COMPREHENSIVE EVALUATION OF AIR QUALITY CONTROL TECHNOLOGIES USED FOR LEAD-ACID BATTERY RECYCLING

Final Report

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ABSTRACT

In this study, a menu of control technologies and best management practices available to reduce lead emissions from the Exide Technologies lead-acid battery recycling facility was developed based on a facility review conducted in March 2011, a review of existing regulations concerning the lead-acid battery recycling industry, and other publically available information regarding emissions controls at similar facilities. The compatibility of the control practices and technologies was analyzed with those currently in place at the Exide Facility. Potential emissions reductions for each control were calculated and the cost and the time required for installation of each practice or control technology was estimated.

A summary of the recommended control technologies and associated estimates of emissions reductions, and costs can be found in Table 1. The hourly lead emission estimates in this report are facility allowable as provided by TCEQ in the designation recommendation modeling file.[1] Actual facility emissions as reported by Exide in their 2009 Emissions Inventory Report are approximately 52 percent of the allowable emissions. This analysis indicates that emissions of lead from the Exide facility can be reduced from both stack and fugitive emission sources by over 60 percent. However, because of the release characteristics of fugitive emissions sources (i.e, ground-level releases), the controls identified for fugitive emissions sources are expected to result in the greatest reductions in ambient lead concentrations and should thus be given first priority.

[1]TCEQ, SIP Modeling Report, Chapter 1 Dispersion Modeling

Table 1. Summary of Recommended Control Technologies for Exide Technologies

Description	Baseline[1] Emissions (lb/hr)	Fugitive Emissions Reduction (lb/hr)	Net[2] Emissions Reduction (lb/hr)	Capital Cost $	Annualized Cost $	Time to Implement
Enclose Battery Breaker Area, Vent To Control Device	0.038	0.034	0.002	2,900,000	1,000,000	1 Year
Enclose Furnace, Refining, and Casting Areas, Vent to Control Device	0.090	0.081	0.030	5,000,000	1,800,000	2 Years
Improve Enclosure of Material Handling	0.130	0.117	0.117	100,000	-	6 Months
Reduce Road Traffic Fugitives	0.039	0.031	0.031	-	24,000	1 Month
Battery Storage Area - Inspect and Remove Broken Batteries	0.030	0.020	0.020		4,000	1 Month
Move Slag Handling Building	0.010	0.009	0.009			1 Year
Hooding to Reduce Truck Loading Fugitives	0.002	0.001	0.001			
Baghouse Media Replacement - Currently Planned	0.265		0.133		143,300	1 Month
Baghouse Media Replacement - Remaining BH	0.170		0.085		80,200	Shutdown Timing
Total Fugitives	0.339	0.293				
Total Stack	0.435		0.135			
Total Stack and Fugitives	0.774		0.428	8,000,000	3,051,500	
Additional Fugitive Control Work Practices			0.033	41,000	49,100	
After All Controls			**0.461**	**8,041,000**	**3,100,600**	

[1]Baseline emissions obtained from the TCEQ designation recommendation modeling files. Note: These may be maximum permitted or allowable emissions.
[2]Net reductions in sources of fugitive emissions are reductions expected minus the contribution from a new stack

1.0 INTRODUCTION

Secondary lead smelters are defined in the National Emissions Standards for Hazardous Air Pollutants (NESHAP) for secondary lead as any facility "at which lead-bearing scrap material, primarily, but limited to, lead-acid batteries, is recycled into elemental lead or lead alloys by smelting." The lead-acid battery recycling process consists of: (1) pre-processing of lead-bearing materials, (2) melting lead metal and reducing lead compounds to lead metal in the smelting furnace, and (3) refining and alloying the lead to customer specifications.

Pollutants are emitted from lead-acid battery recycling as stack and fugitive dust emissions. Stack emissions are the exhaust gases from a control device that are released to the atmosphere. The most common control device encountered in the industry is the fabric filter (or baghouse) that is used to control various emission points (i.e., smelting furnaces, kettles, smelting furnace charging points, smelting furnace taps). Fugitive dust emissions result from the entrainment of hazardous air pollutants (HAP) in ambient air due to material handling, vehicle traffic, wind erosion from storage piles, and other various activities. The primary pollutant of concern in both stack and fugitive emissions from the lead-acid battery recycling industry is lead.

The Exide Technologies lead-acid battery recycling facility in Frisco, Texas has been shown to have lead emissions from the battery reclamation and lead oxide processes that contribute to ambient air concentrations of lead exceeding the primary National Ambient Air Quality Standards (NAAQS) level of 0.15 micrograms per cubic meter ($\mu g/m^3$). The Texas Commission of Environmental Quality (TCEQ) has thus contracted Eastern Research Group, Inc. to conduct a comprehensive evaluation of air quality control technologies used for lead-acid battery recycling that could be used to reduce lead emissions from the Exide facility. The objectives of this report are to:

- Develop a menu of control technologies and industry best management practices available to reduce lead emissions from the Exide facility.
- For each identified control technology or practice, analyze the compatibility with the existing control technologies at the Exide facility and estimate the reductions in lead emissions that can be expected to occur.
- Estimate the cost of and time required for implementing the control measures.

The methodologies used and the results of our analyses are presented in the following sections.

2.0 FACILITY REVIEW

The Frisco Battery Recycling facility is a lead-acid battery reclamation facility that recycles primarily spent automobile and industrial batteries into four products: soft head, hard lead, lead oxide, and sodium sulfate. The scrap batteries are delivered to the facility where they are broken in the battery breaker. The lead from the batteries is then moved to the raw materials storage area. The materials are then taken from the raw materials storage areas and charged to either the blast or reverberatory furnace as required. Finally, the lead bullion is refined into hard and soft lead using several large natural gas fired kettles.

The facility also operates a lead-oxide process at which they further process the soft lead into lead oxide. The soft lead ingots are melted in three melting pots and then reacted with air in six Barton Pot reactors to form lead oxide. Additionally, the facility operates a crystallization process at which they crystallize sodium sulfate from the waste generated by the recycling of lead acid batteries. A complete description of the process at the Exide facility can be found in Attachment 3 of this report as extracted from section 2 of the Exide Technologies 2009 TCEQ Air Emissions Inventory.

On March 21, 2011, Ms. Donna Lazzari of ERG visited the Exide facility. She met with Mr. James Messer and Mr. Don Barar of Exide Technologies and was given a thorough overview of the facility. She identified and evaluated the key measures used by the Exide facility to control emissions from the processes described above. Her findings regarding the key controls implemented for stack and fugitive emissions sources are presented in the following sections. A discussion of the findings in the context of comparisons with industry best control technologies and management practices is presented in section 3.0 of this report.

2.1 Stack Emissions

Table 2 lists the stack emissions points and associated control devices at the Exide facility.

Table 2. Emissions Points and Control Devices at the Exide Technologies Facility

Emission Point ID	Processes Served	Control Device
EPN 38	Blast and Reverberatory Furnaces	Afterburner / Baghouse / Scrubber
EPN48	Battery Breaker	Scrubber
EPN22	Kettle 2	Baghouse
EPN45	Feed Dryer	Baghouse
EPN 18	Kettle 3	Baghouse
EPN 21	Kettle 5	Baghouse
EPN 15	North Oxide Hammer Mill	Baghouse
EPN 14	Oxide Building	Baghouse
EPN 13	Oxide Reactor 1	Baghouse
EPN 12	Oxide Reactor 2	Baghouse
EPN 11	Oxide Reactor 3	Baghouse
EPN 16	Oxide Reactor 4	Baghouse
EPN 24	Oxide Reactor 5	Baghouse
EPN 25	Oxide Reactor 6	Baghouse
EPN 39	Slag Treatment Building	Baghouse
EPN 23	Refining Building	Baghouse
EPN 17	South Oxide Hammer Mill	Baghouse
EPN 37	Reverberatory and Blast Furnace Supplemental Ventilation	Baghouse

As shown in Table 2, the Exide facility employs fabric filtration as the primary technology for control of emissions of lead (and other metal HAP). Based on observations during the site visit, the majority of the baghouses appear to be older units. The facility indicated that they are currently in the process of replacing the older acrylic filtration media in several existing units with a newer polytetrafluoroethylene (PTFE) filtration media. Maintenance is also planned for the filter units to improve the attachment of the filtration media to the filter housing.

