EXIDE TECHNOLOGIES

RECYCLING DIVISION, PETONE

APPLICATION FOR RESOURCE CONSENT
TO GREATER WELLINGTON REGIONAL COUNCIL

REPORT ON PROCESS DETAILS

April 2011

Report prepared by Neville Manson
Recycling Operations Manager
Exide Technologies Limited
PO Box 36026
Wellington Mail Centre
Lower Hutt 5045

1. SUMMARY

1.1 Exide Technologies operate a used lead acid battery (ULAB) recycling facility at 51 - 57 Waione Street, Petone. ULAB recycling has been carried out on the Waione Street site since 1965. The processes were licensed under the Clean Air Act until October 1991. The licence then became a permit to discharge contaminants to air under the Resource Management Act, administered by Greater Wellington Regional Council. The current permit, WGN000128 [24363] expires on 2 November, 2011.

1.2 The facility processes used automotive, industrial and commercial lead acid batteries and some lead scrap, to produce metallic pure lead and lead alloys.

1.3 Exide's recycling facility is the only remaining ULAB recycling plant in New Zealand. The service the Company provides is of national importance. If the facility ceased operations, ULAB's would have to be exported as hazardous wastes or would accumulate in the environment. The facility processed approximately 850,000 ULAB's in the calendar year 2010.

1.4 ULAB's are broken down into components consisting of metallic lead, lead compounds, plastic and waste materials. The acidic electrolyte is neutralised before discharge to the trade waste sewer. Plastic material is despatched off-site for recycling. Lead-containing materials are processed through a rotary furnace which is charged with fluxes, to convert lead and lead compounds to metallic lead and slag. The rotary furnace is fired with natural gas. Molten lead is discharged into a holding kettle and slag (flux and impurities) run into moulds. The slag is stabilised to produce a non-hazardous substance for disposal directly into landfill.

1.5 Metallic lead is purified in one of three alloy pots heated by natural gas. The purified lead is either cast into moulds as pure lead, or converted to various lead alloys before casting.

1.6 Gases and dust generated in the smelting furnace pass through primary settling chambers to remove the majority of particulate and are then cooled and filtered through a large bag filter dust collector to remove the remaining particulate. Gases and a minimal quantity of dust are discharged to atmosphere through the 37m high principal stack. Lead emissions are typically only a few percent of the allowable levels. Dust from the settling chambers and the bag filter is recycled through the furnace.

1.7 Gases and other contaminants generated in the holding kettle, the refining pots and the hygiene air from around the smelting furnace, are ventilated to a cartridge filter dust collector which collects all of the dust into one drum. Gases, hygiene air and a minimal quantity of dust are discharged to atmosphere via the 14.7 metre secondary stack. Lead emissions are typically only a few percent of the allowable levels. Dust from the cartridge filter is recycled through the smelting furnace.

1.8 Spent filters and cartridges are recycled through the smelting furnace to recover the lead content.

1.9 The yard and other areas liable to generate dust during dry weather are kept wet by automatic sprinklers. Lead-containing material is collected in interceptors and is then recycled.

1.10 Contaminants discharged to atmosphere from the principal stack are carbon monoxide, carbon dioxide, oxides of sulphur and nitrogen, minimal organics and an insignificant quantity of lead and other metals. Under normal operation a small quantity of lead compounds may be discharged to air from activities in the yard or from operations within the processing building. Almost all potentially contaminated air is ventilated to atmosphere via dust control equipment. Discharges of lead compounds to air are monitored to ensure compliance with the current air discharge permit and occupational hygiene requirements.

1.11 The Company has made significant improvements to operations since applying for its last consent. The majority of the site is now enclosed. A first flush rainwater system ensures the first 25000 litres of roof run off are filtered before discharge to storm water. A filter press has been installed to improve de-watering of lead compounds. The cartridge filter has been enclosed, improved spark suppression installed and the cartridge design and cleaning system upgraded. The main bag house has been replaced with high fugitive risk area's being enclosed. All process and ventilation controls have been upgraded to incorporate PLC control and continuous monitoring via SCADA systems. All high volume air monitors have been replaced with newer more reliable systems. The secondary stack will have been increased in height by 2.5 metres before the current resource consent expires. A real time continuous ambient air monitor has been purchased to enable more timely response in the event of a fugitive excursion.

2 INTRODUCTION

2.1 Exide Technologies are committed to total battery management from the cradle to grave and regard the recycling of used batteries as an integral part of their worldwide operations.

2.2 The Company is located at 51 - 57 Waione Street, adjoining to 59 & 61 East St, Petone. The Company recycles used automotive, commercial and industrial lead acid batteries, other lead-containing materials and some lead scrap, to produce pure lead and lead alloys. Lead recycling has been carried out at the Waione Street site since 1965. The facility has been owned and operated by Exide Technologies since 2000.

2.3 The Company's processes were specified in Part A 5(d) of the Second Schedule to the Clean Air Act 1972. Clean Air Licence No. HD/04/0025/89 was issued by the Department of Health on 10 November 1989. Following the introduction of the Resource Management Act 1999, an Air Discharge Permit, consent No. WGN DA 950007 was issued by the Wellington Regional Council on 22 August 1995. The consent was renewed, WGN000128 [20336], on 2 November 2001, modified WGN000128 [22828], on 24 June 2003 and reviewed, WGN000128 [24363], on 11 April 2006. The current permit, WGN000128 [24363] expires on 2 November, 2011.

2.4 Exide Technologies directly employs 35 people at their Waione Street site, with 5 others at a support warehouse in Gracefield. Expenditure for the financial year ending March 2011 through the local community exceeded $7 million.

2.5 Exide's ULAB recycling facility is the only remaining battery recycling plant in New Zealand. The service the Company provides is of national importance. If the facility ceased operations, ULAB's would have to be exported as hazardous wastes or would accumulate in the environment. The facility processed approximately 850,000 ULAB's in the calendar year 2010.

