Potential Regional Coordination on Pollution Prevention Technologies and Resources for Industry Sectors Emitting or Transferring Lead or Lead Compounds in the Northeast

Introduction

In late 2001, the Northeast Waste Management Officials' Association (NEWMOA)[1] analyzed the Environmental Protection Agency's 1998 and 1999 Toxics Release Inventory data for releases and transfers of persistent, bioaccumulative and toxic (PBT) chemicals in NEWMOA-member states. From these data, lead and lead compounds were identified as being released and transferred in amounts larger than any other PBT chemical.[2]

NEWMOA then prepared a report titled *"Identifying Industry Sectors in the Northeast That Emit or Transfer Lead or Lead Compounds."* NEWMOA staff presented that report to the NEWMOA Directors in December 2001. The Directors asked NEWMOA to prepare a follow-up report examining the pollution prevention (P2) opportunities for the lead-emitting key sectors in the region and exploring options for addressing lead/lead compound emission/transfer reduction regionally. This report *"Potential Regional Coordination on P2 Technologies and Resources for Industry Sectors Emitting or Transferring Lead or Lead Compounds in the Northeast"* addresses this need.

Pollution Prevention Opportunities for Lead

NEWMOA researched lead and lead compound pollution prevention technologies and resources for the following industry sectors identified previously. These eight[3] two-digit SIC codes account for all the reported lead and lead compounds released and transferred in the northeast states.

10 Metal mining	33 Primary metals
28 Chemicals	34 Fabricated metals
30 Plastics	36 Electrical equipment
32 Stone/Glass/Clay	37 Transportation

[1] The Northeast Waste Management Officials' Association (NEWMOA) is a non-profit, non-partisan interstate governmental association. The membership is composed of state environmental agency directors from the pollution prevention, hazardous and solid waste, and waste site cleanup programs in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont. Karen Thomas was the primary author of this report; Terri Goldberg managed the work.

[2] The 2000 TRI data have become available since the initial research was completed. Massachusetts TURI did not see any significant changes for lead in the 2000 MA data, so NEWMOA decided not to invest the time to analyze the other states' data for the purposes of this report.

[3] The following five codes did not account for significant releases and transfers and were not included in this study: 29 Petroleum, 35 Machinery, 49 Electric Utilities, 39 Miscellaneous, Multiple Codes 20-39 and 5169 Chemical Wholesalers. SIC Code 4953/7389 RCRA/Solvent was also ignored.

NEWMOA found twenty two descriptions of lead P2 technologies that had either already been implemented or were being considered for implementation. The P2 information was gathered from a variety of web-based resources. The findings include a table of the lead-emitting technology and its corresponding P2 alternative, arranged by 2-digit SIC code; and a list of additional resources for each technology. This information is presented in Appendix A in a format that is meant to be useful for regulatory officials and pollution prevention technical assistance providers that are working to reduce emissions and transfers of lead and lead compounds.

NEWMOA then added the P2 information to the data from the previous report to assist in determining the sectors of regional importance with regard to the reduction of lead emissions/transfers. The following table presents the industry sectors ranking first, second and third according to key criteria. These criteria include: sectors represented in the largest number of states, sectors with largest region-wide quantities released, treated on/off site, recycled on/off-site, and sectors with what appear to be available P2 options.

Ranks According to Certain Criteria of Industry Sectors in the Northeast that Emit or Transfer Lead or Lead Compounds

	First	Second	Third
Sectors represented in largest* number of states	Primary Metals	Electrical Equipment	Fabricated Metal Products
Sectors with largest* quantities released region-wide	Metal Mining	Primary Metals	Chemicals
Sectors with largest* quantities treated on/off site region-wide	Chemicals	Primary Metals	Electrical Equipment
Sectors with largest* quantities recycled on/off site region-wide	Electrical Equipment	Primary Metals	Stone/Clay/Glass
Sectors with available P2 options	Electrical Equipment	Primary Metals	Transportation Equipment (lead-free electrocoats)

* Based on the 1998 and 1999 Toxics Release Inventory data.

Using these data, the primary metals industry sector releases, transfers and recycles the second largest quantities of lead and lead compounds and is represented in the largest number of states. The primary metals sector also has a number of web-published P2 options. The electrical equipment sector is represented in many northeast states and recycles the largest quantity of lead and lead compounds. The electrical equipment sector also has a number of web-published P2 options.

Findings

Availability of lead/lead compound P2 technologies & information[4]

- A few pollution prevention technologies for lead and lead compounds exist for most of the industry sectors researched.[5]
- Without investing much more time, NEWMOA was not able to identify the current adoption rate for these technologies in the region, their practicality, or the reduction of lead emissions and transfers that could be realized if the technologies were more widely adopted.