2.2 Fugitive Emissions

Several potential fugitive emissions sources at the Exide facility were identified. Observations and evaluation of the controls for each fugitive emissions source are presented in the following sections. A general observation of all the structures is that they are in need of a thorough inspection and repair of the roof and siding material. Many areas along the foundation of the buildings require repairs to minimize dust emissions.

2.2.1 Battery Breaker Area

The battery breaking area is currently partially enclosed in a three sided building. The area is vented to a wet scrubber to control sulfuric acid emissions. The overall cleanliness in this area is poor and pavement cleanings inside the partial enclosure appear minimal. Although this portion of the process was not dusty because the materials being processed are wet, there appears to be significant room for improvement in control of fugitive emissions from this area. However, the facility indicated that there are current plans to install a permanent total enclosure (PTE) for the battery breaking area that should result in significant reductions in fugitive lead emissions.

2.2.2 Materials Storage and Handling Areas, Dryer Area

The materials storage and handling area is a totally enclosed building vented to a control device. The building has two door openings, one of which is fitted with plastic strips. The building contains piles of material that have been processed by the battery breaker or recycled from other areas of the process and are being prepared to be fed to the dryer, and ultimately the smelting furnace. The materials in this building have a very high lead content. Front-end loaders and other heavy equipment are used to transport and mix the various raw materials.

Based on observation of this building, the true effectiveness of the enclosure at controlling fugitive emissions from the storage piles is questionable. There is a large opening between the materials handling area and the battery breaking area that may make it difficult to maintain the raw materials storage area at sufficient negative pressure. Overall, the facility did not provide strong evidence of sufficient ventilation to maintain this area under adequate negative pressure to effectively control fugitive lead emissions. The building may require significant repairs to the structure to prevent fugitive dust emissions from escaping the enclosure.

The feed dryer is currently located in the raw materials storage area. Exhaust gases from the dryer are vented to a separate baghouse.

2.2.3 Smelting Furnace Areas

The smelting furnaces are currently operated in partial enclosures with ventilation hoods over the tapping and charging points of the furnace. Ventilation air from these points is conveyed to a baghouse. The area was generally dusty and particulate emissions from the furnace were observed in the air surrounding the furnaces. The facility has plans to replace the reverberatory furnace hydraulic ram feeder with a rotary screw to help minimize the amount of dust emitted from the furnace feed area. Plans are also in place to install an area misting system in the blast and reverberatory furnace area to help reduce the dust in the surrounding air. Both of these measures are expected to help reduce emissions from the furnace area. This area appears to be the most significant source of process fugitive emissions at the facility.

2.2.4 Refining and Casting Areas

The refining and casting building is a four sided building that is currently not under negative pressure. Emissions from the refining kettles are captured by negative pressure hoods and conveyed to baghouses. There is evidence that the cover plates over the kettles are bent or not fitted tightly and may be resulting in incomplete closure of the ventilation system. This area of the plant is directly adjacent to the furnace area. It was not as dusty as the furnace area, but appeared to also be a significant source of process fugitive emissions.

2.2.5 Lead Oxide Facility

The lead oxide process is contained in a totally enclosed room that is not maintained at negative pressure. While it appears that this area could be converted to a negative pressure enclosure fairly easily, it appears to be a fairly clean process with a relatively low potential for fugitive emissions.

2.2.6 Slag Fixation Building

An evaluation was not made of the slag treatment building because the facility has plans to move this building to another location. The new location will greatly improve the flow of traffic at the facility, which should help to minimize roadway fugitive emissions.

2.2.7 Plant Roadways and Grounds

All areas in the facility subject to vehicle or foot traffic are paved to minimize fugitive dust emissions. Additionally, paved areas are wetted and cleaned two times per day. However, the pavement appears to be old and is cracked in many areas, making it potentially difficult to properly clean. The facility recently purchased a new pavement cleaner that they claimed is much more effective than the one it replaced.

The grounds around the facility that are not paved are covered in grass or other vegetation, which should help to minimize wind-blown dust. The facility has done a very good job maintaining the groundcover.

3.0 RESULTS OF THE TECHNOLOGY REVIEW

A review of the current technologies used for controlling stack and fugitive emissions from lead smelting facilities was conducted by ERG. The information sources for this review included existing and proposed regulations for primary and secondary lead smelters, supporting documentation for the regulatory development. Other information reviewed included technical information for control technologies available for stack and fugitive emissions of metal HAP. Additionally, state air permits for other operating secondary lead smelting facilities, ambient lead monitoring data collected under the National Ambient Air Quality Standards (NAAQS) program, and background documents for development of the lead NAAQS were used as reference material. Our findings are presented in the following sections.

3.1 Lead Smelting Regulations

The existing federal regulations for control of HAP from lead smelting facilities include the NESHAP for secondary lead smelting (40 CFR Part 63, Subpart X), and primary lead smelting (40 CFR Part 63, Subpart TTT). A revised NESHAP for primary lead smelting was proposed by EPA in February, 2011 and proposal of a revised NESHAP for secondary lead smelting is expected in 2011. In addition to these federal regulations, the South Coast Air Quality Management District (SCAQMD) of California adopted rule 1420.1 (Emissions Standard for Lead from Large Lead-Acid Battery Recycling Facilities) in November 2010 to reduce emissions from two secondary lead smelting facilities located in southern California, and to reduce the ambient air concentrations of lead near these facilities.

Stack emissions limits vary among the different three regulations. The current NESHAP for secondary lead smelting facilities specifies a concentration based limit for lead emissions from stacks, the primary lead smelting NESHAP specifies a production based lead emissions limit, and SCAQMD rule 1420.1 specifies a pounds per hour lead emissions limit.

Fugitive emissions standards also vary among the regulations. The secondary lead smelting NESHAP requires partial enclosures and negative pressure hooding to control process fugitive emissions, with additional housekeeping measures to control other fugitive dust sources. The proposed NESHAP for primary lead smelting and the SCAQMD rule 1420.1 both contain provisions requiring monitoring of the ambient lead concentrations at or near the facilities' property boundaries with a requirement to maintain lead concentrations below the level of the NAAQS (i.e., 0.15 $\mu g/m^3$). The SCAQMD rule requires total enclosures for all processes and material storage areas to control process fugitive emissions and is very prescriptive of the measures required to control other fugitive emissions sources. The primary lead smelting NESHAP requires only the sinter machine to be in an enclosure and requires a standard operating procedures (SOP) manual, approved by the administrator, outlining the fugitive emissions control measures to be implemented at the facility. A detailed comparison of these three regulations is presented in Table 3.