2.6 The recycling facility is appropriately located at Waione Street providing operations are carried out in an environmentally acceptable manner. The proximity to the Gracefield offices and warehouse permits efficient sharing of resources such as specialist services and administration. The Company believes that continual upgrading of the facility to best practical technology is a cost-effective and environmentally sound approach for this location.

3 PROCESSING AREAS AND BUILDINGS

3.1 All processes including battery breaking, material storage, effluent treatment, charge preparation, smelting, purification, alloying operations and slag processing are located within the process building. Extraction systems for the furnace, the refining pots, the holding kettle and slag processing draw their air from within the process building, maintaining it under a constant negative pressure of around -7.5 pascals. This ensures a constant flow of air into the building through open doors and leakage points around building penetrations for ducting, piping and the like. The main access point to the process building is fitted with a rapid acting curtain door which is continuously monitored to ensure excessive open time does not occur.

3.2 Adjacent to the process building is the general services building which contains workshop facilities, laboratory, offices, medical services, and employee's locker rooms and cafeteria.

3.3 Buildings extend up to about eight metres in height. The two dust filters servicing the smelting furnace, the holding kettle, and three refining pots, plus the principal and secondary stack's, are located between the factory building and the general services building adjacent to Waione Street. The yard to the rear of the buildings contains materials receipt and product despatch areas. A combined site and process layout drawing is attached as Figure 5.1

3.4 All but approximately $800m^2$ of the site is now fully enclosed. It is not practical to enclose this last remaining area as an open area is required to allow crane access for maintenance or replacement of extraction fans, duct work and other process equipment.

3.5 Except for maintenance periods, extraction systems which maintain process building negative pressure operate 24 hours per day / seven days per week.

4 DESCRIPTION AND OPERATION OF LEAD RECYCLING PROCESSES

Introduction

4.1 The Company processes used automotive, industrial, and commercial batteries; lead containing materials and some lead scrap; to produce metallic pure lead and lead alloys. The combined smelting and refining operations have an installed capacity of approximately 15,000 tonnes of refined lead output per year, but currently runs at around 70% of capacity, operating Monday to Friday.

Receipt of Raw Materials and Battery Breaking

4.2 Raw materials are received by covered truck through the East Street entrance.

4.3 Automotive batteries are broken down by an automatic battery breaker which separates metallic lead, lead compounds, plastic and waste materials. Component metallic lead, lead dioxide, lead sulphate and plastics, are removed by classifiers in a wet hydrodynamic separation process. Lead compounds are de-watered in a filter press. Industrial and commercial batteries are pre-drained then broken and components separated manually. The acidic electrolyte, and other acidic liquid waste, is neutralised with hydrated lime (calcium hydroxide) and caustic soda as appropriate before discharge with other treated liquid waste to the trade waste sewer. The liquid waste treatment processes are continuously monitored and displayed in the control room. Plastic material is despatched off-site for recycling.

Smelting Operations

4.4 Smelting is the reduction of lead compounds to metallic lead and is a batch process. Scrap lead and lead compounds from the battery breaker, other lead-containing materials and dust collected from the bag and cartridge filters (flue dust), together with coke, steel scrap, and soda ash (sodium carbonate), collectively feedstock, is charged using "boats" (tubular skips) into the rotary furnace. Coke provides carbon to reduce lead oxides and sulphates to metallic lead. Steel scrap converts residual sulphates, sulphur dioxide and lead sulphide, generated in the smelting process, to iron sulphide. Sodium carbonate is a flux to remove impurities, principally iron sulphide, from the melt. The charge is heated to about 1000^{o}C for several hours. Initial heating dries the charge, which contains about 10% moisture from the hydrodynamic separation process. During this period a visible steam plume discharges from the main stack. Further into the charge lead metal and lead compounds melt and then finally the melt is smelted to metallic lead and slag. Metallic lead is tapped into a holding kettle and slag (flux and impurities) to moulds. The complete smelting cycle, including charging the furnace and tapping metal to the holding kettle and slag to moulds, takes about seven hours. The slag is principally iron sodium sulphide with minor quantities of ash residues and small quantities of heavy metals including lead, antimony and arsenic. The slag is crushed and stabilised then disposed of at an authorised landfill. Contact of slag with acid is avoided to prevent generation of hydrogen sulphide.

4.5 The furnace is fired with natural gas. The burner has a maximum heat release of 3.1 MW, but is limited to 2.6MW and typically operates at around 2.0MW. Natural gas usage is typically 140 gigajoules per day.

4.6 The chemistry of secondary lead smelting is complex but can be generally represented by the following chemical reactions, which occur during the reduction phase:

PbO_2	+ C	$\rightarrow$	$Pb + CO_2$
PbO	+ C	$\rightarrow$	Pb + CO
$PbSO_4$	+ 4C	$\rightarrow$	PbS + 4CO
$PbSO_4$	+ 2C	$\rightarrow$	PbS + 2CO
Na_2CO_3	+ PbS	$\rightarrow$	$PbO + Na_2S + CO_2$
2PbO	+ PbS	$\rightarrow$	$3Pb + SO_2$
PbS	+ Fe	$\rightarrow$	Pb + FeS

Sulphur is fixed in the slag according to the following overall reaction;

$$2PbSO_4 + Na_2CO_3 + Fe + 9C \rightarrow 2Pb + FeS.Na_2S + 9CO + CO_2$$

4.7 The discharge of sulphur dioxide with smelting gases is minimised by maximising acid removal prior to smelting, and by optimising the ratio of iron to soda ash in the flux.

4.8 Smelting furnace gases and products of combustion exit the furnace adjacent to the burner. Burnout is completed in the refractory lined duct to the first dropout chamber and in that chamber. Gases are then discharged into the second dropout chamber and then routed to the principal bag filter through a series of cooling coils. Hot gases and particles are quenched in the cooling coils. Gases and particulate enter the dedicated bag filter at about 150°C where they are filtered before discharging through an induced draught fan into the 37 metre high principal stack. Some cooling air from the furnace rear containment hood is added to the hot gases directly down stream of the first dropout chamber.

