Health Consultation

RESPONSIVENESS SUMMARY

CONTINENTAL ALUMINUM EXPOSURE INVESTIGATION:
AIR MONITORING RESULTS

NEW HUDSON, OAKLAND COUNTY, MICHIGAN

EPA FACILITY ID: MI0001941699

MAY 3, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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Prepared by:

Michigan Department of Community Health
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Abbreviations and Acronyms

µg	microgram
µm	micron (micrometer)
AEGL	Acute Exposure Guideline Level
ATSDR	Agency for Toxic Substances and Disease Registry
CaREL	California Reference Exposure Level
CCAM	congenital cystic adenomatoid malformation
DNA	deoxyribonucleic acid
EI	exposure investigation
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
HCl	hydrochloric acid (hydrogen chloride)
HF	hydrofluoric acid (hydrogen fluoride)
MATES-II	Multiple Air Toxics Exposure Study II
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
mg/m^3	milligrams per cubic meter
NAAQS	National Ambient Air Quality Standard
ng/m^3	nanograms per cubic meter
$PM_{2.5}$	particulate matter less than 2.5 microns diameter
PM_{10}	particulate matter less than 10 microns diameter
ppb	parts per billion
ppm	parts per million
RfC	Reference Concentration
SPM	Single Point Monitor (acid monitor)
TEEL	Temporary Emergency Exposure Limit
TSP	Total Suspended Particulates
VOC	volatile organic compound

Summary

Continental Aluminum is an aluminum recycling smelter in Lyon Township, Oakland County, Michigan. In response to a petition for a public health assessment, the Michigan Department of Community Health (MDCH) conducted a three-month exposure investigation (EI) from March through May 2004, investigating chemicals in the air near the smelter. MDCH investigated the presence of acidic aerosols; concentrations of airborne metal particulates, elemental mercury, and volatile organic compounds (VOCs); and certain meteorological parameters to determine what chemicals were present at what concentrations and if Continental Aluminum could be considered a potential source. The results of the EI indicated the concentrations of chemicals in the air were below health-based comparison values. Assuming that the air samples were representative of current conditions, MDCH and the Agency for Toxic Substances and Disease Registry (ATSDR) conclude that there is no apparent current public health hazard.

Purpose and Health Issues

The purpose of this document is to report and interpret the results obtained from an EI conducted by MDCH in response to a public health assessment petition regarding Continental Aluminum. Residents in Lyon Township, where the aluminum recycling smelter is located (Figure 1), believe that emissions from the plant have caused various adverse health effects. Specific complaints are discussed in the Community Health Concerns section of this document. MDCH sampled the air for the most likely contaminants to be found around secondary aluminum refineries (acidic aerosols, airborne metal particulates, and VOCs), as well as for mercury, to determine which chemicals were present and in what quantities. To determine if there was a scientifically plausible link between exposure and health effects, the agency then compared the findings to established comparison values and to the reported health effects.

Background

In February 2002, the federal Agency for Toxic Substances and Disease Registry (ATSDR) received a letter from two state environmental groups and the supervisor of Lyon Township, in southwest Oakland County, Michigan, petitioning for a public health assessment. The petitioners were concerned that air, water, and soil emissions from the Continental Aluminum plant in New Hudson, in the northern part of the township, were causing the adverse health effects claimed by area residents. ATSDR and MDCH, which conducts public health assessments for the federal agency at sites of environmental contamination in Michigan, conducted a site visit and reviewed stack test and available environmental data. In a public health consultation issued March 12, 2003, the agencies concluded that the health hazard posed by the plant's emissions was indeterminate. ("Indeterminate" means that a conclusion regarding the level of health hazard cannot be made because information critical to such a decision, such as extent of exposure, is lacking or insufficient.) The agencies recommended that an exposure investigation be conducted to better ascertain any current public health impact of emissions from Continental Aluminum (ATSDR 2003).

MDCH and ATSDR developed a protocol for the EI, involving residents, township officials, and plant representatives in the planning process, and released a document outlining the EI to the stakeholders in February 2004 (MDCH 2004a). Appendix A contains the protocol. The EI began March 1, 2004 and ended May 31, 2004 (92 days).

Discussion

Environmental Sampling and Data

The Michigan Department of Environmental Quality (MDEQ), under an agreement with MDCH to provide technical support for the EI, set up two air-monitoring trailers in the parking lot of Dolsen Elementary School, about one-half mile north-northeast of Continental Aluminum, during the week of February 23, 2004. (MDCH received approval from the local school district, South Lyon Community Schools, before placement of the trailers.) One trailer contained a Single Point Monitor acid monitor (SPM), meteorological equipment, and high-volume sampling pumps. The second trailer housed two Tekran Model 2537A Ambient Mercury Vapour Analyzers (Tekran). (The EI protocol did not include air monitoring for mercury. The addition of this parameter had been tentative and only occurred shortly before the investigation began. Mercury emissions from other secondary aluminum smelters have been reported [EPA 1995a].) MDCH chose the Dolsen site for the trailers based on prevailing winds making the school predominantly downwind from Continental Aluminum. This site also presented an ideal scenario to determine rates of exposure of air emissions to sensitive subpopulations (i.e., children).

Along with the stationary air monitoring, the investigation included grab sampling of ambient air when local residents or employees of area businesses reported odor events. MDCH convened a citizen advisory group, which discussed the logistics of who would conduct sampling and under what circumstances a sample would be taken. The advisory group agreed that township fire department personnel, a staff person from the county health department, and two local residents would attend to odor sampling events. The group also agreed upon locations of "control" air sampling sites to be paired with the sampling events (Figure 2). MDCH conducted the training of the samplers and provided them with resource folders. Appendix B contains the list of folder contents and samples of those contents (except for the laminated map, sample chain of custody form, and business card).

Table 1 shows which days yielded results for which parameters of the EI. Shaded rows indicate days that were evaluated in detail due to a parameter being noted that day. In all, 46 of the 92 days were evaluated in detail.