Table 3. Summary of Lead Smelting Regulations

	Secondary Lead Smelting NESHAP	Proposed Primary Lead Smelting NESHAP	SCAQMD 1420.1
Fugitive Emissions		Ambient lead concentrations may not exceed 0.15 µg/m^3 on 3- month rolling average basis	Ambient lead concentrations ,may not exceed 0.15 µg/m^3 on 3- month rolling average basis
Stack Emissions	Lead-based concentration limit of 2.0 mg/dscm, operation of a bag leak detection system	Production based limit of 0.22 pounds of lead emitted per ton of lead produced, operation of a bag leak detection system	Facility-wide limit of 0.045 pounds of lead per hour from all stack sources, maximum of 0.010 pounds per hour from any one stack
Process Fugitive Sources (battery breaker, dryer, furnace, refining, casting)	Negative pressure hooding with ventilation to a control device or total enclosure	Negative pressure hooding with ventilation to a control device, sinter machine in enclosed building	Total enclosure of all process fugitive sources
Enclosure requirement (Battery Breaking, Refining & Casting area, Furnace area)	Partial enclosure and pavement cleaning or total enclosure	SOP manual required	Total enclosure
Raw material storage area fugitives	Partial enclosure, wet suppression, and vehicle washing, or total enclosure	SOP manual required	Total enclosure
Plant roadways	All vehicle traffic areas paved, pavement cleaning twice per day	SOP manual required	All vehicle traffic areas paved, pavement cleaning of roadways and foot traffic areas three times per day with HEPA equipped vacuum sweeper.
Other Housekeeping	As specified in SOP	As specified in SOP	Rooftop cleaning, weekly cleaning of any area where lead containing wastes are handled. Other extensive requirements for maintenance, inspections, storage and transport

3.2 Stack Emissions - Control Device Technologies

Devices for control of particulate matter (PM) emissions include cyclones, electrostatic precipitators (ESP), and fabric filters (i.e., baghouses or cartridge filters). Cyclones are widely used for the collection of medium-sized and coarse particles and do not typically achieve the desired efficiency for smaller particles. Therefore, they are typically used as a primary stage filter. ESPs are used for particulate control in many industrial applications, including coal fired boilers, cement kilns, and Kraft paper mills, and can be designed for efficiencies up to 99.9% in these applications.[1] However, fabric filters are generally considered to be a superior choice for fine-particulate collection performance and are less expensive to install and operate than an ESP.[2] For this reason, fabric filters are the most common control device for stack emissions of metal HAP from the secondary lead smelting industry. Wet electrostatic precipitators (WESPs) are particularly efficient for very small particles and can be used as a polishing filter at the outlet of a fabric filter to improve the collection efficiency of very small particles. However, this technology is very expensive to install and operate and is not widely used in the lead smelting industry. A detailed analysis of the performance of each control device at the Exide facility was not performed due to time limitations. Therefore, the discussion in this section is limited to information that is generally applicable to all fabric filter control devices in this industry.

The selection of filtration media is very important to the effectiveness of a fabric filter. Depth filtration media require maintaining a dust cake on the filter bag to achieve effective control. These types of filtration media have been shown to achieve outlet PM concentrations on the order of 10 milligrams per dry standard cubic meter (mg/dscm).[2] Surface filtration media (e.g.,Teflon®, Gore-Tex®, or other expanded PTFE) have been shown to achieve much higher control efficiencies.[3] Well designed and operated fabric filters that use surface filtration media can typically achieve outlet PM concentrations on the order of 1 mg/dscm. Using AP-42 emissions factors, we estimated that the lead portion of the PM exiting fabric filters in the secondary lead smelting industry is approximately 13 percent. Therefore, we believe that an outlet lead concentration on the order of 0.13 mg/dscm is technically feasible. Because the outlet concentrations of lead from the fabric filters at the Exide facility are generally higher than 0.13 mg/dscm, a recommendation is included in this report to improve the performance of these fabric filters.

High efficiency particulate air (HEPA) filters, as defined by the U.S. Department of Energy (DOE) standards adopted by most industries, remove at least 99.97 percent of airborne particles 0.3 microns in diameter. These filters have even higher efficiencies for particles greater than 0.3 microns and less than 0.3 microns (the range around 0.3 microns has the lowest efficiency). HEPA filtration systems can be added at the exit of an existing filtration device (i.e., a baghouse) as a second stage of filtration. Previous tests conducted at secondary lead smelting facilities indicated that an average of 48% of the particles were filterable particulate, 37% were condensable inorganic, and 15% were condensable organic particles.[4] It can be assumed that the large majority of the filterable particulates can be captured by a HEPA filter. The condensable organic portion is not expected to contain lead. Therefore, of the particulate that may potentially contain lead, 57% is filterable particulate. Using this analysis, the efficiency of HEPA filters for lead particles (assuming only the filterable portion will be captured) is estimated at 57 percent.

HEPA filters are recommended as a secondary option if the performance improvement resulting from replacement of the filtration media is not sufficient.

The current NESHAP for secondary lead smelting requires operation of a bag leak detection system (BLDS) for each fabric filter. The current PM detection level requirement for a BLDS is 10 milligrams per actual cubic meter (mg/acm). Based on the lead to PM ratio discussed in the section above, this translates to approximately 1.3 mg/acm of lead. New designs for BLDS can achieve detection levels of 1 mg/acm, which would translate to 0.13 mg/acm of lead. Very low levels of lead can be detected in the outlet gas of a control device, meaning that malfunctions of the control device can be detected almost immediately. A recommendation is included in this report to improve the BLDS at the Exide facility.

Significantly lower stack emissions of metal HAP can be achieved through the use of a WESP at the outlet of existing filtration devices. A WESP was installed at the outlet of a fabric filter at the Quemetco, Inc. facility in City of Industry, California. This unit has demonstrated an add-on lead removal efficiency of 92 percent, resulting in outlet lead concentrations of less than 0.005 mg/dscm in that specific implementation.[5] However, this technology is very expensive to install and operate and is not widely used in the lead smelting industry.

3.3 Fugitive Emissions Control Technologies

The SCAQMD rule 1420.1 contains nearly all of the practices recommended for fugitive emissions control in *Estimating and Controlling Fugitive Lead Emissions From Industrial Sources*[6] and the *Air Pollution Engineering Manual*[2] as well as other practices that were considered during the development of the secondary lead smelting NESHAP. When alternative practices were presented in the reference documents, SCAQMD appears to have selected all of the most stringent fugitive control practices for their rule. For this reason, the SCAQMD rule was considered to be the primary reference source for best practice controls of fugitive lead emissions.

Fugitive emissions from the process units (battery breaker, furnaces, refining kettles, casting) at the Exide facility are currently controlled through the use of external negative pressure hoods. Ventilation air from the hood is then conveyed to a control device. This is a common process fugitive emission control practice throughout the industry and is a particularly important practice for controlling lead exposures of employees at the facilities.

Permanent total enclosures (PTE) are a practice widely used in the lead smelting industry to contain hazardous materials and can be installed to minimize the amount of lead-bearing dust escaping from process or material handling areas. PTEs are permanently installed structures that completely surround a source of emissions. They consist of walls, roofs, windows, doors, and exhaust and make-up air fans. The pollutants are captured by means of a ventilation system that is vented to a control device. In order to qualify as a PTE, an enclosure must meet EPA Method 204 criteria.[7] Typical industrial applications include any process or operation where total fugitive emissions capture is required.

Ambient lead concentrations near the secondary lead smelting facilities were compared to the level of enclosure at each facility. The level of enclosure was determined from descriptions in the air permits of the facilities and other documents such as agreed orders available in public documents. We categorized each facility as either totally enclosed within PTEs or partially enclosed based on this information. Enclosed facilities typically have all process units and the material handling areas contained inside PTEs. Because the facilities were not visited as a part of this study, it was not possible to verify the extent of enclosure at each facility. However, the category assignment is broad and is believed to adequately represent the structures at each facility. A comparison was then made between the enclosure category assigned to the facilities and the ambient monitoring data for each of these facilities. Figure 1 presents a summary of this analysis. In general, the enclosed facilities had significantly lower ambient lead concentrations than the partially enclosed facilities. Because the Exide facility has an enclosure only for the raw material storage area, it was classified as partially enclosed. Based on the strong correlation between enclosure and ambient concentrations of lead near the facilities, it is believed that enclosures are the most important measure a secondary lead smelting facility can implement to control fugitive emissions of lead.