4.9 Discharges from the smelting furnace consist of lead-containing and other dust, water vapour, carbon dioxide, oxides of sulphur and nitrogen; and low concentrations of organics and carbon monoxide. The dropout chambers and the bag filter remove almost all entrained dust before discharge of gases to atmosphere.

4.10 Critical aspects of the smelting operations, including furnace draft, furnace and off gas temperatures, furnace rotation speed and motor load are continuously monitored and displayed in the control room.

Lead Refining

Holding Kettle

4.11 The holding kettle has a capacity of about 42 tonnes of lead and can hold two to three furnace pours. Lead is allowed to cool to about 450^{o}C. De-drossing is carried out by adding coke and the lead is stirred by a removable mechanical stirrer. The kettle and dross drum is contained within a ventilation hood and ventilated to the secondary cartridge filter in common with the refining pots. Small quantities of gases and particulates, not retained by the kettle containment, discharge into the process building. The kettle burner combustion gases discharge through a flue into the furnace front containment hood. Following de-drossing, lead is pumped to one of three refining pots.

Refining Pots

4.12 There are three refining pots. Each pot is contained within a ventilation hood to minimise discharges into the process building. Each pot is fitted with a mechanical stirrer. Each pot is in-directly fired by a natural gas burner, the flues of which discharge to atmosphere above the factory roofline. Various fluxes are used to purify the lead and alloying metals are added to produce battery plate alloy. Fluxes and other purifying compounds include coke, sodium hydroxide, sulphur/pyrites, and sodium nitrate. Metals added to produce battery plate alloy are antimony, metalliferous arsenic, tin selenium and copper.

4.13 To minimise loss of the more volatile arsenic and selenium, these additives are introduced to the stirrer vortex of all pots to ensure incorporation into the lead melt. Therefore, discharges to the ventilation system and fugitive discharges into the process building are reduced to a practicable minimum.

4.14 Discharges from refining pots are captured by the ventilation system but small quantities of un-contained discharges (fugitive emissions) may emit into the process building. Discharges may include lead metal fume, lead oxide, sodium salts, sulphur dioxide, oxides of nitrogen and minimal antimony, selenium, and arsenic metal vapour and possibly oxides.

4.15 The combined maximum heat release of the 3 refining pot burners and the holding kettle burner is 4.2 MW, however it is normal that no more than half of this capacity is utilised at any one time. Natural gas usage is typically 45 gigajoules per day. The 3 refining pot burners draw their combustion air from an external source. The holding kettle burner draws combustion air from within the process building. To mitigate effects of possible contamination of the combustion air, this burner exhausts through the cartridge filter.

4.16 Following purification/alloying as appropriate, the metal is cast into 25kg ingots or 1 tonne blocks. Both casting processes are water cooled. Discharges from casting which are emitted into the process building air consist of a negligible quantity of lead metal fume and a considerable amount of steam.

4.17 Critical aspects of the refining operations, including refining pot temperatures and stirrer motor currents are continuously monitored and displayed in the control room.

Slag Processing

4.18 The smelting operations produce a slag waste stream consisting of fluxes and impurities from the furnace, which is poured from the furnace into moulds. Once cooled, the slag is processed to reduce reactivity and stabilised so that it passes TCLP testing for a range of heavy metals including lead, arsenic and antimony. Once stabilised and TCLP characteristics verified, slag is disposed of into an authorised landfill.

Table 4.1: Summary of Discharges to Air, Sources, and Mitigation Measures

SOURCE	DISCHARGE AND MITIGATION
Yard - Receipt of Raw Materials	Received by covered truck as whole batteries, in drums, skips, bagged, or crated: Minimal discharges to air.
Yard - Holding of Waste Bins	Stored in dedicated areas: Minimal discharges to air.
Yard - Truck Movements	Receipt area kept damp. Process building vehicle access to yard is minimised to prevent tracking of contaminants to yard. Outgoing trucks may track some deposits on wheels to East Street. Company cleans/washes down East Street area adjacent to entrance. Northern and western fence line monitors are positioned to capture and measure discharges to air from the yard
Battery Breaking	Wet process: no discharges to air. Sludge removal - wet process, no discharges to air.
Preparation of Furnace Loading Boats	Lead compounds from battery breaking damp; reject paste damp; recycled bag filter dust etc drummed; coke and fluxes granular: minimal dust. Under extraction to cartridge dust collector.
Yard Generally, Factory Floor etc	No air discharges if kept wet, and kept clean by washing down.
Furnace Loading	Minimal discharges to process building air providing feedstock not excessively wet. Emissions from charging door when loading are captured primarily by the furnace containment hood and extracted to the cartridge dust collector.

SOURCE	DISCHARGE AND MITIGATION
Furnace Smelting	Some gaseous discharges into the process building air from the rear air gap primarily captured by rear extraction hood. Furnace extraction to the primary dropout chamber is maintained at a constant negative pressure so any pressure changes within the furnace are automatically compensated for. Fugitives from the front door are contained within the furnace containment and extracted to the cartridge dust collector. Furnace discharges (lead dust, SO_2 and products of combustion etc) are drawn through dropout chambers, cooling coils, and bag-house to 37m high chimney. Three levels of over temperature alarms maintain the system below maximum operating temperature. Alarms are derived from two separate sources, providing redundant protection. Critical parameters of the bag filter and cartridge filter are continuously monitored and displayed in the control room. Excursions beyond critical levels automatically shut down he process
Furnace Lead Pouring	Lead poured to the Holding Kettle with fume mainly retained by furnace containment and kettle extraction and discharged through the cartridge dust collector.
Furnace Slag Pouring	Slag poured to sub-floor slag train with pots, with fume mainly contained in furnace containment. Fume mainly collected by ventilation system; minor discharge to process building air.
Holding Kettle	Ventilated to cartridge dust collector in common with three alloy pots. Discharges include lead metal fume, and gaseous and particulate products of de-drossing with coke. Minimal un-contained discharges are emitted into the process building air. Kettle gas-fired burner combustion gases discharged into the furnace containment and discharged via the cartridge dust collector.