Airborne Metal Particulates Data

MDCH sampled airborne metal particulates (aluminum, barium, beryllium, cadmium, chromium, copper, lead, manganese, selenium, and zinc) every 6 days, adjusting the schedule as necessary for staff needs. MDCH chose this schedule so as not to always sample on the same day of the week. As well, MDEQ collects samples from its air monitoring stations throughout the state every 6 days and compares data collected during the same 24-hour period between different stations. However, the particulate sampling at the EI trailer was not scheduled for the same days as the state-wide sampling. If longer-term sampling had occurred, MDCH would have adjusted the sampling schedule to coincide with that of MDEQ.

Tables 2a and 2b show the airborne metal particulates data by weight (micrograms [µg] per filter) and by concentration (milligrams per cubic meter [mg/m^3] of air), respectively. Note that, upon analysis, the blank filters taken for March 3 and April 26 contained aluminum, barium, chromium, cadmium, manganese, and zinc. (Blank filters were minimally exposed to the air. They were removed from their storage container, immediately enclosed in a resealable plastic bag, and placed in a shipping container.) The other results were not adjusted against this finding. It is likely that some of the metals found in the air samples were due to the presence of these metals in the filter substrate.

Table 2a shows the 24-hour average of each weather parameter measured on sampling days. (Air monitoring agencies use barometric pressure and temperature when determining total air volume that passes through a filter during sampling.) MDCH also recorded meteorological data by the hour and by the minute. Staff used these data when more detailed evaluation of other EI parameters was necessary. More discussion on the meteorological parameters recorded during the EI follows in the appropriate section below.

Acid Monitor Data

Tables 3a and 3b show when acidic aerosol detections occurred and the respective minute or hourly meteorological parameters associated with those detections. Technical difficulties occurred at the air-monitoring trailer at the beginning of the EI. Consequently, MDCH did not consider any recorded acidic aerosol values valid until March 15. Real-time acid monitoring values, checked when staff attended the trailer, appeared valid. MDCH staff, with assistance from the Oakland County Health Department, tested the monitor on March 10, to verify that the monitor was responding to the presence of acidic aerosols. The test involved holding an aqueous solution of sulfuric acid near the air intake tube for the SPM. The monitor readout changed from 0 parts per billion (ppb) to more than 100 ppb, indicating that the machine was responding.

Because Continental Aluminum’s operating permit lists hydrochloric (HCl) and hydrofluoric (HF) acids as plant emissions, MDCH assumed that the acidic aerosols monitored in the EI would be one of those compounds. However, as discussed in the EI protocol, the SPM cannot differentiate between acids. The ChemCassette® tape, the “detector” component of the SPM, which changes color upon exposure to a mineral acid, simply reacts to a change of pH (measure of acidity) in the air. The user must “tell” the SPM, by means of a “key,” what acid is being monitored. The machine does not verify the identity of the substance. For most of the EI, MDCH used the low-level HCl key to determine the presence of acidic aerosols. This key allowed for the longest sampling time (240 seconds) and the second-lowest detection level (30-1,200 ppb). The SPM’s sulfuric acid key has the lowest detection level (26-750 ppb) with a sampling time window of 120 seconds. (MDCH did not purchase that key.)

On the morning of May 17, MDCH changed keys in the SPM so that the machine was interpreting acidic concentrations as being HF aerosols. The sampling time window for the HF key was 30 seconds, with a detection limit of 0.6-9 parts per million (ppm), which equals 600-9,000 ppb. This detection limit significantly exceeded several of the comparison values for the chemical (Appendix A – Table 3). If the acidic aerosol detected was indeed HF, MDCH reasoned, being detected at the SPM's specified limits would indicate that odors should be present and at least transient adverse health effects would be expected. As indicated in Table 1, the acid monitor showed detections for 10 days after the HCl key was replaced with the HF key. However, there was only one odor complaint reported during that time. On the basis of this information, MDCH concluded that the acidic aerosols detected by the SPM likely were not HF. However, it cannot be determined from these data what compound or compounds triggered the detections in the SPM.

Not all detections by the SPM coincided with odor detections at the trailer (Table 1). Occasionally, field staff attending to the air-monitoring trailer reported detecting odors there. Some of the odors were associated with operations at Continental Aluminum; other odors were attributed to other sources. These odors are discussed further in the Confounders/Notes section below.

Mercury Vapor Data

The Tekran Model 2537A Mercury Vapour Analyzer provides continuous analysis of elemental mercury in air at sub-nanogram-per-cubic-meter (ng/m^3) levels. (A nanogram is 1 billionth of a gram or 1 millionth of a milligram.) The instrument samples air and traps mercury vapor into a cartridge containing an ultra-pure gold adsorbent. The trapped mercury is then desorbed and detected using atomic fluorescence spectrometry. A dual cartridge design allows alternate sampling and desorption, resulting in continuous measurements of the air stream. The instrument is able to produce a reading every 5 minutes (MDEQ 2004). Results for a specific sample are produced 10 minutes after the sample is taken. This includes 5 minutes for the collection and 5 minutes for the analysis to be completed (A. Robinson, MDEQ-Detroit District Air Quality Division, personal communication, 2004).

Due to technical difficulties and the time needed to calibrate the equipment, only data collected March 28 through May 31 (65 days) were considered valid. While two Tekrans were used within the mercury-monitoring trailer, one unit (Unit 2, the mobile unit) had operation difficulties and much of the data collected on that unit consequently was not used. Therefore, the average concentration calculated was from the operation of one of the Tekrans (Unit 1, the stationary or "fixed" unit). The average mercury air concentration at the site was 3.6 ± 1.2 ng/m^3 (n = 17,908 samples). There were six days on which concentration spikes greater than 10 ng/m^3 were detected (see Table 4).

There is evidence that suggests that this site is being impacted by a source, as yet unidentified, that is emitting elemental mercury. The evidence is as follows:

1. The average concentration of elemental mercury in the air in New Hudson (3.6 ± 1.2 ng/m3) is higher than the background concentration from areas not impacted by industrial sources (approximately 1.5 ng/m3) (Keeler 2003, Malcolm et al. 2003, Bullock 2004).