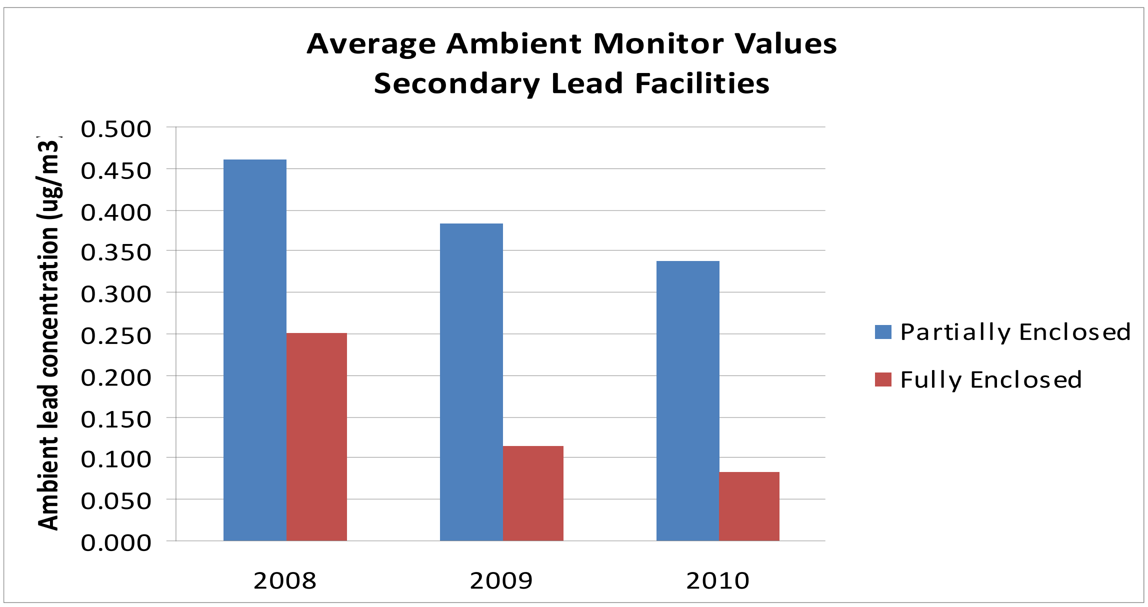

Figure 1. Average Ambient Monitor Values near Secondary Lead Facilities

Other work practices that have been found to be effective for control of fugitive emissions that originate outside of the process areas are those that help to minimize wind-blown dust. These include work practices that remove any dust that may contain lead from surfaces outside the PTEs. Additionally, inspection of building exteriors, ductwork, and other equipment outside of a PTE can identify areas of leakage so that maintenance can be performed. Other practices help to minimize the amount of exposed lead-containing dirt that can become entrained by wind. These include paving all traffic areas, maintenance of a vegetative cover in other areas, and use of dust suppressants on areas that cannot support vegetation. In order to minimize the amount of lead containing material that is tracked out of the PTEs, work practices limiting open transport of lead-containing trash, sweepings, or equipment that has been contaminated with lead are should be considered. The Exide facility has implemented many of these practices, but not to the level described in the SCAQMD rule. A detailed description of each additional recommended work practice is included in section 4.2 of this report.

4.0 RECOMMENDED EMISSION CONTROL PRACTICES

The following sections present our recommended control technologies and practices for both stack and fugitive sources at the Exide facility based on the technology review presented above. The recommended control technologies and practices are presented in order of relative importance, as determined through the combination of the review of the Exide facility and the technology review presented in this report. Although the estimated emissions from fugitive sources are lower than those from stack sources, they are believed to have a greater proportional impact on local ambient lead concentrations due to the nature of the release characteristics of fugitive sources. Effective control of these emission sources is critical to reduce the local ambient air concentration of lead, and should be of the highest priority.

4.1 Installation of Permanent Total Enclosures

Construction of PTEs is recommended for all areas where lead bearing material is handled or processed. This includes the following sources:

- Smelting furnaces,
- Battery breaker area,
- Refining kettle area,
- Casting area, and
- Any other area where lead-bearing materials are handled.

Consideration should also be given to enclosure PTE for the slag processing building and lead oxide building. The slag processing building is of lower priority because the amount of lead in the slag is relatively low (~1 % of slag). Based on observation of the area and the nature of the materials processed, the lead-oxide process is relatively clean. Therefore, a PTE for this areas should be considered as a contingency measure.

The PTE should be maintained under negative pressure at all times. Continuous in-draft air flow will assure containment of lead-bearing dust particles. Ventilation air from the PTE should be conveyed to a fabric filter (baghouse) control device. Specific best management practices associated with operation of the enclosures include:

1. Continuous monitoring of the differential pressure of the building to ensure that negative pressure of at least 0.02 mm of Hg is maintained at all times.
2. Daily monitoring of the in-draft velocity at all access points. The in-draft velocity should be at least 300 feet per minute at all times.
3. Monthly inspections of the building and timely repair of any leak points or other possible routes for emissions of lead to the atmosphere.

4. Proper design of the control device to handle the total flow of air from the building. For this report, an estimate of ten turnovers per hour of the building volume has been used to estimate the capacity of the control device. Six to ten turnovers per hour is typical.

A control efficiency of 90% was assumed for fugitive emissions sources located in PTEs. EPA has developed criteria for determining 100% total enclosure for industrial operations (EPA method 204). However, for the purpose of this study, it was assumed that the capture efficiency would be less than 100% because the lead-bearing material is not stored in containers as it is moved by front end loaders and other types of heavy equipment, and it can therefore be tracked outside the building.

The total emission reduction for installation of a PTE assumes a 90% reduction in fugitive emissions. Because the buildings will now be vented to a control device with a large air flow, there will be emissions from a stack that were not present before. Emissions from these stacks were estimated using the total air flow expected from the PTE and an outlet concentration of 0.2 milligrams of lead per actual cubic (mg/acm) meter of air flow. This is considered to be an achievable concentration of lead as described in Section 3.2 of this report.

The raw material storage building at the Exide facility is currently located in a PTE. However, improvements are recommended to the PTE to ensure at least a 90 percent control of fugitive lead emissions. These recommendations include: inspection and repairs of any gaps in the building envelope, replacement of the existing roll-up doors, and installation of a continuous differential pressure monitor. Additionally, the opening between the raw material storage building and the battery breaker building should be closed off and access doors should be installed to ensure proper negative pressure of the raw materials storage building. After the battery breaker building is fully enclosed, this will not be necessary.

The costs and emissions reductions associated with enclosing the battery breaker building, smelting furnaces areas, and refining and casting areas were estimated (see Table 1). The cost estimates include improvements to the existing structures to meet the standard required for total enclosures as defined in 40 CFR §63.542, installation of the necessary ventilation system for the buildings, and purchasing of the control devices. A reduction in the footprint of the facility could result in lower costs for the PTEs, but for the purposes of this report, the current area and layout of the facility was used. Our cost estimates for PTEs have an accuracy of ± 30 percent and are based on EPA cost estimation guidelines.[8] A detailed engineering study would be required to develop more accurate estimates.

4.2 Fugitive Control Work Practices

Additional housekeeping measures should be considered to control fugitive emissions outside of the building areas. A list of recommended practices has been developed to further minimize fugitive emissions. These recommended practices include:

- More thorough cleaning of the outdoor pavements (Much of the outdoor pavement is cracked in many locations. These cracks have a tendency to accumulate dirt, making it difficult to remove. Sealing cracks should be considered as part of a contingency plan.),

- Monthly cleaning of the building exteriors and roofs to remove accumulated dust,
- Daily inspection of the battery storage areas and removal of any broken or leaking batteries to an enclosure and cleaning of any area contaminated by leaking battery,
- Quarterly inspection of any ductwork not contained in total enclosures for leaks (including the ductwork to the baghouses and systems used to convey dust from the baghouses),
- Performance of any maintenance on equipment that may be contaminated with lead inside a total enclosure or cleaning of the equipment before moving to the maintenance building,
- Transport of all lead bearing materials in closed conveyor systems or sealed containers, including the sweepings from the street cleaner (Note: after enclosures are constructed, the need to transport slag and other materials will be significantly reduced.), and
- Installation of hooding or other devices to capture fugitive dust at the lead-oxide truck loading area.

Estimates of costs and time required to implement the practices are presented in Table 4. A list of additional fugitive emissions control practices has been developed that could be adopted if necessary. They include:

- Use of a dust suppressant or cover fill on the exposed landfill areas used for treated slag, and
- Adoption of additional "clean room" practices to prevent tracking of lead materials, including:
  - Requiring all personnel to enter and exit through a change area where shoes and clothing used exclusively in the plant could be donned. This would limit the opening of access doors as well as prevent tracking of lead material.
  - Fitting of the bay areas where raw materials enter the plant and products leave with a sealing mechanism to prevent dust from leaving the building
  - Designation of equipment for use only "inside" or "outside" process areas.