SOURCE	DISCHARGE AND MITIGATION
Refining Pots	Ventilated to cartridge dust collector in common with holding kettle. Discharges include lead and alloying metal fumes and gaseous and particulate products of purification using fluxes. Minimal un-contained discharges are emitted into the process building air. Discharges include limited lead metal fume, lead oxide, sodium salts, sulphur dioxide, oxides of nitrogen and minimal antimony, selenium and arsenic metal vapour and possibly oxides. Pot burner flues discharge combustion products above the roof.
Casting	Discharges emitted into process building air. Minimal lead metal fume; and steam.
Flue Dust	Collected bag filter and cartridge filter dusts. Collected material screwed to drums, contained within the process building. Spillages discharge onto wet concrete pad. Some lead-containing dust to process building air.
Furnace Bag Filter Chimney	37 metres high. Receives discharge from furnace bag filter. Discharge contains minimal dust, minimal lead and other metal fume, and minimal organics; normal products of combustion; and sulphur oxides.
Cartridge Dust Collector vent	14.7 metres high. Receives hygiene air from three refining pots, holding kettle, containment of both ends of the furnace and loading area for furnace boats. Discharge contains minimal dust, minimal lead and other metal fume and oxides of sulphur and nitrogen,
Process Building Ventilation	The entire process building acts as a secondary containment for any fugitives that escape into the process building air. Extraction systems for the furnace, the refining pots, the holding kettle and slag processing draw their air from the process building, maintaining it under a constant negative pressure of around -7.5 pascals. This ensures a constant flow of air into the building through open doors and leakage points around building penetrations for ducting, piping and the like. The main access point to the process building is fitted with a rapid acting curtain door which is continuously monitored to ensure excessive open time does not occur.
Slag Processing	Dust is created when slag blocks are broken into small pieces and crushed even smaller. This material is then mixed with water to make a wet mud. No discharges when wet.

Discharge Control Equipment

Furnace Discharges

4.19 Furnace discharge control equipment consists of two dropout chambers, cooling coils, and a Windsor Model PT448 pulse jet bag filter. The bag filter is designed to operate at an air flow volume of up to 7.5 m^3/second actual temperature. Actual flow varies as the induced draft fan operates under closed loop control to maintain a constant draft on the furnace. The unit contains 448, 3 metre long filter socks. Filter surface area is 506 m^2. Filter material is Nomex needlefelt with anti-acid sock treatment. Socks are replaced every 2 to 2.5 years and disposed of through the smelting furnace. The filter operates with on demand cleaning which achieves consistent pressure drop, optimum filter cake retention and minimal bleed through. Filtration velocity (design) is 14.8 mm/second. Dust retained by the filter socks discharges into the hopper and is screwed into 200 litre steel drums. Results from the latest emission testing, carried out by Source Testing NZ Ltd in February 2011, show a maximum particulate of 116 g/hr at a volumetric flow of 5.7 m^3/second actual temperature, with an average over 6.5 hours of 75 g/hr.

4.20 The bag filter discharges through an induced draught fan to the 37m high principal stack at a design efflux velocity of 17.9 m/second.

4.21 Critical aspects of the furnace discharge control equipment, including bag house temperatures and differential pressure, flow rate and particulate discharged form the principal stack are continuously monitored and displayed in the control room. Excursions beyond critical limits automatically shut the furnace burner down.

Hygiene Ventilation System

4.22 The holding kettle, part of the ventilation from the furnace containment hood, and ventilation from the three refining pots (collectively hygiene ventilation) are discharged through a common duct to a Torit cartridge filter dust collector. The cartridge filter has a design flow of 25 m^3/second, actual temperature and a filter surface area of 2550 m^2. Filtration velocity (design) is 9.8 mm/second. Cartridges are replaced every 9 to 12 months and disposed of through the smelting furnace. Results from the latest emission testing, carried out by Source Testing NZ Ltd in February 2011, show a maximum of 47 g/hr at a volumetric flow of 23.7 m^3/second actual temperature, with an average over 6.5 hours of 32 g/hr.

4.23 The cartridge filter discharges through an induced draught fan to the 14.7 m high secondary stack at a design efflux velocity of 17.0 m/second.

4.24 Critical aspects of the hygiene ventilation control equipment, including cartridge house temperatures and differential pressure, flow rate and particulate discharged form the secondary stack, are continuously monitored and displayed in the control room. Excursions beyond critical limits automatically shut the furnace burner and/or the cartridge filter extraction fan down.

Yard Dust Control

4.25 To minimise dust transportation the yard, factory floor, and area around the bag filters etc, is kept wet by water sprays or by hosing. These areas are also regularly hosed down to remove accumulated materials. Water is discharged into the effluent treatment system, solids allowed to settle, liquid neutralised as appropriate, and then discharged to the trade waste sewer.

Storm Water

4.26 Storm water run off from the process building roof is captured and directed to a first flush containment tank. Under normal rain events 100% of run off is filtered prior to discharge to storm water. Under an abnormal rain event, at minimum the first 25000 litres of run off is filtered prior to discharge to storm water. The process utilises a sand filter, with back wash water directed to the effluent treatment system.

4.27 Chemicals and other compounds used in smelting and refining processes are:

Caustic Soda (sodium hydroxide) - 25kg bags
Selenium – 25 kg drums
Antimony – 23 kg ingots
Metalliferous arsenic -25 kg drums
Sodium nitrate - 25kg bags
Soda ash (sodium carbonate) - 25kg bags
Steel turnings and other steel scrap
Hydrated lime (calcium hydroxide) - 25kg bags
Sulphur –25kg bags
Coke – 20kg bags
Pyrites – 25kg bags
Tin – 30 kg ingots
Gypsum (calcium sulphate) – 1 tonne bags

5 PROCESS CHANGES SINCE 2001

5.1 Rapid Roller door Installation

The entrance to the main processing building has been fitted with a rapid opening roller door to minimise the door open time during accessing and exiting the building. Subsequently this has been replaced with a more reliable model and continuous monitoring and recording of open times has been added. The rapid door is backed up by a screen curtain to provide an additional barrier to fugitive emissions when the door is open for access. Previously this main door had been a significant source of fugitive emissions.

