BART DETERMINATION SUPPORT DOCUMENT FOR ALCOA INTALCO WORKS FERNDALE, WASHINGTON

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EXECUTIVE SUMMARY

The Best Available Retrofit Technology (BART) program is part of the larger effort under the federal Clean Air Act Amendments of 1977 to eliminate human-caused visibility impairment in all mandatory federal Class I areas. Sources that are required to comply with the BART requirements are those sources that:

1. Fall within 26 specified industrial source categories.
2. Commenced operation or completed permitting between August 7, 1962 and August 7, 1977.
3. Have the potential to emit more than 250 tons/year of one or more visibility impairing compounds.
4. Cause or contribute to visibility impairment within at least one mandatory federal Class I area.

The Alcoa Intalco Works (Intalco) is a primary aluminum smelter facility utilizing the prebake process. The smelter is located on Cherry Point near Ferndale, Washington. The aluminum smelting process produces emissions of particulate matter (PM), fluorides, sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_X), and hydrocarbons. The pollutants considered to be visibility impairing are PM, SO_2, and NO_X.

Aluminum smelters such as the Intalco facility are one of the 26 listed BART source categories. The Intalco plant was constructed in 1965 and has the potential to emit more than 250 tons/year of PM and SO_2. Most of the plant's emission units are BART-eligible. Intalco's major sources of visibility impairing pollutants are three potlines and an anode bake furnace.

Modeling of visibility impairment was done following the Oregon/Idaho/Washington/EPA-Region 10 BART modeling protocol.[1] Modeled visibility impacts of baseline emissions show impacts on the 8th highest day in any year (the 98th percentile value) to be greater than 0.5 deciviews (dv) at seven Class 1 areas. The highest impact was 2.36 dv on Olympic National Park. Modeling showed that SO_2 emissions from the existing dry alumina/baghouse potline emission control system created 94 percent of the facility's total visibility impact.

Intalco prepared a BART technical analysis using Washington State's BART Guidance.[2]

The Washington State Department of Ecology (Ecology) determined that the current level of emissions control is BART for the applicable units at the Alcoa Intalco Works primary aluminum smelter facility. The potlines and anode bake furnace are currently well controlled for particulate emissions. A wet scrubber on each source would be required to control SO_2 emissions. Modeling indicated that addition of a wet scrubber system on the potlines could reduce the visibility impact on Olympic National Park by over a deciview. However, the potline scrubber system's estimated $7,500 cost per ton of SO_2 removed was determined to be excessive.

[1] Modeling protocol available at http://www.deq.state.or.us/aq/haze/docs/bartprotocol.pdf.

[2] "Best Available Retrofit Technology Determinations Under the Federal Regional Haze Rule," Washington State Department of Ecology, June 12, 2007.

Ecology also determined that the wet scrubber would have an excessive capital cost of $234.5 million and unacceptable impacts on solid waste generation, electrical power use, and water consumption. Ecology determined that a scrubber on the anode bake furnace would have an excessive $36,400 cost per ton of SO_2 removed.

1. INTRODUCTION

1.1 The BART Program and Analysis Process

The federal Clean Air Act Amendments of 1977 (CAA) established a national goal of eliminating man-made visibility impairment in all mandatory federal Class I areas. The Act requires certain sources to utilize Best Available Retrofit Technology (BART) to reduce visibility impairment as part of the overall plan to achieve that goal.

Requirements for the BART program and analysis process are given in 40 CFR 51, Subpart P and Appendix Y to Part 51.[3] Sources are "BART-eligible" if they:

1. Fall within 26 specified industrial source categories.
2. Commenced operation or completed permitting between August 7, 1962 and August 7, 1977.
3. Have the potential to emit more than 250 tons/year of one or more visibility impairing compounds including sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM), and volatile organic compounds (VOCs).

Emission units that meet the source category, age, and potential to emit criteria must also make the facility "cause or contribute" to visibility impairment within at least one mandatory federal Class I area for a "BART-eligible facility" to be "subject to BART." Ecology has adopted the "cause and contribute" criteria that the United States Environmental Protection Agency (EPA) suggested in its guideline. BART-eligible units at a source cause visibility impairment if their modeled visibility impairment is at least 1.0 deciview (dv). Similarly the criterion for contributing to impairment means that the source causes a modeled visibility change of 0.5 dv or more.

The BART analysis protocol in Appendix Y to Part 51, Sections III–V uses a 5-step analysis to determine BART for SO_2, NO_X, and PM. The five steps are:

Step 1 – Identify all available retrofit control technologies.
Step 2 – Eliminate technically infeasible control technologies.
Step 3 – Evaluate the control effectiveness of remaining control technologies.
Step 4 – Evaluate impacts and document the results.
Step 5 – Evaluate visibility impacts.