Table 4. Additional Fugitive Control Practices

Description	Capital Cost $	Annualized Cost $	Time to Implement
Thorough Pavement Cleaning	-	16,000	1 Month
Building Exterior Cleaning	28,000	14,000	3 Months
Ductwork Inspection		2,400	1 Month
Maintenance	2,000	5,700	3 Months
Material Transport	2,000		3 Months
Lead Oxide Loading Fugitive Control	20,200	3,000	6 Months
Dust Suppressant at Landfill	1,000	10,000	2 Months

Table 4. Additional Fugitive Control Practices

Description	Capital Cost $	Annualized Cost $	Time to Implement
Personnel Entrance			1 Month
Shipping Bay Enclosure	8,000	1,000	3 Months
Total	**61,200**	**52,100**	

4.3 Practices to Control Stack Emissions

Because fugitive emissions at ground level have a greater potential to affect local ambient concentrations of lead, control of emissions from fugitive sources was considered the highest priority. However, stack emissions also contribute to the local ambient lead concentration. Moreover, stack emissions may ultimately contribute to fugitive emissions through re-entrainment of stack emissions that have deposited onto facility surfaces. The recommended control technologies for stack emissions from the Exide facility include replacement of filtration media and installation of secondary HEPA filtration systems. Replacement of the existing baghouses should be considered as a contingency option if the necessary reductions are not achieved through replacement of the filtration media or installation of HEPA filters.

4.3.1 Replacement of Filtration Media

The outlet lead concentrations measured at the Exide facility are in the range of 0.03 to 1.4 mg/acm. Calculations were not performed to determine the outlet concentrations on a dry basis (mg/dscm), but they are expected to be in a similar range. Based on analyses presented in this report, significant reductions in outlet lead concentrations are achievable. The replacement of the existing filter media with Gore-Tex® brand PTFE media is planned for five of the existing baghouses (i.e., EPs # 18, 21, 37, 22 and 38). Future stack tests will verify the impacts of these improvements, but for the purposes of this evaluation, we assumed a 50% reduction in outlet lead concentrations for any filtration media replacements. Estimates of emissions reductions and costs associated with replacement of filtration media are presented in Table 1. Detailed design information for each baghouse was not readily available, and therefore, the cost estimate for replacement of filtration media is given as a range. Additional engineering analyses are required to provide a more accurate estimate.

4.3.2 HEPA Filters

If the facility does not achieve sufficient performance improvement after replacement of the filtration media in the existing baghouses, HEPA filters should be considered as a contingency option. Estimates of emissions reductions and costs associated with installation of HEPA filters are presented in Table 1.

4.3.3 Operation of a Bag Leak Detection System

Routine maintenance of the BLDS is critical to achieving consistent performance. Replacement BLDS with a lower level of detection and continuous recording of the output should be considered for any control device with historically poor performance or for any existing BLDS with historical maintenance or operational problems preventing continuous monitoring. Given the time constraints of this study, historical performance of these systems was not evaluated. Additional engineering analyses would be required to identify specific performance issues with these devices.

The replacement cost for one BLDS is approximately $33,000 with an annual operating cost, including maintenance, of $12,000. Alternatively, a light scattering PM continuous emissions monitoring system (CEMS) can be installed at a capital cost of $114,000 and annual cost of $43,000. Using stack test information that contains both PM and lead, PM concentrations measured by the CEMS could be used to approximate lead concentrations. An example output graph of a PM CEMS is provided in Attachment 1.

4.3.4 Replacement of Existing Baghouses

If the reductions in lead emissions due to the replacement of filtration media and planned maintenance are not sufficient, consideration should be given to replacement of some of the existing baghouses. Improvements in fabric filter design in the last 10 years have resulted in improved performance. Choosing which fabric filters to replace should be based on performance data obtained after replacement of the filtration media. Given the time constraints of this study, the costs to replace existing control devices have not been estimated in this report. Additional engineering analyses would be required to identify specific devices for replacement after the new filtration media is installed and subsequent stack tests have been performed. A summary of the recommended stack emission control options is presented in Table 5.

Table 5. Stack Emission Control Options

Description	Capital Cost $	Annualized Cost $	Time to Implement
Filtration Media Replacement	1-3 MM *Note 1		3 Months
HEPA Filters	890,000	200,000	1 Year
BLDS Replacement	165,000	Note 2	3 Months
PM CEMS	570,000	215,000	6 Months
Replacement Baghouse (one unit)	1-2 MM	*Note 2	1-2 Years

*Note 1: Detailed design information for each baghouse is required to provide a more accurate estimate.

*Note 2: No additional annualized cost as this device is currently installed.

4.4 Additional Recommendations

Ambient monitoring results fluctuate from day-to-day and can be highly sensitive to meteorological conditions. They can also fluctuate due to differences in day-to-day activities at the facility. The following recommendations are to help the facility identify the practices that have the greatest impact on ambient air lead concentrations:

- The facility should receive timely analyses of the ambient lead concentrations.
- The facility should keep detailed records of day-to-day activities and events that could influence the monitoring results in order to draw correlations to ambient lead concentrations.
- The sampling system should use a "sample saver" or similar device to protect the collected sample for the high volume monitors because samples left in the collection devices for several days can become contaminated.
- The facility should use the same test method as monitors employed by the TCEQ in order to correlate results from ambient monitors operated by the facility with those operated by the TCEQ.

Maintenance of building enclosures, control devices, and monitoring systems is critical to ensure consistent performance and should be given high priority.

Additional time will be required to perform the fugitive emissions control practices recommended. Dedication of personnel to these specific activities is recommended in order to prevent a conflict of operational priorities.

4.5 Wet Electrostatic Precipitator (WESP)

This option is presented in this section of this report, but is not recommended as one of the options for control of particulates due to its high cost. To be consistent with the only existing implementation of a WESP in this industry, the cost of a WESP installation and the resulting emissions reductions expected at the Exide facility were estimated assuming that the WESP would control of all the all process vents at the facility that have emissions greater than 0.01 pound per hour (EPs # 18, 21, 38, 45, and 48). As shown in Table 6, the cost varies significantly depending on the desired efficiency. The flow rate into the unit was estimated at 285,000 cubic feet per minute (cfm).

Table 6. Summary of the WESP Control Option

Efficiency (%)	Capital Cost $	Annualized Cost ($)	Emission Reduction (lb/hr)	Emission Reduction (lb/yr)
95	25,000,000	4,300,000	0.195	1657
90	20,000,000	4,000,000	0.185	1569
85	17,000,000	3,700,000	0.174	1482

5.0 RECOMMENDATIONS FOR FUTURE STUDIES

Because fugitive emissions are expected to have the largest contribution to ambient lead concentrations, as each improvement is made to the control of fugitive emissions at the Exide facility, a comparison should be made to the ambient monitoring data. This analysis can determine if additional similar measures could be effective at reducing the ambient concentration further.

Due to the time constraints of this study, data from the existing BLDS at the Exide facility were not analyzed. However, a review of this data may help to determine if upsets to the fabric filters are common, and additionally, if these upsets are correlated to the ambient lead monitoring data. If there are upset periods, the emission levels from the stacks may be much higher on a short term basis than the emission rates established during a stack test. An evaluation of this data would also be useful to determine the appropriate priority of replacing the BLDS or installing a PM CEMS.

A review of the differential pressure in the raw material storage building also was not performed as a part of this study. A review of this data could determine the true effectiveness of this structure in controlling of fugitive emissions from this area. If this building is not maintained at a sufficient negative pressure at all times, improvements to this building should be one of the highest priorities. As PTEs are constructed, the data from differential pressure monitors data should be reviewed on a regular basis to evaluate the effectiveness of the enclosures.