Regional expertise in certain sectors

- Certain programs in the region have experience in lead reduction efforts for specific industry sectors.
- For example, the Massachusetts Toxics Use Reduction Institute has been conducting research for many years into lead-free solder in electronics and alternatives to lead for wire cable insulation.

Choosing sectors to realize most gain

- The "electrical equipment" and "primary metals" industry sectors emerge as the favorites according to the preliminary criteria studied.

Options for Regional Coordination

The following are possible options for regional coordination on lead reduction.

- NEWMOA could provide the available lead P2 information to state regulatory and technical assistance providers through a variety of means, including the NEWMOA website, creation of a lead workgroup, a web conference, a workshop, or a track within a larger conference.

- NEWMOA could assist in spreading the knowledge of regional expertise in lead-free solder in electronics and alternatives to lead for wire cable insulation through the means mentioned above.

- NEWMOA could continue to study the common regional industry sectors where lead and lead compounds are emitted and transferred to attempt to determine the current adoption rates of these technologies in the region, their practicality or the

[4] Overall the NEWMOA researchers found that information on lead P2 technologies is difficult to locate on the web.
[5] NEWMOA did not find any web references for pollution prevention technologies for Chemicals or Stone/Glass/Clay.

reduction that could be realized if the technologies were more widely adopted. This information would assist the region in targeting lead P2 efforts.

- NEWMOA could determine important regional industry sectors where P2 options do not exist and explore avenues for supporting research in these areas.

NEWMOA looks forward to further direction on how best to assist the states in their lead reduction efforts.

APPENDIX A

Pollution Prevention Technologies and Resources

Table 1 provides a summary of the lead-based manufacturing technologies and the corresponding pollution prevention options implemented in the available web references. Following the table is additional information about each technology, including references.

Table 1: Lead-Emitting Technologies and Pollution Prevention Options Implemented

SIC	Lead-emitting Technology	P2 Improvement or Alternative
10 Metal Mining	Two-step sintering and blasting in a lead smelting furnace	One-step, continuous "QSL Process" to smelt lead sulfide concentrates, lead sulfate and mixed oxide sulfate secondaries
	Open operations, wet scrubbers and electrostatic precipitators used in lead smelting	Doghouse enclosures and fabric filters
	Lead-based thread compounds used on drill pipe	Zinc-based thread compounds*
30 Plastics	Lead compounds used as colorants for plastics	Mixed-phase metal oxide pigments (e.g., nickel titanates, bismuth vanadate) and organic pigments
33 Primary Metals	Old fossil fuel combustion source for foundry furnace	Closed, electric induction heating system
	Oxygen-enhanced natural gas burners in anode holding furnace used to manufacture copper rods	Plasma torch heating which reduces air flow
	Lead emissions from casting furnace dust	Maintain optimal operating parameters, recycle dust to original process, recycle off-site
	Lead compounds used for heat stabilization of PVC cable	Mixed meal salt blends (e.g., Ba/Zn, Ca/Zn, Al/Mg/Ca/Zn), organotin compounds, and organic compounds (e.g., organosulfide compounds and heterocyclic compounds)
34 Fabricated Metal Products	Lead-based primer for manufacture of ammunition	Lead-free primer
	Lead bullets	Bullets made of tungsten/polymer, tungsten iron and steel shot shells
	Lead solder for manufacture of copper and steel radiators	Lead-free solder
	Molten lead annealing for wire manufacture	Induction heating in inert atmosphere
36 Electrical Equipment	Leaded etch resist used in manufacture of printed wiring boards (PWBs)	Tin, dry film, or nickel gold etch resist
	Lead used in terminal plating of wired products	Tin plating and tin-copper alloy
	Removal of tin/lead plating from circuit boards (strip etch resist)	Improved bath operations to reduce need for removal*
	Tin/lead solder used in the manufacture of flexible interconnects	Organic materials
	Tin/lead solder used in surface mount technology (SMT) components	Tin/silver/copper alloy
	Lead solder mask used in manufacture of PWB's	Nickel/gold, immersion bismuth/immersion silver, and organic solderability preservatives
	Leaded glass in CRTs	Lead-free glass
37 Transportation Equipment	Leaded primers and electrocoats for automobiles	Lead-free primers and electrocoats
	Leaded electrical sealants for aircraft components	Non-lead additives for polysulfide formulations and non-polysulfide formulations.
	Lead-based solder for repair to truck cabs	"LP-1000 Lenco Pull" to pull dents out of cabs rather than drilling which requires soldering to repair and "#523 Alloy," a lead-free solder

* These technologies were collected by the Arizona DEQ from Pollution Prevention plans and may not have been implemented.