Ecology requires a facility that is "subject to BART" to prepare a BART technical analysis report and submit it to Ecology. Ecology then evaluates the report and makes a BART determination decision. This decision is then issued to the source owner as an enforceable Order, and included in the state's Regional Haze State Implementation Plan (SIP).

[3] Appendix Y to 40 CFR 51–Guidelines for BART Determinations Under the Regional Haze Rule.

As allowed by the EPA BART guidance, Ecology has chosen to consider all five factors in its BART determinations. To be selected as BART, a control has to be available, technically feasible, cost effective, provide a visibility benefit, and have a minimal potential for adverse non-air quality impacts. Normally, the potential visibility improvement from a particular control technology is only one of the factors weighed for determining whether a control constitutes BART. However, if two available and feasible controls are essentially equivalent in cost effectiveness and non-air quality impacts, visibility improvement becomes the deciding factor for the determination of BART.

1.2 The Alcoa Intalco Plant

Alcoa Intalco Works (Intalco) is a primary aluminum smelter facility located in Ferndale, Washington, near Cherry Point along the Strait of Georgia. The facility produces primary aluminum metal by the Hall-Heroult reduction process. It was originally constructed in 1965, and began operation in 1966. Intalco is a Title V source operating under Air Operating Permit No. 000295-0. Primary aluminum ore reduction plants are one of the 26 BART-eligible source categories. Intalco submitted a BART Determination Report to the Washington State Department of Ecology (Ecology) on December 4, 2007 as required by Order #5070.

1.3 BART-Eligible Units at Intalco

A review of the Intalco emission sources found that:

1. All of the plant's individual emission units except for one remelt furnace are BART-eligible by construction date.
2. The individual emission units in total have a potential to emit greater than or equal to 250 tons/year of both sulfur dioxide (SO_2) and particulate matter (PM).
3. A baseline Class I area visibility impact analysis of 2003-2005 emissions using the CALPUFF model indicated impacts for the entire facility exceeded the 0.5 deciview (dv) contribution threshold in at least one Class I area. This confirmed that Intalco was subject to BART, and was required to prepare a BART Determination.

Intalco's primary aluminum reduction operations include three potlines, an electrode manufacturing operation consisting of a paste production operation and a green anode baking furnace, and miscellaneous material handling operations. These units were placed into six groups:

1. Potlines (3)
2. Anode bake furnace (1)
3. Aluminum holding furnaces (12)
4. Various material handling and transfer operations
5. Combustion sources (natural gas, diesel, propane)
6. Other small miscellaneous sources

1.3.1 Existing Potline Emissions Control

The potline operation manufactures metallic aluminum by the electrolytic reduction of alumina in the side-worked prebake cells. Direct electrical current passes between the anodes and the carbon cathode that lines the cell walls. This current electrolytically reduces the alumina to metallic aluminum and oxygen. Molten aluminum is deposited and accumulates over time at the cathode beneath a layer of molten cryolite bath. Periodically the molten aluminum is siphoned from beneath the cryolite bath and processed to achieve specific metal properties or is retained as pure aluminum. The produced aluminum is solidified into intermediate or final products.
The major pollutants emitted from the cells are PM, hydrogen fluoride, SO_2, and carbon monoxide. PM includes particulate fluoride and alumina. SO_2 comes from the sulfur in the petroleum coke and pitch components used to make the anodes that are consumed by the process. NO_X emissions are minimal since there is no external fuel or combustion zone and there are no large sources of nitrogen in the raw materials.

The potlines at Intalco consist of six potroom groups of electrolytic reduction cells connected in series that produce molten aluminum. There are two potroom groups per potline. Each potroom is comprised of 120 reduction cells (or pots) with 18 anodes per cell. All pots at Intalco are hooded to control emissions. Emissions captured by the hoods are drawn through one of six primary control systems. Each primary control system consists of a dry alumina injection system followed by a baghouse for the control of PM and fluoride emissions. The six primary control systems are located in the courtyards between the potrooms. The system at Intalco is large, treating approximately 1,815,000 acfm of 180°F exhaust gases. This primary PM control system has an efficiency of about 97.7 percent.

A small fraction of the pot emissions escape capture by the hoods and are released inside the potrooms. These secondary emissions are drawn through a secondary control system which consists of a series of 159 wet roof scrubbers that control PM and fluoride emissions. PM control efficiency for this secondary system is approximately 82 percent.

1.3.2 Existing Anode Bake Furnace Emissions Control

Anodes are manufactured in an ancillary on-site anode plant. Purchased calcined petroleum coke and anode butt material is crushed and sized, mixed together with pitch, and formed into blocks called "green anodes." The green anodes are then cooled prior to being baked in the anode bake furnace. Only after the anodes have been baked can they be used in the potlines.