A design review of all the existing fabric filters was not conducted as a part of this study. However, a review of these devices may be able to determine if some of the devices should be replaced, rather than being repaired with replacement of filter media. As the filter media is replaced in the control devices, a stack test should be performed to determine the effectiveness of the new media. The outlet concentration should be compared to the concentration presented in this report that is believed to be achievable by a well-performing fabric filter to determine if HEPA filters should be installed or if the fabric filter should be replaced.

6.0 REFERENCES

[1] Davis, Wayne (2000). *Air Pollution Engineering Manual*, Second Edition, New York: John Wiley & Sons.

[2] Wang, Lawrence (2004). *Air Pollution Control Engineering*, Totowa, New Jersey: Humana Press

[3] http://www.gepower.com/prod_serv/serv/env_serv/en/downloads/GE_WCT_JAN_2011.pdf

[4] EPA. (1992). *Secondary Lead Smelter Emission Test Report, East Penn Manufacturing, EMB Report 92-SLS-3*

[5] Bartocci, A.C., *Wet Electrostatic Precipitator (WESP) Control for Meeting Metals Emission Standards, Paper #585, http://www.envitechinc.com/2009-it3-lead-smelter-paper/*

[6] EPA (1994), *Estimating and Controlling Fugitive Lead Emissions From Industrial Sources.*

[8] EPA Air Pollution Control Cost Manual, Sixth Edition (2002), http://epa.gov/ttn/catc/dir1/.

Attachment 1
Figure 1- PM CEMS Output

CAM TECHNICAL GUIDANCE DOCUMENT[1]

A.19A BAGHOUSE FOR PM CONTROL

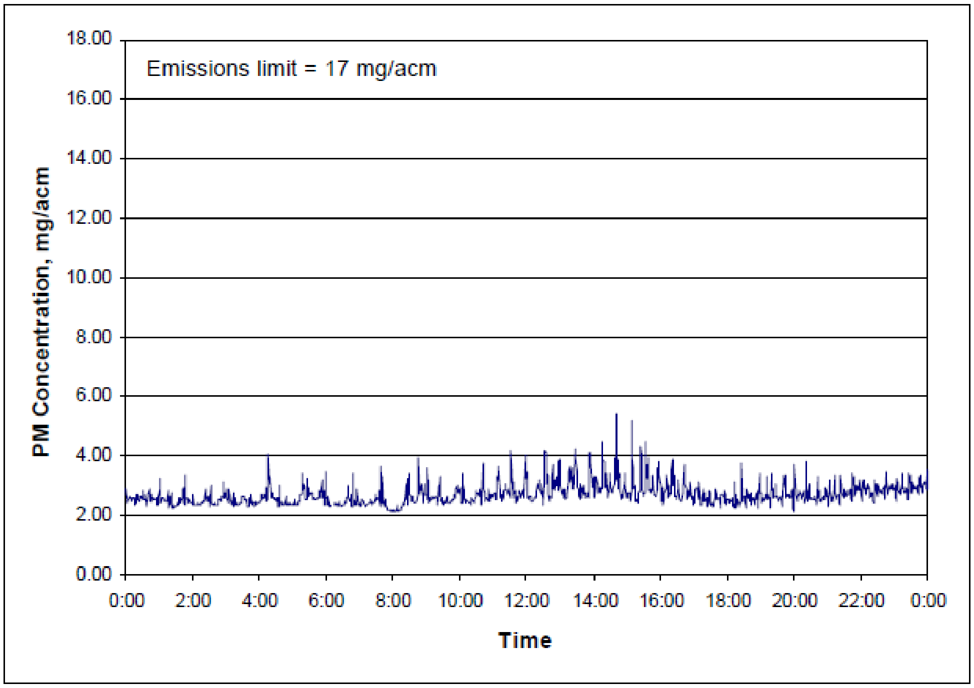

Figure A.19a-1. Light scattering monitor data for a typical day.

Attachment 2
Cost Estimation Methodology

Permanent Total Enclosure Cost Methodology

PTE costs were estimated for four buildings associated with the blast furnace area, the reverberatory furnace area, the battery breaker area, and the slag treatment area. To calculate costs for the enclosures for the blast furnace area, the battery breaker area, and the slag treatment area, the Air Compliance Advisor (ACA) Air Pollution Control Technology Evaluation program was used.[2] The ACA is based on cost estimation techniques described in the EPA Air Pollution Control Cost Manual. It has a built-in wizard specific to PTE cost estimates. Because the facility is planning to move the entire slag treatment building, the cost for this building was estimated using the RS Means[3] online manual for construction costs. Section 2 in chapter 3 of the EPA Air Pollution Cost Manual was also reviewed to determine the appropriate assumptions for the PTEs, which are discussed below. See figure 2 for a schematic showing the estimated boundary for each building and Table A-1 for the building design details.

Table A-1. Building Information for PTEs.

Building	Length (ft)	Width (ft)	Height (ft)	Wall Area (ft^2)	Volume (ft^3)	Control Device Flow Rate (ft^3/min)
Blast Furnace Area	258	100	40	28640	1,032,000	172,000
Reverberatory Furnace Area	154	96	40	20000	591,360	98,560
Battery Breaker Area	186	130	40	25280	967,200	161,200
Slag Treatment Area	120	40	40	12800	192,000	32,000
Oxide North	222	80	40		710,400	118,400
Oxide South	120	40	40		192,000	32,000

Note that information on the oxide north and oxide south buildings is shown in Table 5, but no estimate is provided for a PTE as these buildings need only minimal repairs to be considered PTEs. The size of these buildings was used to estimate the specifications of a baghouse needed to ventilate the total enclosure.

When designing a PTE, the flow through the building dictates its effectiveness. Variables to consider are the desired exhaust flow rate (ft^3/min), the natural draft opening (NDO) face velocity (ft/min), and the area of the NDOs (ft^2). For the exhaust flow rate, OSHA guidelines require a minimum flow equivalent to 4 room air changes per hour (RAC/hr). with values of 10-15 RAC/hr recommended for worker comfort. For this analysis, 10 RAC/hr was used to estimate the flow rates shown in Table 5. The Exide facility currently operates a PTE for its raw material storage building. A flow rate for this building was calculated and compared to the current flow rate from the associated emission point (EPN 45). The two flow rates are very similar, thus confirming that this assumption is appropriate.

The NDO face velocity should be selected such that the direction of air flow is inward. A minimum face velocity of 200 ft/min is required, but to ensure inward flow and to provide a margin of safety, a value of 600 ft/min is recommended. For this analysis, a face velocity of 600 ft/min was assumed.

Based on the flow rate and NDO face velocity, the NDO area is analyzed. The NDO area must be big enough to provide the desired flow rate through the building and is based on any openings such as doors and louvers. To create flow, it is also possible to use makeup air by installing a fan with a duct system; however, installation of a fan was not considered in our analysis. Since no makeup fan is required, the only costs related to the NDO area are attributed to doors and louvers.

There are existing structures in place for the blast furnace, reverberatory furnace, and battery breaker areas. As such, costs for floors and ceilings were not included in the PTE cost estimates. New walls, however, were included in the cost estimates. Other equipment included in the cost estimates were rollup doors, louvers, and differential pressure monitors. The cost estimate for the slag handling area PTE is different in that it is assumed an entire new building must be built. Therefore, the cost estimated via RS Means includes foundation, building supports, and walls.

Baghouse Cost Methodology

To calculate the cost for new baghouses, the EPA Air Pollution Control Cost Manual was used along with the (ACA) Air Pollution Control Technology Evaluation program. Section 6, chapter 1 of the EPA Control Cost Manual specifically discusses baghouses. The ACA program automates the calculations for each baghouse using the equations from the EPA Control Cost Manual.

Costs were calculated for shaker, reverse-air, and pulse-jet type baghouses for comparison. Shaker and reverse-air baghouses, on average, were more than 1.5 times the cost of pulse-jet baghouses. Therefore, only cost estimates for pulse-jet baghouses are provided.