5.2 Continuous Stack Particulate Monitors

Unreliable and low sensitivity triboelectric stack particulate monitors have been replaced by electrodynamic particulate monitors with capability to be calibrated to report real time particulate emissions. Electrodynamic particulate monitors are less susceptible to water vapour and changes in particulate characteristics than the tribolelectric units replaced. The particulate monitors are connected to the process monitoring systems and provide alarms which initiate shut down if abnormal operation is detected.

5.3 Spark Suppression System

The cartridge filter duct has been extended in a 50m loop to aid suppression of sparks, which previously had been a source of cartridge filter damage and dust leakage. Since the installation of this duct extension, no hits have been recorded on the Grecon spark detector system and no cartridge filter failures due to sparks have been recorded.

5.4 Cartridge Filter Enclosure

The cartridge filter and associated dust handling areas have been completely enclosed in a building which ventilates into the main process building and then back to the cartridge filter as part of the process building hygiene air system. Filter change out and maintenance, previously a major source of fugitive emissions, are now conducted in a contained environment.

5.5 Filter Press Installation

A filter press has replaced the oxide dewatering towers. Furnace feedstock is now consistently drier. Spillage of wet oxide, tracking and drying out, previously a major source of fugitives, has now been largely eliminated.

5.6 Cartridge Filter Design Change

The original design of the cartridge filters had a tight pleat which did not allow for efficient cleaning. Dust build up on the cartridge reduced the volume of extraction air available to the hygiene system and resulted in increased cartridge failures and emission to air. A redesigned filter cartridge, in con junction with an improved filter cleaning system, has resulted in more efficient cleaning, lower differential operating pressure, improved hygiene air extraction volumes, lower dust bleed through and improved filter life and performance.

5.7 Furnace Draft Controls Upgrade

The furnace draft fan has been upgraded to a closed loop control operating against a fixed set point. This ensures that regardless of conditions in the furnace and off gas system, a consistent negative pressure is maintained on the furnace and fugitive emissions from the furnace are minimised. Addition of this control also allowed additional over temperature protection to be added.

5.8 Process Controls Upgrade

All processes have progressively been upgraded from manual operations to fully automated PLC controlled operations with continuous monitoring and recording. This has enabled several additional levels of protection to be added to environmental and process controls, with staged process turn down, then automatic shut in the event of any abnormal operations being detected. Elements of the previous control system are retained to provide duplicate monitoring and alarm systems for redundant protection.

5.9 Bag House Replacement

The main bag house and principal stack have been replaced. The bag house is of similar design to the original, but incorporates several design improvements learned from the operation of the original design which ensure fugitive emissions are minimised or eliminated.

- The flue dust collection point has been enclosed in sealed room which ventilates back into the main process building and then into the cartridge filter via the process building hygiene ventilation system. This enclosure also allows controlled access to the dirty side of the bag house for maintenance purposes.
- The clean air side of the bag house has been compartmentalised to allow

maintenance on one side while the other side remains in operation. The clean air chamber is high enough that support cages can be removed and bags changed with the chamber closed up. This ensures the bag house remains under negative pressure and any dust generated is collected and filtered through the second chamber. Fugitive emission during maintenance is eliminated.

- The entire structure is manufactured from stainless steel to eliminate the risk of corrosion to the structure, which was a source of fugitives from the old bag house towards the end of its useful life.

5.10 Furnace Burner Upgrade

The furnace burner has been upgraded to a high velocity dual fuel burner. The improved efficiency and heat release characteristics of the new burner have enabled the transition of fuel source from diesel to natural gas. The 20,000 litre diesel fuel storage tank on site is now redundant and will be removed before the current resource consent expires.

5.11 Slag Processing

A process to crush and stabilise slag has been developed and equipment installed. This has been an evolving process over several years, with the process in it current form being in place since 2008.

5.12 Environmental Capital Expenditure

Since the 2005 resource consent review $3.5 million, from a total capital spend of $4.5 million, has been spent on upgrading or enhancing environmental controls.

6 PLANNED PROCESS CHANGES

6.1 Secondary Stack Extension

Turbulence generated from the nearby Lever's building, the cartridge house enclosure and the new bag house structure has adversely impacted the secondary stack. Planning is well advanced to extend this stack by 2.5 metres and this will be completed before the current resource consent expires.

6.2 Sodium Nitrate Fluxing Automation

Nitrogen dioxide gas discharge from the secondary stack has occurred twice, in August 2009 and February 2011, due to disruptions in the fluxing operation resulting in the decomposition of sodium nitrate to nitrogen dioxide. An initial counter measure to monitor the fluxing operation via PLC, with alarms to warn of abnormal operating conditions, was completed in February, 2011. An automated screw feeder for sodium nitrate fluxing additions has been ordered and will be installed. The target date for completion is the end of April, 2011 subject to supplier delivery. Sodium nitrate fluxing will then be fully automated with critical process parameters continuously monitored, alarmed and interlocked to prevent sodium nitrate additions under abnormal operation.

6.3 Enclosed Process Building Access Walkway

Access between the process building and the amenities block is currently open area, giving rise to potential fugitives from dusts tracked by pedestrians and from contaminated overalls. The access way will be fully enclosed and all pedestrian access to the process building will be via this route.

6.4 Battery Breaker Rapid Acting Curtain Door.

Access to the battery breaker is currently via a door protected by a strip curtain. A rapid acting curtain door will be installed. Although fugitives emission from this door is minimal, the rapid acting door will assist in maintaining overall building negative pressure and fugitive escape from other areas within the process building.