2. The average concentration of elemental mercury in the air in New Hudson (3.6 ± 1.2 ng/m3) during the EI (March to May 2004) was higher than concentrations detected during concurrent (January to June 2004: 2.4 ± 1.4 ng/m3, n=1,428) and historical (2001-2002: 2.4 ng/m3) sampling in Detroit, Michigan. Detroit is assumed to be impacted by a source based on comparisons to background data collected from an upwind location in Dexter, Michigan (January to June 2004: 1.5 ± 0.7 ng/m3, n=1,343).

   -Source data are from the "Michigan Mercury Monitoring Network," a partnership between the MDEQ Air Quality Division and the University of Michigan Air Quality Laboratory (Keeler et al. 2004), and from a 2001-2002 ambient air toxics monitoring study conducted by MDEQ (A. Robinson, MDEQ-Detroit District Air Quality Division, personal communication, 2004), respectively.

Therefore, the average value of 3.6 ± 1.2 ng/m^3 reported during the EI, as well as the numerous spikes in elemental mercury concentrations, suggest that the New Hudson area is being impacted. However, the source cannot be determined from these data. It is possible that a source other than Continental Aluminum could be responsible for these elevated levels of elemental mercury in air. MDCH has referred this matter to MDEQ for follow-up.

Odor Complaint Data

There were 18 days for which odors were reported during the EI (Table 5). Sampling events occurred on nine of those days. On two other occasions, samplers went to the odor event site but did not detect an odor and therefore did not sample. The remaining odor complaint reports did not include notification of samplers.

The odors were most often described as "metallic" and "burning wire" or "hot wire". Odor intensity ranged from "just detectable" to "can't smell anything else." The range of descriptor and intensity parameters recorded during the EI was similar to odors reported before and after the investigation. Usually, a person would use the same descriptor and intensity score in subsequent odor complaints. (To protect the identities of complainants, these data are not shown.)

Comparing when (minute) and where the odor was detected and wind direction to the location of Continental Aluminum from the odor usually indicated a potential connection. (It is difficult to compare the hourly average wind direction provided for the last three complaints, as winds can shift substantially over time.) The aluminum smelter cannot be eliminated as a potential source of the odors.

Some complaints, received before the EI, reported that odors were at their worst on “still, heavy” days (days with low wind speeds and high relative humidity). It is difficult to determine from the data in Table 5 if this is necessarily the case. Most of the odor intensity scores were “2” (“can’t smell anything else”), regardless of meteorological parameters. The olfactory organ is the most sensitive system in the body. There are many factors, both subjective and objective, that determine the severity of and reaction to an odor event (Schiffman et al. 2000, Hirsch 2002). One person’s sensitivity to odor stimuli may be affected by meteorological conditions, another person may perceive no difference when the weather changes.

Odor Sampling Data

Figure 3 shows where each of the odor event samples was taken. Figures 4-13 detail individual sampling events. Mileage from Continental Aluminum to each sample site is listed in each figure. Mileage from the plant to each control site (1-8) ranged from 0.34-1.0 mile.

Table 6a shows the list of analytes and their respective detection limits for which odor samples were tested. Not all analytes were detected in the samples. Therefore, only those chemicals detected in at least one sample are shown in Table 6b.

Several chemicals were detected in blank samples. The blanks were not opened in the field. It is unlikely they had leaky valves, otherwise the low detection levels for the VOCs would have resulted in detections of more chemicals. The detections in the blanks may have been anomalies, possibly due to the canisters reaching the limit of their shelf life (J. Swift, Eastern Research Group, personal communication, 2004). Although the EI protocol had indicated that canisters nearing the end of their shelf life would be replaced, Eastern Research Group later informed MDCH that the older canisters would perform just as well so long as the vacuum was holding. Pre-sampling vacuum testing indicated that all canisters maintained a vacuum during storage. On the basis of this information, MDCH chose not to exchange canisters and potentially miss a sampling opportunity. When the elapsed time between cleaning and being brought to atmospheric pressure was compared to the analytical results for each sampling event, “age” of canister did not seem to have an effect on a chemical’s presence or concentration. Low-level laboratory techniques are sensitive and detecting trace amounts of certain analytes is not uncommon in analytical work. In addition, some VOCs are common field blank or laboratory contaminants (e.g., acetone, methyl ethyl ketone, methylene chloride; EPA 1999).

Meteorological Data

At 2 AM on April 4, Eastern Standard Time switched to Daylight Saving Time. The clocks on the air monitoring equipment did not make this change. Therefore, the meteorological parameters recorded after the switch have been adjusted to the appropriate time.

Technical difficulties occurred at the air monitoring trailer during the start-up of the EI. Minute data (data recorded every minute) for all parameters were not reliable until March 15. Hourly data for barometric pressure and relative humidity were not available until March 22. As necessary, MDCH used hourly data from the MDEQ meteorological station in Ypsilanti (about 20 miles south). These instances are noted in the various tables and figures.

Additionally, a power outage occurred May 9. Although the machines in the trailer came back on-line when power was restored and displayed real-time data, minute data on and after this date were unavailable. Hourly data were available only intermittently. Again, as necessary, MDCH used hourly data from the MDEQ Ypsilanti station. These instances are noted in the various tables and figures.

When wind speeds decrease below 3 mph, wind direction becomes less and less reliable (E. Hansen, MDEQ Air Monitoring Unit, personal communication, 2004). As necessary when using minute data, MDCH omitted wind direction when wind speed was 2 mph or less. These instances are noted in the various tables and figures.

The wind direction value indicates from which direction the wind is originating. When the weathervane crosses north, going clockwise, wind direction changes from 359° to 0°. (North is at 0°, or 360°.) As necessary when using minute data, MDCH subtracted 360° from a west-of-north wind direction, or added 360° to an east-of-north wind direction, to indicate when the weathervane crossed north. (Otherwise, it might be assumed that weathervane made a nearly-complete counterclockwise circle going from, for instance, 355° to 5°, when it actually only rotated clockwise 10°.) These instances are noted in the various tables and figures.

Confounders/Notes

"Confounders" are other activities that can cause data to be misrepresentative of an event of interest. Several potentially confounding events occurred during the EI, including structural and brush fires, parking lot cleaning, and septic system off-gassing. Some of these events occurred on days when specific air monitoring parameters were recorded, others occurred on "non-parameter" days. Table 1 notes each event and discusses the likelihood of the EI being affected by it. Other events, not considered potential confounders, are noted below.