Bag selection has a large impact on costs, particularly annualized costs, and is an important component. For this analysis, Teflon® bags (PTFE) were selected. Using Teflon® bags is consistent with language in South Coast Air Quality Management District (SCAQMD) Rule 1420.1. From Table 1.8 of chapter 1 in the EPA Control Cost Manual, the estimated price for Teflon® bags is $17.88/ft^2 of cloth area, which equates to $225 per bag. Cloth area was calculated using the volumetric flow rate (ft^3/min) and air-to-cloth ratio (ft/min). Based on Table 1.1 of the cost manual for lead oxide dust, an air-to-cloth ratio of 6 ft/min for pulse-jet baghouses was selected. Since these baghouses are associated with building enclosures, the flow rate used in the calculations corresponds to the amount of flow necessary to provide 10 room air changes per hour for each building. See Table 5 in the PTE cost estimate section above for the design flow rate used.

Using the preceding assumptions, the EPA Control Cost Manual and ACA are able to provide both initial and annual costs. For each baghouse the ACA also calculates an estimate for auxiliary equipment such as ductwork, fans, and stacks. The total annual cost (TAC) is calculated using a 20-year life for baghouse equipment, except for the Teflon bags, which were assumed to have a 2-year life. For an outline of the methodology used to calculate the costs, see Table 1.9 and Table 1.11 of Section 6, Chapter 1 of the EPA Control Cost Manual.

Wet Electrostatic Precipitator Cost Methodology

The cost for ducting process baghouse outlets to a (WESP) was estimated using the EPA Air Pollution Control Cost Manual. Section 6 of Chapter 3 of the EPA cost manual discusses wet electrostatic precipitators and Section 2 of Chapter 1 discusses auxiliary equipment needed, such as ductwork and stacks.

A determination of the emission points that need further reductions in emissions was first made. Lead emissions data was gathered from the 2009 emissions inventory for the Exide Frisco plant and was compared against the requirements of SCAQMD Rule 1420.1. This rule stipulates that each stack emission point must have a lead emission rate of less than .01 lb/hr. Five emission points at the Exide plant were determined to have lead emissions greater than .01 lb/hr. These emission points and their associated flow rates are shown in Table A-2.

Table A-2. Emission Points with Lead Emissions Greater Than .01 lb/hr.

EP	Lead (lb/hr)	Flow Rate (ft^3/min)
18	0.030	30,900
21	0.050	67,500
38	0.040	61,500
45	0.050	100,100
48	0.015	24,500

The EPA Control Cost Manual provides a table to estimate WESP costs which was used for this analysis. Costs are provided on a dollars per cfm basis and depend on the desired control efficiency of the unit. See Table 3.14 of Section 6 in Chapter 3 of the cost manual for a full breakdown of the cost options. For this analysis, cost estimates were provided for three different WESP control efficiencies at the rates shown: $22.6/cfm for 95% control efficiency, $18/cfm for 90% control efficiency, and $14.7/cfm for 85% control efficiency. Since all emission points would be ducted to one WESP, the flow rate used was a summation of the flow rates provided in Table 3(285,000 cfm). The cost values from Table 3.14 of the EPA Cost Manual did not include auxiliary costs. These auxiliary costs, however, constitute a significant investment, as the outlet for each emission point would need to be ducted to the common WESP. Using an average distance of 500 feet from each emission point to the WESP, along with estimates for stack and fan costs, a total auxiliary cost estimate of $500,000 was added to each WESP prior to calculating the total capital installed (TCI).

HEPA Filter Cost Methodology

HEPA filters were analyzed as an emission reduction option for installation after baghouses. To estimate HEPA filter costs, AAF International was contacted to provide a cost estimate.[4] For a 60,000 cfm flow rate, an equipment cost of $75,000 was provided for filters and housing. With this information, a flat cost of $1.25/cfm was applied to each emission point flow rate for an equipment estimate. The applicable emission points are shown in Table 2 above. For auxiliary equipment, a duct length of 50 feet was used to estimate ductwork costs.

Bag Replacement Cost Methodology

The cost estimate for replacing the current bags with Teflon bags was estimated using the EPA Air Pollution Control Cost Manual. Section 6 of Chapter 1 of the EPA Control Cost Manual discusses baghouses with specific guidelines for estimating bag prices. Since this cost is for replacement of bags on current baghouses, the estimate depends on the type of baghouse currently in place. The specific design of their baghouses was not known, so a cost range was provided. For this analysis, the bag replacement cost was calculated assuming all baghouses were of the pulse-jet design and then assuming all baghouses were the shaker design.

From Table 1.8 of Chapter 1 in the EPA Control Cost Manual, the price for Teflon bags is estimated at $\$17.88/ft^2$ of cloth area. Cloth area was calculated using the volumetric flow rate (ft^3/min) and air-to-cloth ratio (ft/min). Using Table 1.1 of the EPA Control Cost Manual for lead oxide dust, an air-to-cloth ratio of 6 ft/min for pulse-jet baghouses was selected and a ratio of 2 ft/min was chosen for shaker baghouses. Table 6 of this document provides the flow rate information used for each emission point.

Methodology for Other Cost Estimates

The cost of the material handling enclosure improvements included replacement of the existing roll-up doors separation of the battery breaking area from the material handling area of the building, and repair of the existing building.

Hourly labor rates of $22 were used for all estimates. The cost for additional cleaning of the heavily trafficked roads was estimated using an additional three hours per day of labor for 365 days per year. The cost for inspection of the battery breaking area was estimated using an additional 30 minutes of labor per day.

The capital costs for cleaning the buildings was estimated using an estimate of $2,000 to install plumbing for water supply at 14 access points throughout the facility. Monthly cost was estimated using the cost to rent a scissor lift two days per month, with a total labor of 32 hours per month. A washing station costing $2,000, with labor required to operate the washing station one hour per day, 5 days per week, was used to estimate the cost to perform maintenance in a total enclosure or clean and remove the parts to a non-enclosed building. A cost of $2,000 was estimated to purchase containers for storage of dust to be transported.

For control of fugitive emissions at the lead oxide truck loading area, the cost of a cartridge filtration system with associated fittings and ductwork was estimated. For application of a dust suppressant at the landfill, a cost of $10,000 was estimated using the equivalent of 1 road mile of surface area.[5] The cost to install sealing mechanisms at the shipping bays was estimated using a cost of $1,000 per shipping bay purchase price and a $1,000 installation cost for enclosure for 4 shipping bays.[6]

References

[1] *EPA. CAM Technical Guidance Document A.19A Baghouse for PM control- Facility V.*

[2] ACA program is provided at the Clean Air Technology Center on EPA's website, http://epa.gov/ttn/catc/products.html.