6.5 Continuous Real Time Ambient Air Monitoring

A continuous real time ambient air quality monitor has been ordered and will be commissioned by the end of May, 2011. This will provide real time monitoring and reporting of 23 elements in ambient air. The system has been extensively tested in the USA at a site in close proximity to a primary lead smelter. Good correlation between this ambient air quality monitor, standard high volume/ICPMS analysis monitors and USEPA reference method high volume/XRF analysis monitors has been demonstrated. All three existing high volume monitors will be retained and will remain the basis for evaluating compliance to established boundary limits. However, even with priority analysis of the high volume filters, results are not received for 2-3 weeks after exposure. Any event resulting in elevated levels is difficult to track after this length of time. With real time monitoring, any event resulting in higher than normal ambient air concentrations will be able to be identified and tracked immediately.

7 **QUANTIFICATION OF DISCHARGES TO AIR**

Smelting Discharges from Principal Chimney

Furnace Bag Filter

7.1 Volumetric flow, total particulate, lead and total acidity (as SO_2) was determined by Source Testing NZ Ltd on 17th and 18th February, 2011. Particulate testing was carried out according to United States Environmental Protection Agency (USEPA) Method 5. A copy of these results has been reported to the Regional Council.

7.2 Volumetric flow during the testing period averaged 5.7 m^3/second at an average temperature of 149°C. Sampling for total particulate and total acidity as SO_2, was carried out over 6.5 hours utilising three tests to capture a full smelting cycle. A summary of results for the Furnace Bag Filter discharges are presented in Table 8.1.

Table 7.1:Summary of Test Results for Smelter Furnace Bag Filter Discharges - Total Particulate and Total Acidity as SO_2 - 17&18 February 2011

Parameter	Test 1	Test 2	Test 3	Average
Time	130 min	131 min	126 min	2.15 hours
Dust Concentration (mg/Nm^3)	4.0	10.0	4.7	6.1
Lead Dust Concentration (mg/Nm^3)	0.004	0.004	0.004	0.004
Dust Mass Emission (g/hr)	55	116	57	75
Lead Dust Emission (g/hr)	0.06	0.04	0.05	0.05
Acid Gases Concentration (mg/Nm^3 as SO_2)	258	25	2448	910
Total Acid Gases Emission (kg/hr as SO_2)	3.4	0.3	28.0	10.0

7.3 Total dust concentration for each test was low - less than 10 mg/m^3 which is approaching the limit of accuracy for this method for the sampling period involved. The mass emission of lead dust based on actual concentrations was

0.05 g/hour as a weighted average, over the 6.5 hours of testing. Total acid gas emission as SO_2 was 10.0 kg/hr as a weighted average. The variance of one reading related to the timing of the smelting cycle of the furnace.

7.4 These results are generally consistent with the stack tests completed in April 2009 and May 2010 by Source Testing New Zealand Limited

7.5 Concentrations of antimony, arsenic, cadmium and selenium were low, approaching laboratory analytical detection limits.

7.6 Testing of dioxin and furan discharges from the smelter furnace bag filter stack were last carried out on 21 and 27 January 2010. The concentration of dioxins (PCDD's) and furans (PCDF's) reported as International Toxicity Equivalents (I-TEQ) were:

- 0.31ng/Nm^3 adjusted to 11% oxygen, with volumetric flow rates during the test averaging 4.1m^3/second at 148°C (2.6Nm^3/second)[1].

The concentration of dioxins and furans emitted to atmosphere during the tests varied depending on the smelting cycle. The emission concentration of 0.31 ng/Sm^3 is around 1/3rd the current United Kingdom emission limit of 1ng/Nm^3 at 11% oxygen. The operation of a high efficiency furnace gas bag filter system is a major factor in the Company achieving low dioxin and furan emissions. These compounds substantially adsorb onto dust particulate. Consequently, the high degree of dust control achieved limits the emission of dioxins and furans.

New Zealand does not have national emission standards or guidelines for dioxins and furans. These results compare favourably with other sources identified by the N.Z. Ministry for the Environment National Inventory of Dioxin Emissions.

Visual Appearance of Principal Chimney Discharge

7.7 Discharges from the principal stack are usually virtually indistinguishable against a blue sky background. During cold conditions a steam plume may be seen and this corresponds to the beginning of the smelting cycle when most of the charge water evaporates. This white steam plume may be enhanced by low concentrations of sulphur trioxide which may make the plume more persistent than a plume from a gas fired or diesel oil fired thermal plant. Occasionally a light blue haze is apparent.

1 ng/Nm^3 is nanograms per cubic metre of discharge gas adjusted to 0^{o}C dry gas basis. A nanogram is 1 millionth of a milligram.

Discharges from Cartridge Filter Vent

Hygiene Air Cartridge Filter

7.8 Testing of the hygiene and refinery cartridge filter discharges was carried out by Source Testing NZ Ltd on 15th and 16th February, 2011. Methodology was identical to that reported for testing the furnace bag filter.

7.9 Volumetric flow during the testing period averaged 23.7 m^3/second at an average temperature of 54℃. Sampling for total particulate and total acidity as SO_2, was carried out over 6.5 hours utilising three tests to capture a full smelting cycle. A summary of test results for the cartridge filter discharges are presented in Table 8.2.

Table 7.2: Summary of Test Results for Hygiene and Refinery Cartridge Filter Dust Collector Discharges - Total Particulate and Total Acidity as SO_2 - 12 &16 February 2011.

Parameter	Test 1	Test 2	Test 3	Average
Time	136 min	130 min	136 min	2.23 hours
Dust Concentration (mg/Nm^3)	0.2	0.5	0.7	0.5
Lead Dust Concentration (mg/Nm^3)	0.008	0.007	0.008	.008
Dust Mass Emission (g/hr)	15	33	47	32
Lead Dust Emission (g/hr)	0.6	0.5	0.6	0.6
Acid Gases Concentration (mg/Nm^3 as SO_2)	18	8	7	11
Total Acid Gases Emission (kg/hr as SO_2)	1.3	0.5	0.5	0.7

7.10 The total particulate concentration for each test was low, less than 1 mg/m^3, which is below the limit of accuracy of the method. The mass emission of lead dust based on actual concentrations was 0.6 g/hr as a weighted average over the 6.7 hours of testing. Total acid gas emission as SO_2 was 0.7 kg/hr as a weighted average.