The staff person at the trailer the morning of March 24 detected a faint odor associated with Continental Aluminum and notified a sampler. That person was unable to detect an odor upon arrival at the trailer, so they did not take a sample. However, later in the day, another person contacted the sampler regarding an odor event, which resulted in a sample being taken. The acid monitor also recorded detections of acidic aerosols this day, although later than the sampled odor event.

On April 6, field staff noticed a hot wire or metal odor while at the trailer. The staff person chose not to notify a sampler, although she did associate the smell with

Continental Aluminum. She filled out an odor surveillance form (odor complaint) for MDCH and the township files.

As mentioned in the Meteorological Parameters section, a power outage occurred in the area on May 9.

On May 17, MDCH switched keys in the acid monitor, as discussed in the Acid Monitor Data section.

Comparison of Results to Comparison Values

Airborne Metal Particulates

Table 2b lists the concentrations of metals detected in collected air samples. The EI Protocol (see Appendix A - Table 3) shows the lowest comparison value for each metal measured. The analytical results are all below the respective screening levels, in some cases by several orders of magnitude. (An “order of magnitude” is a multiple of 10. For example, “three orders of magnitude” equals 10 x 10 x 10 or 1,000.)

The chemical that came closest to its respective lowest comparison value was chromium. Most of the detections for chromium should be considered estimates. They fell between the limit of detection (when the machine recognizes a chemical and differentiates it from background “noise”) and the limit of quantitation (when a machine can reliably determine the amount of the chemical, usually up to five times the detection limit). However, the March 19 chromium concentration approached, though was still less than, the Reference Concentration (RfC) for that metal.

Chromium exists in several valence (physical-chemical) states. The most commonly seen valences are (0), (III), and (VI). Chromium (0), or elemental, is the pure form of the metal. Chromium (III), or trivalent, is an essential micronutrient. Chromium (VI), or hexavalent, is a human carcinogen.

Analytical data are not available to indicate what portion of the chromium detected in the sample is the hexavalent form (P. Pope, DataChem Laboratories Inc., personal communication, 2004). The California Environmental Protection Agency (CalEPA) conducted a comprehensive air-monitoring program called the Multiple Air Toxics Exposure Study (MATES-II). In that study, the agency collected air samples from 10 stationary sites in California for 1 year and 14 temporary sites for 1 month each. Study results showed that total chromium concentrations consisted of 3.7% chromium (VI) (South Coast AQMD 2000). In Michigan, MDEQ conducted an ambient air toxics monitoring study at seven sites in the Detroit area in 2001-2002. The data included analysis of total chromium and hexavalent chromium at four sites. Analytical results indicated that only 1%-2.4% of total chromium was in the hexavalent form (R. Sills, MDEQ Air Quality Division, personal communication, 2004). Judging from the MATES-II and MDEQ’s findings, the chromium in the particulate samples taken at Dolsen Elementary School was probably a mixture of valences. In that mixture, the chromium (VI) concentration probably made up less than 10-15% of total chromium. To be protective, MDCH used the comparison values for chromium (VI). MDCH does not expect there to be an increased risk of adverse health effects (cancer or non-cancer) due to exposure to the concentrations of airborne metal particulates found in the EI.

Acid Monitor Data

As discussed earlier in this document and in the EI protocol document (Appendix A), MDCH could not verify the identity of the compound or compounds that triggered the detections on the SPM. The acid monitor can be set up to read for six mineral acids: HCl, HF, sulfuric acid, nitric acid, hydrogen iodide, or hydrogen bromide. Of these, HCl and HF are common emissions from secondary aluminum smelters (EPA 1986, 1995). As concluded earlier in this document, it is unlikely that the acidic aerosol was HF. For this discussion, MDCH is assuming that the acidic aerosol detected by the SPM up to the morning of May 17 was HCl.

Tables 3a and 3b show minute and hourly-average data, respectively, for the assumed-HCl concentrations and meteorological parameters. The maximum assumed-HCl concentration detected exceeded only the RfC for HCl. However, the RfC addresses 24-hour (continuous) exposure. The detections of acidic aerosols at the air-monitoring trailer at Dolsen Elementary School were not continuous. The shortest event during the EI lasted 8 minutes and the longest lasted almost 34 hours. (MDCH considered an acidic-aerosol detection a new event if at least 60 minutes had elapsed since the last detection.) The intermittent nature of these events indicates that exposure to acidic aerosols in the area near Continental Aluminum is sporadic. It is more appropriate to compare the detection results to short-term, or acute, comparison values, such as the California Reference Exposure Level (CaREL) and the Acute Exposure Guideline Levels (AEGLs). The CaREL for HCl is 290 ppb, over a 1-hour averaging time (averaging all readings taken within 1 hour) (CalEPA 1999a). The maximum assumed-HCl minute concentration in Table 3a was 46 ppb. It is likely that the highest 1-hour average of the assumed-HCl concentrations would be less than 46 ppb, which is less than one-fifth the CaREL for HCl. The maximum assumed-HCl hourly concentration in Table 3b was 37 ppb, also well below the CaREL for HCl. MDCH does not expect adverse health effects to occur as a result of exposure to assumed-HCl concentrations recorded during the EI.

Mercury Vapor Data

The inhalation comparison values for mercury vapor are listed in the following table:

Table 7. Mercury vapor inhalation comparison values used for MDCH Exposure Investigation (EI) at Continental Aluminum

Mercury Comparison Value	**Concentration**	**Reference**
CaREL	1.8 µg/m^3 (1,800 ng/m^3)	CalEPA 1999b
AEGL	None reported	Not applicable
ERPG/TEEL		DOE 2004
Level 0	0.025 mg/m^3 (25,000 ng/m^3)	
Level 1	0.1 mg/m^3 (100,000 ng/m^3)	
Level 2	2.05 mg/m^3 (2,050,000 ng/m^3)	
Level 3	4.10 mg/m^3 (4,100,000 ng/m^3)	
EMEG - air		ATSDR 2004a
Acute	None reported	
Intermediate	None reported	
Chronic	0.2 µg/m^3 (200 ng/m^3)	
RfC	0.3 µg/m^3 (300 ng/m^3)	EPA 1995b

CaREL = California Reference Exposure Level; AEGL = Acute Exposure Guideline Level
ERPG = Emergency Response Planning Guideline; TEEL = Temporary Emergency Exposure Limit
EMEG = Environmental Media Evaluation Guide; RfC = Reference Concentration

Note: Definitions for comparison values are in the EI Protocol (Appendix A).