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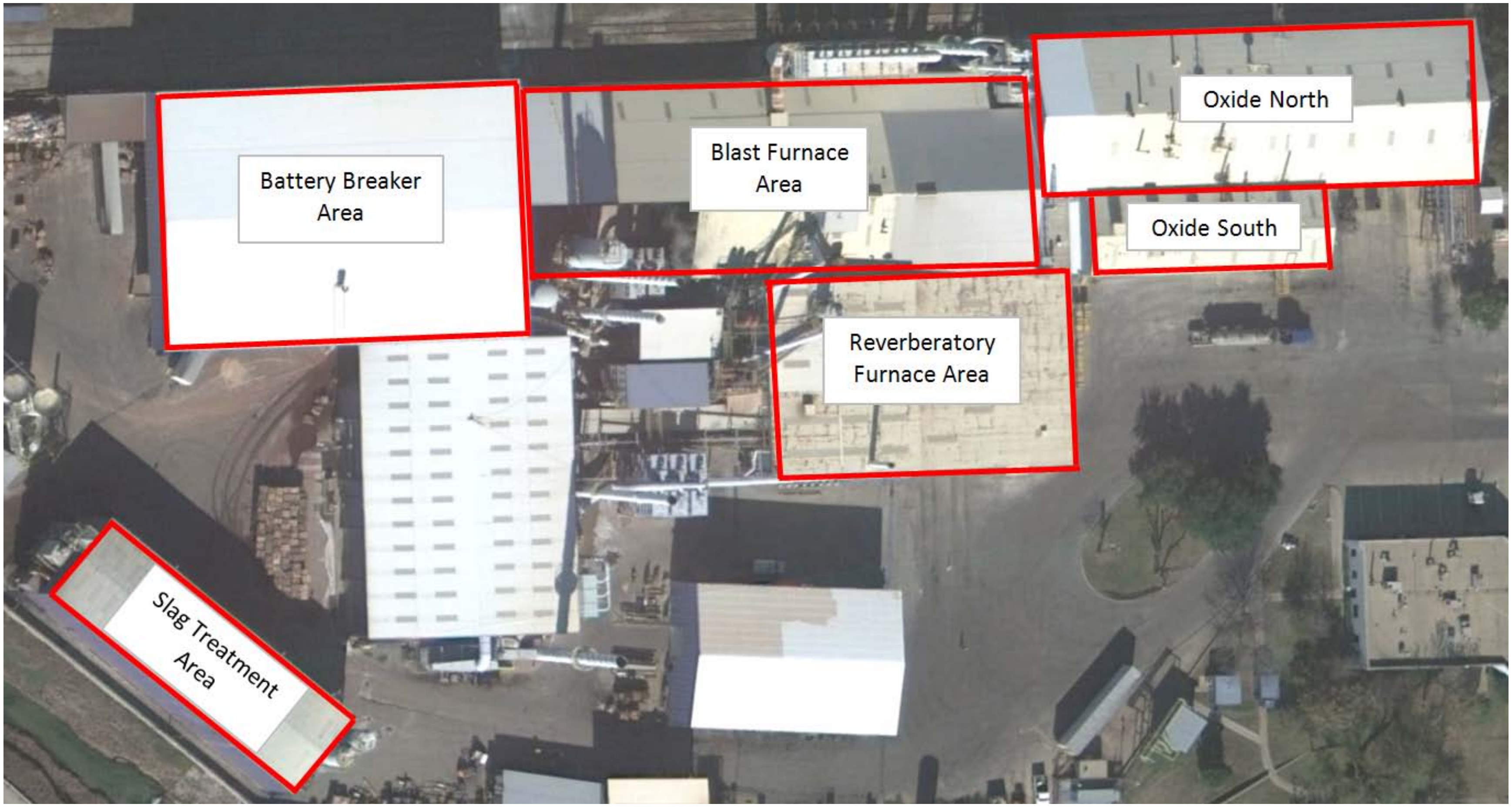

Figure 2: Overhead shot of Exide Technologies Frisco Plant showing estimated boundaries for each building PTE.

Attachment 3
Exide Technologies Process Description

(This document was extracted from Exide Technologies 2009 TCEQ Air Emissions Inventory, Section 2 – Process Description)

The Frisco Battery Recycling facility is a lead-acid battery reclamation facility. Spent automobile and industrial batteries are the primary source of lead to the operation, but Exide also receives quantities of scrap lead and lead-contaminated wastes for lead recovery. The facility's operations yield four products: soft lead, hard lead (alloys), lead oxide, and sodium sulfate.

2.1 Smelting and Refining Operations

Scrap batteries are delivered to Exide by trucks and stored in the battery storage area prior to processing. The batteries received by Exide are broken in the battery breaker (EPN 48FUG) and the component parts are separated by gravity in a water bath. Sulfuric acid emissions from the Battery Breaker are controlled by a scrubber (EPN 48). The lead from the batteries is rinsed to remove residual sulfuric acid before being stored in the raw material storage area (EPN 44) and the raw material storage building along with other lead-bearing scraps. Emissions from the raw material storage building are controlled by a ventilation system and dust collector (EPN 45). Material to be fed to the reverberatory furnace is first mixed inside the raw material storage building and then dried in a natural gas-fired dryer to remove moisture. Residual sulfuric acid is also removed. The removal of moisture minimizes steam explosions in the furnace and the removal of sulfuric acid reduces the amount of SO_2 generated in the reverberatory furnace. Dryer flue gases are vented through a baghouse and a flushed de-mister before being emitted through the soft lead baghouse stack (EPN 21). Materials in both raw material storage facilities are transported by front-end loaders. The material is taken from the storage areas and charged to either the blast furnace or the reverberatory furnace via front-end loader as required. Stack gases from the blast furnace pass initially through a low-NOx afterburner to completely burn CO or any other uncombusted compounds present. Stack gases from each furnace then pass through cooling zones, primary settling chambers ("A-pipes"), baghouses, and finally a common scrubber for sulfur dioxide control prior to being emitted to the atmosphere (EPN 38). Fugitive emissions from the reverberatory furnace, blast furnace, and the lead refining building have been assigned their own EPNs (35, 10, and 36, respectively). Process fugitive emissions from the blast furnace are routed to the hard lead, special alloy, and supplemental ventilation baghouses (EPNs 18, 22, and 37). Process fugitive emissions from the reverberatory furnace are routed to the special alloy and supplemental ventilation baghouses (EPNs 22 and 37). Refining of the lead bullion is accomplished in several large natural gas fired kettles. The bullion from the blast furnace is refined into hard lead, also called lead alloys. The bullion from the reverberatory furnace is refined into soft lead, a portion of which feeds the lead oxide process. The soft lead, hard lead, and special alloy refining areas all have dedicated vacuum hooding with a baghouse to control lead fumes and other contaminant emissions (EPNs 18, 21, and 22). Products of the natural gas combustion are vented to the atmosphere (EPNs 54 and 55). Slag from the reverberatory furnace, drosses from both refining operations, and metals from wastewater treatment become feed for the blast furnace. Slag from the blast furnace is taken by front end loader to the slag treatment building where it is crushed, screened, and mixed with cement, water, and a patented fixing agent to chemically fix the remaining lead content in a nonleachable form. The slag treatment operations have a dedicated ventilation system with a baghouse, which maintains negative pressure on the entire building for particulate emissions control (EPN 39).

2.2 Oxide Process

Much of the soft lead produced at the facility is further processed into lead oxide. Soft lead ingots are initially melted in three melting pots and then reacted with air in six Barton Pot reactors to form lead oxide. The lead oxide particles are removed in six settling chambers controlled by baghouses. Emissions from the reactors and the settling chambers are from these baghouse stacks (EPNs 11, 12, 13, 16, 24, and 25). The settling chambers feed two oxide hammermills with separate baghouses (EPNs 15 and 17). The homogenized oxide particles then feed storage hoppers and weigh hoppers before being shipped. Two covered screw-conveyors load the oxide product into hopper trucks for shipment. Both conveyors have ventilators, and a bag filter is installed on the hopper truck vent before oxide loading begins (EPN 26). The oxide hygiene baghouse controls fugitive emissions from the oxide building including three melting pots and from both truck loading stations (EPN 14). Emissions from the melting pots and the oxide reactors natural gas burners are emitted to the atmosphere through their dedicated stacks (EPNs 56, 57, and 58). All smelting, refining, and oxide production facilities operate 24 hours a day, 5-7 days a week, about 50 weeks a year (345 days/yr). The slag treatment facility operates 4 hours a day, 5 days a week, 52 weeks a year.

2.3 Crystallization Process

The crystallization process is conducted in the area of the plant referred to as the crystallizer. The focus of the operations in the crystallizer is to produce sodium sulfate (salt) as a byproduct. The sodium sulfate is crystallized from the waste water generated by the recycling of lead acid batteries. The waste water is provided from the upstream operations after metals removal. The waste water is preheated by a heat exchanger and then sent to the vapor body. The vapor body will concentrate the salt solution by recirculation to a heat exchanger via a compressor. This process heats the solution and the higher concentration / denser salt solution is removed from the vapor body, dried and stored for shipment. A boiler is used to indirectly heat the solution from the vapor body that is in recirculation. This indirect heat stream (water) is then used to preheat the waste water before it enters the vapor body. The use of a compressor on the recirculation stream allows the boiler to operate at various firing rates ranging from idle to max (100%) in automatic mode. The final outputs are Sodium Sulfate in dry powder form and condensed water (condensate)