10 Metal Mining

QSL Process

Use of continuous, one-step process "QSL Process" to smelt lead sulfide concentrates, lead sulfate and mixed oxide sulfate secondaries reduces lead emissions. (International Cleaner Production Information Clearinghouse, http://www.p2pays.org/ref/11/10729.htm)

Additional resources:
http://www.emcentre.com/unepweb/tec_case/basicm_27/newtech/n2.htm
http://www.ldaint.org/technotes1.htm#The%20QSL%20process

Process Improvements for Smelters

Use of doghouse enclosures where appropriate and preference to fabric filters over wet scrubbers or wet electrostatic precipitators. ("Lead and Zinc Smelting," P2 and Abatement Handbook, World Bank Group, 1998, http://wbln0018.worldbank.org/essd/essd.nsf/GlobalView/PPAH/$File/64_leadz.pdf)

Additional resources:
http://www.cleanerproduction.com/industries/nonferrous.html

Missouri's Doe Run lead smelter is implementing changes to further control fugitive emissions from the blast furnace and refinery portions of the smelter. From the St. Louis Business Journal, 8/1/02: "the improvements included installing a new air filter system to reduce air emissions; additional building enclosures, and completely enclosing the blast furnace/dross paint building." (contact Tony Petruska, EPA Region 7 Air, RCRA and Toxics, Petruska.Anthony@epamail.epa.gov)

Lead-free Thread Compounds

Asarco plans to replace lead-based thread compounds with zinc-based thread compounds used to extend the life of the drill pipe. (Lead in Arizona: P2 Opportunities, AZ DEQ, 1996, http://www.p2pays.org/search/pdfframe.asp?pdfurl=/ref/12/11632.pdf).

An internet search of "lead-free thread compounds" yields many vendors.

30 Plastics

Lead-free Colorants for Plastics

Mixed-phase metal oxide pigments (e.g., nickel titanates, bismuth vanadate) and organic pigments are alternatives for some uses of lead compounds as colorants for plastics. (Toxics Use Reduction Institute, "Environmental, Health and Safety Issues in the Coated Wire and Cable Industry," 2002, http://www.turi.org/PDF/Wire_Cable_TechReport.pdf)

33 Primary Metals

Improved Heating Processes for Metal Furnaces

Replacement of fossil fuel combustion heating with closed, electric induction heating of foundry furnace reduces emissions of lead, nickel, CO_2, CO, and NOx and saves energy. (1993 NICE3 grant, http://es.epa.gov/program/p2dept/energy/nice3/nice3228.html)

Possible replacement of oxygen-enhanced natural gas burners with plasma torches in the anode holding furnace used to manufacture copper rod at Southwire Company in GA. (http://www.p2pays.org/search/pdfframe.asp?pdfurl=/ref/04/03261.pdf)

Emissions of lead from metal casting furnace dust can be minimized by maintaining optimal operating conditions including avoiding superheating of the metal, maintaining adequate flux or slag cover over the metal, and preheating the metal. Recycling of dust to the original process or off-site is also possible. (EPA Sector Notebook, "Profile of the Metal Castings Industry," 1997 http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/casting.html)

Lead-free Insulated Wire and Cable

Mixed meal salt blends (e.g., Ba/Zn, Ca/Zn, Al/Mg/Ca/Zn), organotin compounds, and organic compounds (e.g., organosulfide compounds and heterocyclic compounds) are possible alternatives for lead compounds used for heat stabilization of PVC cable. (Toxics Use Reduction Institute, "Environmental, Health and Safety Issues in the Coated Wire and Cable Industry," 2002, http://www.turi.org/PDF/Wire_Cable_TechReport.pdf)

34 Fabricated Metal Products

Lead-free Paint and Lead-free Bullets

Lead-free primer for ammunition and lead-free bullets made of tungsten/polymer, tungsten iron and steel shot shells used at Federal Cartridge in Minnesota. ("A Review of P2 Technologies to Reduce TRI Generation and Emissions in MN" by Kerr, Greiner, Anderson & April, Inc., p. 84, http://www.moea.state.mn.us/publications/SIC3482.pdf)

Lead-free Solder

Lead-free solder alloy for manufacture of copper & steel radiators at General ThermoDynamics in WI. (http://www.wmc.org/programs/bfoe95/generaltherm.htm)

Lead-free Annealing

Induction heating annealing of wire in an inert atmosphere to replace molten lead bath annealing at Riverdale Mills in MA. ("Elimination of Acid and Lead in Wire Strand Annealing and Galvanizing," MA Toxics Use Reduction Institute, 2000, http://www.turi.org/PDF/riverdale.pdf)