The highest concentration detected by the Tekran analyzer was 511 ng/m^3, which exceeded the RfC and chronic EMEG but only in one 5-minute sample. As discussed earlier, the RfC for a chemical addresses 24-hour, lifetime exposure. The chronic EMEG addresses an exposure duration longer than one year. Note that the wind direction at the time of this peak sample, and during the second highest recording measured 20 minutes later, was from the northeast, eliminating Continental Aluminum as a potential source for those two samples.

Elemental mercury vapor, such as that detected by the Tekran, tends to travel greater distances than does particulate mercury. When investigating a potential local source, a second upwind analyzer would provide information on whether detected mercury originated locally or at a distant source (J. Taylor-Morgan, MDEQ Air Quality Division, personal communication, 2004). The second Tekran analyzer was not working properly to deploy it to an upwind site for comparison. Therefore, it is unknown if the mercury detected during the EI was from a local or a distant source. MDCH has referred this matter to MDEQ.

Mercury has no odor. Therefore, any odors detected during the times when the Tekran reported above-normal concentrations were not due to elemental mercury.

Elevated detections of elemental mercury during the Continental Aluminum EI demonstrate that the area is being impacted by a source of elemental mercury. However, the concentrations detected do not pose a health risk through exposure by inhalation. The average concentration detected (3.6 ng/m^3) is more than 50 times below ATSDR's comparison value (200 ng/m^3).

Odor Sampling Data

All of the detected chemicals sampled during odor events fell well below their respective comparison values (Table 6b). The only chemicals that came to within an order of magnitude (one-tenth) of their respective lowest comparison values were 1,3-butadiene, at about one-sixth its RfC, and benzene, not quite one-half its intermediate EMEG. The maximum concentration of 1,3-butadiene detected (0.15 ppb) was from a control sample. The rest of the detections for this chemical occurred only at odor event sampling sites. 1,3-Butadiene is found in petroleum products and engine exhausts and is used in making plastics. The maximum concentration of benzene (1.67 ppb) occurred at an odor event sampling site. Benzene was found in all field samples (control as well as odor samples) and two blank samples. Benzene commonly is found in gasoline and exhaust fumes and is used in the manufacture of rubber and lubricants. While it is possible that the scrap being processed by Continental Aluminum, despite being inspected for impurities, included plastics, rubber, or solvents that contained 1,3-butadiene or benzene, it is also possible that the detections of these chemicals were due to nearby vehicular traffic.

The only chemical to exceed its odor threshold was toluene, with an odor threshold of 0.27 ppb and a maximum detected concentration of 1.81 ppb. The odor of toluene, a common solvent, is described as “sweet, pungent, benzene-like” (HSDB 2004). (Benzene causes the odor one smells in gasoline.) Toluene is present in paints, lacquers, rubber, and automobile exhaust. While it is possible that the scrap being processed by Continental Aluminum contained rubber (any solvent in paints or lacquers would have evaporated when the paint dried on the new product), it is also possible that the detections of toluene were due to nearby vehicular traffic.

Note that none of the odor descriptions for the chemicals tested for in the odor-sampling portion of the EI (Appendix A – Table 1) matched the most common descriptors for odor events that were sampled: “metallic” or “burning wire” (Table 5). This might lead to the argument that the compounds causing the odors were not tested for in the EI. A metallic odor is to be expected near an operating smelter. Ten metals, including aluminum, were tested for in the airborne-particulate testing. MDCH tested for VOCs during odor events because of the possibility of paint or solvents adhered to scrap entering the furnace, being volatilized, and entering ambient air as odors. Historic odor complaints included “chemical,” “plastic,” and “paint” as descriptors (Appendix C), suggesting VOCs might have been present.

Because the detected VOCs fell well below their respective comparison values, it is unlikely that these concentrations would cause adverse health effects following acute (short-term) or chronic (long-term) exposure.

<u>Plausibility of Link to Reported Health Effects</u>

Most health complaints reported by residents of Lyon Township were of a respiratory nature. The ATSDR *Toxicological Profile for Aluminum* (1999) discusses lung effects in workers exposed to fine aluminum dust or to alumina (aluminum hydroxide). These effects, also seen in research animals, are suggestive of dust overload. Dust overload occurs when the volume of dust in the lungs markedly impairs pulmonary clearance mechanisms. This condition is not dependent on the toxicity of the compound. Dust overloading has been shown to modify both the dosimetry (what actual dose is delivered) and toxicological effects of the compound. When excessive amounts of widely considered benign dusts are persistently retained in the lungs, the resultant lung effects are similar to those observed following exposure to highly toxic dusts. It is unclear whether the observed respiratory effects might be related to aluminum toxicity or dust overload. It should be noted that complainants in Lyon Township have reported odors, smoke, and noise, but not excess dust in the air.

Particulate matter, or PM, is one of the criteria pollutants listed in the Clean Air Act and its Amendments for which EPA has listed National Ambient Air Quality Standards (NAAQS). Beginning in 1987, EPA restricted the standard from Total Suspended Particulates (TSP) to the mass concentration of inhalable particles less than or equal to 10 microns (micrometers, µm), or PM_{10} (Federal Register, as cited by Bascom et al. 1996). PM_{10} can enter the thoracic airway, whereas some components of TSP might be filtered or expelled earlier along the respiratory tract by the body's protective mechanisms (nostril filtration, coughing).