Fugitive Discharges (Boundary Monitors)

7.11 Condition 12 of the current resource consent imposes lead in air limits at three monitoring locations on the southern, western and northern boundaries. Current limits are 1.5µg/m^3, 0.55µg/m^3 and 0.8µg/m^3 on the respective boundaries. Process upgrades since the establishment of these limits in 2006 have seen a steady reduction of lead in air levels measured at the boundary monitors. A significant improvement has been seen since the commissioning of the new bag house in March,2009. For the calendar year 2010 lead in air recorded at the three boundary monitors, expressed as mean annual concentrations, were 0.12µg/m^3, 0.10µg/m^3 and 0.13µg/m^3 at the southern, western and northern boundaries respectively. The northern boundary monitor now appears to be the best indictor to ongoing site performance and it is intended to co-locate a continuous real time ambient air quality monitor at this site to allow more timely response to elevated lead in air levels and point source identification.

8 PROCESS MONITORING

Battery Breaking and Effluent Neutralisation and Disposal

8.1 Battery breaking and liquid effluent neutralisation is automatically controlled. Neutralisation and liquid effluent discharge pH is continuously monitored and alarmed if set points are exceeded. Data is logged on a recorder every 30 seconds. Only effluent which meets the specification is discharged. Out of specification waste is automatically re-circulated through the system. Effluent meeting discharge pH specifications is directed to a secondary treatment process where it is dosed with ferric chloride and a flocculent to promote solids settling and dissolved heavy metals reduction. A secondary monitoring and dosing system provides final pH polishing. The pH meters are regularly checked and calibrated against standard buffer solutions.

Feedstock Composition

8.2 Feedstock composition is carefully controlled to optimise smelter furnace operation and lead production.

Smelter Furnace

8.3 The furnace temperature and draft are continuously monitored and displayed in the control room. Temperature excursions from normal are alarmed and automatic burner shut down initiated if maximum set point is exceeded. The furnace cycle is controlled by PLC with stage times, temperatures and furnace rotation speeds optimised to minimise dust generation and maintain a constant negative furnace pressure. Furnace draft is maintained at a constant level by a variable speed fan under closed loop control against set point.

Furnace Bag Filter

8.4 Differential pressure, temperature and discharge particulate concentrations are continuously monitored and displayed in the control room. Excursions from normal are alarmed and automatic burner turn down, then shut down initiated if maximum set points are exceeded. The Company operates a checking and maintenance schedule and commissions regular air discharge monitoring to gauge compliance with their air discharge permit and calibrate the particulate detectors.

Cartridge Filter Dust Collector

8.5 Differential pressure, temperature and discharge particulate concentrations are continuously monitored and displayed in the control room. Excursions from normal are alarmed and automatic furnace burner and cartridge filter fan shut down initiated if maximum set points are exceeded. The filter cartridges are protected by a spark detection and water quenching system.

Holding Kettle

8.6 Kettle lead temperature is monitored and the burner automatically shut down if maximum set points are exceeded.

Refining Pots

8.7 The refining pot temperatures are continuously monitored and displayed in the control room. Interlocks prevent refining operations if dust extraction is not operational or if process temperature maximum set points are exceeded. Refining pot stirrer motor currents are continuously monitored and displayed in the control room. Interlocks prevent refining operations if minimum and maximum set points are exceeded.

Yard, Factory, and Other Areas

8.8 Monitoring of the yard and other areas liable to dry out and create dust during dry and windy conditions, is the responsibility of the process Team Leaders. The yard areas are kept wet by automatic sprinklers.

Occupational Hygiene Monitoring

8.9 The Company's Occupational Health Nurse is responsible for co-ordinating regular occupational hygiene monitoring. Biological monitoring gauges compliance with statutory and internal compliance requirements and determines effectiveness of measures to minimise the discharge of lead compounds into the work environment air. Results of biological monitoring are compared with other world wide Exide facilities on a monthly basis. The Petone facility currently has the lowest blood lead levels for lead recycling operations world wide.

9 ABNORMAL OPERATION AND MITIGATION MEASURES

Battery Breaking and Liquid Waste Neutralisation

9.1 A significant acid spill or failure of primary pH monitoring and dosing equipment may result in acidic wastes discharging to the Trade Waste Sewer. Normal on-going supervision and regular calibration of pH meters and neutralisation controllers mitigates this risk. Out of specification waste is automatically re-circulated through the system and a secondary monitoring and dosing system provides back up.

9.2 As battery breaking is a wet process, there is little risk of dry dust being generated. A malfunction of the classifier may result in excess plastic materials contaminating lead and lead compounds. This is unlikely. Degraded classifier performance may result in an increase in organic materials charged into the furnace. This could increase specific energy of feedstock therefore reduce furnace fuel consumption, but could increase organic residues in the slag and increase organic discharges into the bag filter. As plate separators are no longer PVC the chlorine content of stack discharges would not increase.

9.3 Failure of the oxide filter press to adequately de-water lead compounds could result in excessive water carried over into feedstock and the risk of over pressuring the furnace.

Furnace Operation

9.4 Failure of the oxide filter press to adequately de-water lead compounds could result in excessive water carried over into feedstock and the risk of over pressuring the furnace. Draft pressure monitoring with closed loop control to the induced draft fan, ensures furnace negative pressure is maintained in such an event. Any small amount of fugitives resulting from such an event is contained within the process building environment due to the -7.5 pascal negative pressure which is constantly maintained. Unidentified volatiles or flammable materials which although unlikely could find their way into a furnace charge are mitigated in the same way.

9.5 Fume arising from the failure of a slag pot or launder during a slag pour would be substantially contained within the furnace front containment hood and the slag train hood and extracted to the cartridge filter. The slag train is below floor level and spilt slag would be contained. Molten slag has a very high heat capacity and contact of molten slag with even a relatively small quantity of water would result in the release of a significant amount of energy in the form of a steam explosion.