Containment Systems for Lead Ammunition at Firing Ranges (resources)
(These technologies are not included in the summary table because they do not address P2 in manufacturing.)

http://www.supertrap.com/Downloads_files/Pb5-stdy.pdf
http://www.estcp.org/projects/pollution/199609v.cfm
http://biology.usgs.gov/news/96-04.htm
http://www.health.state.ny.us/nysdoh/lead/shoot.htm

36 Electrical Equipment

PWB Manufacture – Etch Resist & Solder

Lead-free etch resist made of tin, dry film, or nickel gold for PWBs. ("A Review of P2 Technologies to Reduce TRI Generation and Emissions in MN" by Kerr, Greiner, Anderson & April, Inc., p. 92, http://www.moea.state.mn.us/publications/SIC3571.pdf)

Lead-free solder mask alternatives include nickel/gold, immersion bismuth/immersion silver, and organic solderability preservatives for PWBs. ("A Review of P2 Technologies to Reduce TRI Generation and Emissions in MN" by Kerr, Greiner, Anderson & April, Inc., p. 96, http://www.moea.state.mn.us/publications/SIC3571.pdf)

Avanti Circuits plans to improve bath operating conditions to reduce generation of recyclable solder stripper waste for tin/lead plating removal from circuit boards. (Lead in Arizona: P2 Opportunities, AZ DEQ, 1996, http://www.p2pays.org/search/pdfframe.asp?pdfurl=/ref/12/11632.pdf). One way this can be accomplished is by reducing the tin/lead thickness (http://www.compete.tm.fr/PCB-env-bestpract.ppt)

Additional Information

MA Toxics Use Reduction Institute's Lead-free Electronics Program
http://www.turi.org/messages/lead_free_electronics.htm

"An Analysis of Lead-Free Soldering," UK Department of Trade and Industry, http://www.primetechnologywatch.org.uk/supportdoc/Lead-free%20report%20-%201999.pdf

Development and Application of Lead-Free Solder Bending Technology
http://www.pfae.com/engineering/uploadmarket/pdf/engineering_05.pdf

IPC Association Connecting Electronics Industries, http://www.leadfree.org/

Additional information on manufacture websites:

From www.sheldahl.com: Sheldahl has projects in place to reduce or eliminate the use of tin/lead solder in the manufacture of flexible interconnects. Alternative organic materials are evaluated, and where possible, recommended. Sheldahl has also invested in tin electroplating to form a protective layer for chemical etching of copper.

From www.murata.com: Eliminating lead from terminal plating by replacing it with tin plating and tin-copper alloy as a new material for surface treatment of terminations of wired products. Reducing lead used in solder, for glass in electrodes, and for polyvinyl chloride stabilizers by replacing it with other materials. Researching the substitution of lead contained in ceramics, glass materials and free cutting alloys.

From www.intel.com: Intel has selected a tin/silver/copper alloy as the replacement for tin/lead solder used in surface mount technology (SMT) components.

Lead-free Glass

Use of lead-free glass to manufacture CRTs for televisions by Techneglas Inc. in PA (PE DEP, http://www.dep.state.pa.us/dep/deputate/fieldops/ne/PPC_News/PPSucces.htm)

37 Transportation Equipment

Lead-free Paint & Electrocoats

Use of lead-free topcoats and primers on fire and emergency rescue vehicles at Pierce Manufacturing in WI. (http://www.wmc.org/programs/bfoe94/pierce.htm).

Use of lead-free electrocoat for automobiles at Chrysler Corporation
(http://www.p2pays.org/search/pdfframe.asp?pdfurl=/ref/03/02478.pdf)
and
Introduction of Lead-free Electrocoat Primer Paint at Daimler-Chrysler Canada
http://www.cvma.ca/News/CVMAP2Project.pdf

International Truck and Engine Corporation's projects to remove lead from their operations (paint, electrocoat, solder)
http://www.pollutionengineering.com/archives/2001/1201/1201_F3.asp

Additional information:

Products Finishing Online, "HAPs and Lead-free Electrocoat for Automotive Applications"
http://www.pfonline.com/articles/049602.html

http://www.ppg.com/car_autocoat/ppgelectrocoat/enviroprime.htm

Automotive Design and Production, "How Nissan Assures High Quality Painting,"
http://www.autofieldguide.com/articles/119904.html

Lead-free Sealants

Evaluation of lead-free electrical sealants for aircraft components by the DOD. Alternatives included non-lead additives for polysulfide formulations and non-polysulfide formulations. (SERDP, 1997, http://www.serdp.org/research/PP/PP-429.pdf)