In a 1996 risk assessment of PM, EPA stated that the pollutant should be split further into a coarse fraction (PM_{10}) and a fine fraction ($PM_{2.5}$, less than 2.5 microns). Particles ranging from 2.5-10 µm in size include resuspended road dust (soil particles, engine oil including metals, tire particles, sulfate, and nitrate), construction and wind-blown dust, silicon, titanium, aluminum, iron, sodium, and chlorine. Particles smaller than 2.5 µm include combustion, condensation, and coagulation products of gases and ultrafine particles; carbon; lead; vanadium; bromine; and sulfur and nitrogen oxides. In studies where coarse fraction particles were the dominant fraction of PM_{10}, major short-term effects observed included aggravation of asthma and increased upper respiratory illness (Bascom et al. 1996). The current NAAQS 24-hour value for PM_{10} is 150 $\mu g/m^3$ and for $PM_{2.5}$ is 65 $\mu g/m^3$. All of the values for PM_{10} in Table 2b are below both criteria. (One milligram [mg] equals 1,000 micrograms [µg].) Although the health effects described by Bascom et al. (1996) have been reported by some Lyon Township residents, adverse health effects related to particle burden toxicity would not be expected following exposure to the levels of PM_{10} found during the EI.

The individual chemical data collected during the EI indicated that the chemicals investigated did not exceed their respective comparison values outlined in the EI protocol. Therefore, it is not likely that exposure to any chemical *by itself* would result in adverse health effects. However, these chemicals did not occur alone but rather as complex mixtures. The science regarding interactions of chemical mixtures is still in its infancy. One chemical might have no effect on another (additive effect) or may act synergistically (one chemical causes the action of another chemical to be greater than expected), or antagonistically (one chemical causes the action of another chemical to be less than expected). The concentrations of the detected chemicals were, for the most part, more than one order of magnitude lower than their respective lowest comparison values. Current exposure-based assessment of joint toxic action of chemical mixtures (ATSDR

2002) suggests that the mixtures presented in the EI data would not be expected to cause adverse health effects.

Schiffman et al. (2000) discuss three paradigms, or examples, in which ambient odors may produce health symptoms in a community. Any or all of these paradigms might be occurring in Lyon Township. In the first paradigm, an odor-producing chemical (or mixture) occurs at a level that also causes irritation or other effects. Therefore, it is the irritation, not the odor itself, causing the effects, with the odor serving as an exposure marker. The irritation generally occurs at a concentration three to 10 times higher than when the odor is first detectable (the odor threshold). Although the concentration of each individual compound identified in the odorous air may not exceed the concentration known to cause irritation, the combined load of the complex mixture can exceed the irritation threshold. As already discussed, the concentrations of the chemicals detected in the air samples from the EI are all below their respective lowest comparison values. It cannot be said with certainty that the combination of these chemicals may be causing health effects, especially since the data do not identify or quantify the same chemicals consistently.

In the second paradigm, health symptoms appear at concentrations that would not be expected to be irritating. Concentrations exceed the odor threshold but fall well below irritant thresholds. Sulfur gases and organic amines can cause such scenarios. Symptoms can include nausea, vomiting, and headaches. The mechanism by which these symptoms are induced, when the potency of the odor far exceeds the potency of its irritancy, is not well understood. The degree of unpleasantness of the odor, the exposure history (previous experience with the odor), doubts about whether or not the odor is safe, and emotional status may play a role in inducing health symptoms. Noxious odors that are neither irritating nor toxic can set up a series of events, such as stress or nutritional problems (from failure to eat if one is feeling nauseous), that can lead to health effects. In Lyon Township, historic odor complaints and anecdotal evidence indicate that experiencing these odors is stressful to many residents. This stress can exacerbate or cause symptoms when people are exposed to the odors.

The third paradigm occurs when the odor-causing chemical is part of a mixture that contains a co-pollutant that is responsible for the reported health effects. Similar to the first example, the odor serves as an exposure marker, however a different chemical or air contaminant (such as dust or an allergen) is causing the effects. The body may become physically conditioned to reacting to the odor, regardless of whether the actual irritant is present in the future. It is difficult to determine if this might be the case in Lyon Township because emotional reaction to the odor, as discussed in the second paradigm, is likely also a factor in how a person reacts to an odor.

Specific concerns voiced by the community are addressed in the Community Health Concerns section.

Adequacy of Environmental Data

Anecdotal evidence from the community reports that the odors associated with Continental Aluminum were much worse when the plant first started operating in 1998. Several complainants reported that children playing outside were ushered indoors during odor events. MDCH reviewed odor complaints submitted to MDEQ and to Lyon Township from 1998 to 2002 (Appendix C). Complaints have diminished over time, but it is unknown whether this reflects a decline in the number of odor events or community members losing interest or becoming apathetic ("burn-out"). It is unknown whether emissions from the plant were higher when it first started operating because air data for that time are unavailable. (Stack-testing at the plant addresses only emissions going through the furnace stacks or the pollution control equipment and not potential fugitive emissions.) However, as discussed in the next paragraph, additional environmental sampling would not likely provide this information with any degree of certainty.

Air samples provide a "snapshot" of conditions happening at a specific time. The samples may or may not be representative of long-term conditions. Extrapolation of air data may not be appropriate for historic exposure assessment. Soil samples might provide information helpful in determining potential sources in non-attainment situations regarding particulate matter (PM). However, it would be difficult, if not impossible, to determine the degree of exposure during past odor events, when people reported health effects (acute events), from soil data. Models for this type of exposure assessment have yet to be developed and validated. Additionally, other components of the air emissions expected from aluminum recycling smelters, such as VOCs and acidic aerosols, would be more likely to undergo chemical reactions while still airborne and might not even deposit locally. Thus, this type of exposure assessment would contain a high degree of uncertainty due to lack of site-specific data. It would not be prudent to attempt to use soil data to estimate past exposure to acute events or chronic exposure.

Several community members have expressed interest in knowing "everything" that is in the air around Continental Aluminum. MDCH and ATSDR limited the chemicals investigated in the EI to those expected to be emitted from secondary aluminum smelters (EPA 1986, 1995). The EI further focused on those chemicals that could cause the reactions noted historically by odor complainants, and those of particular concern to the petitioners. If these "sentinel" chemicals were problematic, then further detailed analyses of the air might be warranted. However, the data indicated that the chemicals did not exceed health-based standards. Therefore, at this time, it is not necessary to investigate the presence of other chemical classes.