The anode bake furnace structure is a series of interconnected refractory flues connected to side main exhaust manifolds. The furnace is fueled with natural gas. Exhaust gases are routed so that flue gases preheat the next section of the furnace to be fired. Flue gases from the anode bake furnace contain PM, hydrogen fluoride, SO_2, NO_X, carbon monoxide, and hydrocarbons.

The bake furnace emissions are controlled by an alumina dry scrubber which is similar to the ones used for the potline primary control system. The bake oven gas stream is cooled by a water spray to reduce the inlet temperature before it enters the scrubber. Fresh and recycled alumina are injected into the gas stream, gaseous fluoride and polycyclic organic matter (POM) are adsorbed onto the alumina surface, and fabric filters on top of the reactor compartments collect entrained particulate matter present in the gas stream. The control system for the anode bake furnace treats approximately 216,000 acfm of 205°F exhaust gases. The fabric filters reduce PM emissions by as much as 99 percent.

1.3.3 Existing Aluminum Holding Furnace Emissions Control

The 12 holding furnaces at Intalco vary in size. They are heated by natural gas burners. The largest of these furnaces has a natural gas rated burner rated at 22 MMBtu/hr. There are no emission controls associated with the aluminum furnaces at Intalco. Emissions come from combustion of natural gas in the burners and the activities associated with treating molten metal while being processed in the furnaces.

1.3.4 Existing Controls for Material Handling and Transfer Operations, Other Natural Gas Combustion, and Other Small Miscellaneous Sources

The remaining emission units are various material handling and transfer operations, natural gas, diesel, and propane combustion, and other small miscellaneous sources that support the potlines, anode bake furnace and holding furnace operations. Aside from the natural gas combustion products, emissions from most of the support operations consist of relatively small amounts of PM that are controlled by fabric filter-type control devices. Fabric filters effectively remove about 99 percent of particulate emissions.

Natural gas consumption is mostly in the previously discussed anode bake furnace and aluminum holding furnaces. The balance comes from burners in the paste plant. Propane is used in forklifts. There are five small auxiliary diesel generators.

2. BART TECHNOLOGY ANALYSIS

The Intalco BART technology analysis was based on the 5-step process defined in BART guidance and listed in Section 1.1 of this report. Intalco's analysis included a review of available and technically feasible retrofit technologies (Steps 1 and 2), determination of control effectiveness for feasible options (Step 3), evaluation of cost and secondary impacts for feasible alternatives (Step 4), and analysis of impacts and visibility improvements (Step 5). The analysis looked at controls for SO_2, PM, and NO_X from each category of emission units: the potlines, anode bake furnace, aluminum holding furnaces, handling and transfer operations, combustion sources, and other small sources.

2.1 Potline Control Options

2.1.1 SO_2 Control Options

Eight different SO_2 add-on control options along with pollution prevention were considered as having potential application for potline SO_2 emission control. Six of the control options use wet scrubbing and two use dry scrubbing technology. A description of each technology is found in Appendix A.

Wet Scrubbing Technologies

- Limestone slurry scrubbing with forced oxidation (LSFO)
- Limestone slurry scrubbing with natural oxidation (LSNO)
- Conventional lime wet scrubbing
- Seawater scrubbing
- Dual alkali sodium/lime scrubbing (dilute mode)
- Conventional sodium scrubbing

Dry Scrubbing Technologies

- Dry sorbent injection
- Semi-dry scrubbing (spray dryer)

Limestone Slurry Forced Oxidation (LSFO) was determined to be a technically feasible wet scrubbing retrofit control option for the potroom reactors even though it is not ideally suited for scrubbing SO_2 concentrations that are less than or equal to 105 ppm. LSFO was also selected to be the best choice of the wet scrubbing technologies.

Dry sorbent injection downstream of the potline reactor fabric filters is not technically feasible because of the low temperatures (less than or equal to 205°F) and low SO_2 concentrations (less than or equal to 105 ppm). Spray dry scrubbing downstream of the potline reactors fabric filters is not technically feasible because of the low temperatures (less than or equal to 205°F) and low SO_2 concentrations (less than or equal to 105 ppm).

Pollution Prevention

The guidelines for BART determinations under the Regional Haze Rule recommend consideration of pollution prevention options in addition to add-on controls. The primary opportunity for pollution prevention in the smelting process to minimize SO_2 emissions is through controlling the sulfur content in the incoming petroleum coke used to make the anodes.

Intalco's Title V operating permit currently has a number of operational limits that cap allowable emissions of SO_2 from the facility, including a net potline aluminum production limit of 307,000 tons/year; a daily potline SO_2 limit of 37,780 lb/day; limits on sulfur in coke and pitch at 3.0 percent and 0.6 percent, respectively; and a carbon consumption limit of 0.425 pounds of carbon per pound of aluminum produced.

