possible Emission Limits

	Unit 2	Unit 3	Unit 4
Arsenic	1.6 g/hr (4.44 E-4 g/sec)	1.43 g/hr (4.0 E-4 g/sec)	15.9 g/hr (4.41 E-3 g/sec)
Beryllium	0.11 g/hr (3.02 E-5 g/sec)	.09 g/hr (2.43 E-5 g/sec)	0.25 g/hr (7.04 E-5 g/sec)
Cadmium	.093 g/hr (2.58 E-5 g/sec)	.075 g/hr (2.08 E-5 g/sec)	0.23 g/hr (6.33 g/sec)
Chromium+6	0.113 g/hr (3.15 E-5 g/sec)	.092 g/hr (2.56 E-5 g/sec)	0.803 g/hr (2.23 E-4 g/sec)
Lead	24 g/hr (6.7 E-3 g/sec)	19.3 g/hr (5.4 E-3 g/sec)	34 g/hr (9.33 E-3 g/sec)
Mercury	2.22 g/hr (6.16 E-4 g/sec)	2.17 g/hr (6.03 E-4 g/sec)	2.91 g/hr (8.07 E-4 g/sec)

It should be emphasized that the above values only represent one of many possibilities for restricting the metals emissions from the three units at the Onyx facility. The Permittee might, alternatively, opt to apportion the various calculated risks differently among the three units.

Included as attachments to this report are spreadsheets generated as part of this analysis. These include (1) ER – maximum recommended emission rates based on risk of 1 E-6 and HI = 0.25 (which is itself based Table 1, above) in grams per second; and (2) calculated recommended emission rates (and/or Tier 1 metals feed rates) in grams per hour. A lists of input parameters for the IRAP model and other relevant information has also been included in the attachments.

ATTACHMENTS

Emission Rates (grams/sec)

	Stack 2				Stack 3				Stack 4			
	Adult		Child		Adult		Child		Adult		Child	
	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Arsenic	4.44e-04	3.70e-02	9.52e-04	1.54e-02	3.98e-04	3.00e-02	8.55e-04	1.26e-02	4.41e-03	2.10e-01	5.85e-03	5.58e-02
Beryllium	3.56e-05	4.92e-02	3.02e-05	7.96e-03	2.87e-05	3.96e-02	2.43e-05	6.39e-03	9.43e-05	1.24e-01	7.04e-05	1.82e-02
Cadmium	2.58e-05	1.47e+00	7.52e-05	6.81e-03	2.08e-05	1.56e+00	6.02e-05	7.14e-01	6.33e-05		1.81e-04	6.25e+01
Chrome, Hex	3.15e-05	4.31e-01	7.30e-05	2.00e-01	2.56e-05	3.47e-01	5.95e-05	1.61e-01	2.23e-04	2.78e+00	3.13e-04	8.33e-01
Lead	6.70e-03	3.73e-02	6.70e-03	3.73e-02	5.40e-03	3.93e-02	5.40e-03	3.93e-02	9.33e-03	3.33e-01	9.33e-03	3.33e-01
Mercuric Cl		2.21e-03		6.63e-04		2.17e-03		6.49e-04		2.92e-03		8.68e-04
Mercury		5.43e-01		2.45e-01		5.68e-01		2.55e-01				2.58e-01
Methyl Hg		2.16e-02		9.06e-03		2.10e-02		8.83e-03		2.92e-02		1.20e-02
Total Hg		2.00e-03		6.16e-04		1.96e-03		6.03e-04		2.65e-03		8.07e-04

Emission Rates / Feed Rates (grams/hour)

	Stack 2				Stack 3				Stack 4			
	Adult		Child		Adult		Child		Adult		Child	
	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ	Risk	HQ
Arsenic	1.60	133.14	3.43	55.56	1.43	108.04	3.08	45.23	15.86	756.30	21.05	200.89
Beryllium	0.13	177.17	0.11	28.66	0.10	142.41	0.09	23.02	0.34	445.54	0.25	65.69
Cadmium	0.09	5294.12	0.27	24.52	0.07	5625.00	0.22	2571.43	0.23		0.65	225000.00
Chrome, Hex	0.11	1551.72	0.26	720.00	0.09	1250.00	0.21	580.65	0.80	10000.00	1.13	3000.00
Lead	24.50	135.00	24.50	135.00	19.38	142.10	19.38	142.10	33.61	1200.00	33.61	1200.00
Mercuric Cl		7.96		2.39		7.83		2.34		10.50		3.12
Mercury		1956.52		882.35		2045.45		918.37				927.84
Methyl Hg		77.59		32.61		75.63		31.80		105.14		43.27
Total Hg		7.20		2.22		7.07		2.17		9.54		2.91