ATSDR Child Health Considerations

Children may be at greater risk than adults from exposure to hazardous substances at sites of environmental contamination. Children engage in activities such as playing outdoors and hand-to-mouth behaviors that could increase their intake of hazardous substances. They are shorter than most adults, and therefore breathe dust, soil, and vapors found closer to the ground. Their lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages. Even before birth, children are forming the body organs they need to last a lifetime. Injury during key periods of growth and development could lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the mother could lead to exposure of the fetus, via the placenta, or affect the fetus because of injury or illness sustained by the mother (ATSDR 1998). The obvious implication for environmental health is that children can experience substantially greater exposures to toxicants in soil, water, or air than adults can.

Children likely have varying rates of exposure to airborne chemicals dependent on their location relative to the source and meteorological conditions. Children attending Dolsen Elementary School, which is about 1/2 mile north-northeast of the plant, could be exposed to airborne chemicals emitted by Continental Aluminum when prevailing winds blow from the southwest. The comparison values used in this EI are based on the most sensitive toxic endpoints determined by laboratory or epidemiological studies. As discussed previously, concentrations of the chemicals investigated in the EI fell well below their respective comparison values. It is not likely that children's health was adversely affected as a result of exposure to airborne chemicals tested for in the EI.

Deposition of airborne chemicals to the earth can lead to exposure via skin contact and ingestion. Continental Aluminum has been in operation in Lyon Township for almost 7 years. This relatively short time span should not have resulted in significant deposition. In 2001, two private citizens had the soil in their respective yards analyzed for various metals and anions (Table 8). The samples were taken 3 years after the plant began operations in the area. No earlier soil data are available for these addresses. These residences are predominantly downwind of Continental Aluminum and closer to the plant than is Dolsen Elementary School. While concentrations of a few metals exceeded the default value for Michigan background (an average value for unimpacted soil), overall results were less than the MDEQ Part 201 Generic Clean-up Criteria for residential soils (MDEQ 2002) and the ATSDR chronic EMEG for children (ATSDR 2004b). It is not likely that concentrations of chemicals associated with emissions from Continental Aluminum in the soil at Dolsen Elementary School, or in the area around the smelter, are at levels that should warrant concern regarding skin contact and ingestion.

Community Health Concerns

<u>General Health Complaints</u>

Residents of Lyon Township, and people who work there, have reported many and diverse health effects that they associate with exposure to emissions from Continental Aluminum. (This information was self-reported. MDCH did not conduct a health survey.) These effects include: irritation of mucous membranes (eyes, nose, throat), nosebleeds, breathing difficulties, asthma attacks, sinus infections, headaches, migraines, and nausea. The township building inspector suffered corneal abrasions when he was investigating a report of smoke and odor coming from the plant. These health effects can occur as a result of exposure to airborne irritants, such as acidic aerosols, or odors. According to the samplers and the citizen who notified them, the May 18 odor event was the strongest odor experienced during the EI and was reminiscent of historical odor events. The analytical data reported for this odor event showed that concentrations of chemicals of interest were below health-based comparison values. Nonetheless, as discussed earlier, health effects from irritating odors could occur below acute and chronic health criteria.

Asthma Incidence

At the request of a Lyon Township resident, an asthma epidemiologist at MDCH reviewed the incidence of asthma hospitalizations (per 10,000 population basis), using the primary discharge diagnosis code, for the years 1990 through 2001 for Oakland County (MDCH 2003). Although inpatient hospitalization and mortality represent the most severe consequences of asthma, MDCH routinely uses this information to explore the impact asthma has on communities. New diagnoses cannot be determined from these data. Also, because the database does not include individual identifiers, calculated hospitalization rates may include multiple admissions by the same person.

The epidemiologist condensed the data for zip code area 48165 (New Hudson) into three equal periods (1990-1993, 1994-1997, and 1998-2001), due to the small number of events. (These data indicate the number of people per 10,000 living in a specific zip code that were hospitalized, regardless of the zip-code location of the hospital.) The asthma hospitalization rate per 10,000 people for these time periods in the area were 3.6, 3.1, and 2.3, respectively. The downward trend was not statistically significant. (The hospitalization rate was calculated for children and adults collectively. The epidemiologist was unable to calculate pediatric asthma hospitalizations separately due to the small number of events for the zip-code areas.) In 2000, the asthma hospitalization rate for New Hudson, South Lyon (zip code 48178), and Milford (zip codes 48380 and 48381) combined was 7.46 per 10,000, according to a database compiled by Wayne State University. As a comparison, for that same year, the asthma hospitalization rates for Oakland County and the state of Michigan were 11.8 and 15.8 per 10,000, respectively (MDCH 2003).

Aluminum Levels in Blood

One set of parents concerned about allegations regarding Continental Aluminum's emissions independently had the blood aluminum level checked in their elementary school-age child. Although they live in the prevailing upwind direction from the plant, the child would be attending Dolsen Elementary School (primarily downwind from the plant) and the parents wanted to establish a baseline to which they could compare future levels. Test results indicated that the child had levels of aluminum in his blood slightly above (well within an order of magnitude of) the laboratory-reported reference levels (data not shown). (The *Merck Manual*, 17th Edition [1999], reports normal adult serum aluminum levels as 3-10 micrograms per liter.) The child was *not* showing symptoms associated with aluminum toxicosis (neurologic, bone, or lung effects). The parents consulted with the Michigan Poison Control Center regarding potential household sources of aluminum (private well water, antacids, soda cans, some cookware), but no likely source could be found. The parents plan to have the child tested annually.

Another set of parents also independently had their children tested for blood aluminum levels. The family moved to the area about 15 years ago and lives a couple of miles east of the plant. One child currently attends Dolsen Elementary School and the other finished attending the school last year. Both children's results were above (well within an order of magnitude of) the laboratory-provided reference range. Neither child was symptomatic. The parents and the pediatrician's office contacted MDCH for guidance on what the levels meant and what actions might be necessary. In response, MDCH researched the subject and compiled information into factsheets for both the public and healthcare providers. (These factsheets have been posted on the MDCH website at http://www.michigan.gov/mdch-toxics, under the "Health assessments and related documents" link for Continental Aluminum.)