The slag train is bunded to prevent accidental ingress of water. Regular inspections are conducted to monitor for potential ground water ingress.

9.6 Loss of or reduction in hygiene air ventilation at the front and rear containment hoods would result in increased fugitive emissions from the furnace door and burner openings, into the process building. Cartridge filter controls automatically shut down the furnace burner in such an event. Natural buoyancy and convective flow provide sufficient flow to contain dust and smoke with the burner off.

9.7 Loss of or reduction in furnace draft would result in increased fugitive emissions from the furnace door and burner openings, into the process building. Bag filter controls automatically shut down the furnace burner in such an event. Natural buoyancy and convective flow provide sufficient flow to contain dust and smoke with the burner off.

Bag and Cartridge Filtration Equipment

9.8 Failure of the furnace bag filter will markedly increase discharges of lead-containing dust to atmosphere through the principal chimney. The most likely cause of serious malfunction is filter fires. Spark carry over from the furnace, volatiles igniting in the furnace off gases, or excessive over temperature at the bag house inlet could initiate a filter fire. Cooling coils, fitted between the furnace and the bag house reduced this risk to a minimum. Temperatures are monitored at four points in the off gas trail and excursions above limits at three of these points will shut the furnace burner down. Quenching air is introduced into the off gas trail if required at a point prior to the cooling coils or at the inlet to the bag house. Failure due to fire is assessed as being highly unlikely. Currently the most likely cause of severe abnormal operation would be splitting of furnace filter bags or detachment of bags from their venturis. Complete failure of filter bags is detected by monitoring the differential pressure across the bag filter. Partial or complete failure of filter bags is detected by the stack discharge particulate monitor, which will alarm initiating automatic shut-down of the furnace. The design of filter bag, support cage and venturi are such that detachment of a bag is highly unlikely.

9.9 Failure of the cartridge dust collector would cause a moderate increase in particulate discharge from the secondary stack. The most likely cause of serious malfunction is filter fires. The duct to the cartridge dust collector is fitted with a Grecon spark arrestor which detects sparks and extinguishes them with a fine mist spray of water into the duct. Since the last application was submitted, the inlet duct up stream of the Grecon has been extended in a 50 m long loop, to minimise the risk of spark carry over and potential cartridge fires. Since this extension was completed, there have been no spark hits on the Grecon or cartridge failures due to sparks. Filter cartridge material is fire retardant to minimise the risk of fire propagating through the collector housing in the event of a cartridge igniting from spark or other heat source. Any increase in temperature or particulate, due to fire, initiates automatic shut down of the system and closes a fire stop damper. Mechanical abrasion can cause partial cartridge failure. Partial or complete failure of filter cartridges is detected by the stack discharge particulate monitor, which will alarm initiating automatic shut-down of the furnace burner and cartridge filter fan.

9.10 Failure to maintain the correct automatic bag filter cleaning cycle could result in excessive build up of cake on the filter media and increase bag filter pressure drop. Excessive differential pressure would reduce volumetric flow and cause fugitive escape of furnace gases through the charge door and from the air gap under normal operation. Most of this fugitive escape would be contained by the furnace front and rear hoods. The automatic bag filter cleaning cycle is highly reliable. The bag filter differential pressure and flow rate are continuously monitored and displayed in the control room. Excessive pressure drop will activate an alarm and initiate shut-down of the furnace burner.

9.11 Failure to maintain the correct automatic cartridge filter cleaning cycle could result in excessive build up of cake on the filter media and increase cartridge filter pressure drop. Excessive differential pressure could reduce volumetric flow, reducing dust capture at source, increased fugitives within the process building and a reduction in the negative pressure maintained on the process building. This could result in increased fugitive emission from the process building. The cartridge filter differential pressure and flow rate are continuously monitored and displayed in the control room. Excessive pressure drop will activate an alarm. Building negative pressure at 5 points within the process building are continuously monitored and displayed within the control room.

Containment of Collected (Flue) Dust

9.12 Particulate (flue dust) collected in the bag and cartridge filters is screwed into 200 litre steel drums and then recycled through the furnace. All flue dust handling is now contained within the main process building, which is maintained under a constant negative pressure of about -7.5 pascals. Accidental spillage of flue dust is contained within the process building.

Refining Operations

9.13 Discharges arising from fluxing and purification of lead in the refining pots are minimised by appropriate operation and are extracted to the hygiene air cartridge filter dust collector. Adequate extraction is ensured by the cartridge filter mitigating measures. Additional measures ensure refining operations are adequately mitigated. Stirrer motors are interlocked so that pot stirring is not possible if extraction is not operating. Refining operations that utilise sodium nitrate as an oxidiser, if not adequately controlled, can result in a discharge of nitrogen dioxide. Sodium nitrate refining is now an automated process, with additions controlled by a volumetric screw feeder. Refining pot temperatures and stirrer motor currents are continuously monitored and displayed in the control room. Limits on temperatures and motor current are alarmed and the screw feeder and stirrers are interlocked to prevent operation.

Yard, Factory Floor, and Other Working Areas

9.14 Failure to keep the yard, factory floor and the concrete pad around the bag filter wet and washed down could cause dust mobilisation during dry windy weather. Such conditions are substantially prevented by automatic yard sprinklers and maintaining the process building under a negative pressure of -7.5 pascals.

9.15 Failure to maintain adequate process building negative pressure could result in increased fugitive emissions from openings and doors. In the six months 1 July 2010 to 31 December 2010 the critical opening, the rapid opening roller door access to the main process building, never recorded a positive pressure. In the corresponding period the bag house bottom containment and the south wall behind the furnace recorded positive pressures 3% and 1.5% of the time respectively. These were generally short term excursions during times of high winds from the north westerly quarter.

Contacting of Slag and Acid

9.16 Slag and acid react to give hydrogen sulphide. Slag is handled and stored away from any acid to avoid reaction.

Slag Processing

9.17 Slag crushing and mixing creates dust. These discharges are be minimised by appropriate operation and by point source capture and extraction to a dedicated bag house