MDCH is advising that people *not* have their blood analyzed for aluminum since exposure is common. (Aluminum is present in many foods, over-the-counter medicines, and hygiene products.) The majority of aluminum intake is not absorbed, that which is absorbed being excreted by the kidneys. The primary population of concern, then, is those persons with kidney disorders, such as dialysis patients. MDCH conferred further with the ATSDR Division of Toxicology, the ATSDR Regional Office, the Pediatric Environmental Health Specialty Unit at Chicago's Cook Hospital, and the Michigan Poison Control Center to determine acceptable reference ranges for aluminum in serum or urine (there is little consensus between laboratories). As a result of these discussions, MDCH updated the factsheets, providing the information to stakeholders and posting it on the agency's website. Regarding the three children who were tested, the reported blood aluminum levels are not of clinical concern.

Mutagenicity or Tumorgenicity

Other persons have expressed concerns that emissions from Continental Aluminum could have mutagenic (changing DNA) or tumorigenic (causing benign or malignant tumors) effects. In one family, both children were diagnosed with noncancerous tumors defined as "aneurismal bone cysts." The children were born before the family moved to Lyon Township but were diagnosed after they had lived in the area for 4 years. (They had moved to the township before Continental Aluminum started production there, and diagnoses occurred after the plant had been in operation for at least 1 year.) The family lives in the predominant upwind direction from Continental Aluminum. According to the medical literature, it is not unusual for these cysts to occur randomly, but it is unusual for the cysts to occur in related individuals. The parents report that there is no genetic basis for both children to have these tumors. One child has developed asthma and recently has been diagnosed with Crohn's disease. The results of the EI air testing show no exceedances of comparison values of the detected chemicals. Given this information and the lack of data regarding etiology of aneurismal bone cysts, MDCH cannot conclude that there is any link between the diagnoses and emissions from Continental Aluminum.

In another family, living in the area since 1996 and residing predominantly upwind of Continental Aluminum, the mother exercised daily during her pregnancy by walking along the bike trail (a former railroad) that goes through the community and behind the plant (Figure 1). She claims that on occasion she would smell odors emanating from the plant. She recalls one day when the odor was particularly strong, for which MDEQ subsequently cited Continental Aluminum. (Continental Aluminum received a Letter of

Violation from MDEQ on December 8, 1999 in response to strong odors verified December 3, 1999 [see Significant Date Chronology in ATSDR 2003]). The woman remembers suddenly feeling ill during her walk on that particular day. Following several prenatal tests, doctors diagnosed the unborn child with a “level 3 CCAM,” a congenital cystic adenomatoid malformation of the left lung. The woman brought the pregnancy to term. Doctors removed the infant’s lung several days after birth. The child has had several surgeries since. Similar to the discussion regarding the bone cysts, MDCH cannot conclude that there is a link between maternal exposure to the emissions of Continental Aluminum and mutagenic or teratogenic (birth deformities) effects.

Another woman contacted MDCH and asked whether her husband’s brain tumor could be a result of exposure to emissions from Continental Aluminum. The couple lives outside of the township but has operated a business just south of the plant for more than 20 years. Although predominantly upwind, their business could be affected by fugitive emissions or wind eddies from the plant due to its proximity. The husband was diagnosed with the tumor about 2 or 3 years after Continental Aluminum began operations in the township. It cannot be determined from the EI data whether the tumor could have been caused by something in the air.

Noise

Members of the community also had been concerned about noise, especially at night, coming from Continental Aluminum. In February 2004, the company added mufflers to the baghouse stacks in an attempt to reduce noise and vibration generated by the pollution control equipment. Anecdotal evidence indicates that this step has improved the situation for most residents. Due to the nature of operations at the plant, there continue to be occasional loud sounds, such as metal hoppers being moved about and semi trucks entering and leaving the premises. In the 1978 report *Noise: A Health Problem*, EPA’s Office of Noise Abatement and Control concluded that unwanted noise can be more than just an annoyance. Noise can contribute to stress, interfere with learning, and pose a public health hazard (EPA 1978). (The Office of Noise Abatement and Control lost its funding in 1982 and has yet to be reestablished [HR4308 1996]). While MDCH and MDEQ have no authority to regulate noise issues, it is addressed here because, as a stressor, noise might be contributing to the health effects reported by some residents of Lyon Township.

Conclusions

MDCH and ATSDR conclude that the concentrations of chemicals detected in the air during the exposure investigation in Lyon Township posed no apparent health hazard by inhalation. Exposure is occurring but not at levels at which adverse health effects would be expected. Assuming that air samples taken March 1 through May 31, 2004 were representative of average conditions in the township, **air concentrations of the detected chemicals pose no apparent current public health hazard.**

As discussed earlier in this document, further environmental sampling likely will *not* help determine the hazards of past exposures. Soil data from 2001, three years after Continental Aluminum began operations in Lyon Township, indicated that soil concentrations did not exceed health-based comparison values and suggested that emissions from Continental Aluminum were not depositing significantly to area soils.

Because the air data from the EI do not indicate that there are significant emissions and the soil data from 2001 do not show an impact from deposition, there is no scientific evidence supporting further study of this site.

Recommendations

None at this time.

Public Health Action Plan

►MDCH and ATSDR will provide a brief summary of this report to Lyon Township residents, which they can provide to their private physicians when seeking medical care relating to respiratory complaints.

►MDEQ will investigate further mercury concentrations in the area around Continental Aluminum and provide regulatory guidance, as needed, to suspected sources.

If any citizen has additional information or health concerns regarding this health consultation, please contact the Michigan Department of Community Health, Environmental and Occupational Epidemiology Division, at 1-800-648-6942.

Preparers of Report

Michigan Department of Community Health

Christina Bush, Toxicologist

Robin L. Freer, Resource Specialist

ATSDR Regional Representative

Mark Johnson
Regional Services, Region V
Office of the Assistant Administrator

ATSDR Technical Project Officer

Trent LeCoultre
Division of Health Assessment and Consultation
Superfund Site Assessment Branch

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Certification

This **Continental Aluminum Exposure Investigation: Air Monitoring Results** Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the cooperative agreement partner.

Technical Project Officer, CAT, SPAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Team Lead, CAT, SPAB, DHAC, ATSDR