The current levels of sulfur in petroleum coke used by other aluminum smelters was evaluated to determine whether a pollution prevention option using lower sulfur content coke would be a feasible BART option for Intalco. This analysis indicated that some smelters currently utilize coke with sulfur contents as low as two percent. An analysis was also done to determine whether coke with sulfur levels below three percent can be anticipated to be available into the future. The primary conclusions from this analysis indicate that:

- There will be a continuing increase in the sulfur content of available coke. Low sulfur crude oil supplies are becoming less available and more expensive for petroleum refineries. In the future, refineries with coking capacity are expected to minimize their raw material costs by using more of the higher sulfur crude oils and oil sands that are less costly.
- As oil fields age, the sulfur content of the crude oil is known to increase and the crude oil in the fields becomes more viscous and harder to extract. This effect is expected to increase the sulfur content of the petroleum materials available to produce anode grade coke.
- Coke is a relatively small, low revenue component of a refinery's product profile. It is a low value product made from the thick, tar-like refinery wastes left over after all of the more valuable components have been removed from the petroleum crude. The aluminum industry has little influence in controlling the quantity, quality, and price of the coke produced by refineries.
- Global primary aluminum production is expected to grow, resulting in a commensurate growth in demand for anode grade coke. Growth in aluminum production will continue to outpace the growth in coke production.
- Coke providers are blending imported, high cost, lower sulfur coke with domestically sourced coke in attempts to meet the current specification requirements for coke.
- Removal or reduction of the sulfur content of the coke once it has been received is not feasible.

Feasible SO_2 Control Options from RBLC Database

The data in the USEPA's RACT/BACT/LAER (RBLC) database supports the approach of limiting raw material sulfur content as a control option for the potlines and the anode bake furnace. Many facilities have limited sulfur content in coke to limit SO_2 emissions. Two facilities have limits of three percent sulfur content in coke and one has a 2.95 percent sulfur content limit. One facility is shown in the RBLC to have a wet scrubber to control SO_2 emissions;[4] however, an investigation revealed that the wet scrubber was not required as part of a best available control technology (BACT) determination and that the facility currently does not operate a wet scrubber to control SO_2 emissions. That facility's current Title V permit for "Potline 5" limits coke sulfur content to three percent, coal tar pitch sulfur to 0.8 percent, potline SO_2 emissions to 364.52 lb/hr from the primary emissions control unit, 7.44 lb/hr from the roof

[4] RBLC ID ky-0070 for NSA–A division of Southwire Company on Potline 5 now Century Aluminum of Kentucky, LLC, Kentucky Title V Permit #V-01-019.

scrubbers, and 49.356 lb/ton of aluminum produced. Alcoa Intalco has a current limit of 44.8 lb SO_2 emitted per ton of aluminum produced.

Cost and Other Impacts of Feasible SO_2 Potline Controls

Wet scrubber costs for Intalco were estimated based on cost quotes received by Alcoa from two flue gas desulphurization equipment vendors. The cost quotes were originally provided as part of the BART analysis for Alcoa's Tennessee Operations in Alcoa, TN. Both vendors provided cost proposals for wet scrubbing systems based on LSFO scrubbers. Lime or sodium based scrubbers could also be used for potlines, but lime and sodium are less desirable reagents considering that these reagents are much more expensive. An advantage of the limestone forced oxidation process is that the spent slurry is oxidized to gypsum, which dewaters more efficiently, resulting in less waste materials requiring disposal. An LFSO scrubber was determined to be the most appropriate control device for the cost analysis.

Neither of the two vendors provided a comprehensive installed cost estimate. Both preliminary designs were based on a central scrubbing center as the least cost approach, where exhaust from all dry scrubbing systems would be ducted to a centralized scrubbing system. Both design estimates were based on systems that would provide 100 percent availability of emissions control on each day of the year, given that potlines cannot be easily shutdown and restarted for control system outages. To achieve this 100 percent availability, the proposed designs includes two scrubber towers, one to be active, and one to be held in reserve.

The capital and total annualized costs for a potline wet scrubber system as proposed was $234.5 million and 46.8 million per year, respectively. The wet scrubber cost effectiveness was $7,500 per ton of SO_2 removed. A lower cost option based on a single absorber tower was analyzed by Ecology. A discussion of this option is included in Section 4, Ecology's BART determination.

The LSFO scrubber process oxidizes the spent slurry to gypsum sludge. The sludge volume would be 27,130 tons annually from the potline wet scrubber. It was not known at the time of the BART report preparation whether the gypsum would have commercial value or whether there would be any demand for it. If not sold, the sludges must be land filled.

It is estimated that 182.5 million gallons of water will be required annually to operate the potline wet scrubber at a cost of approximately $97,000. This would increase Intalco's daily water demand by approximately nine percent.

A total of approximately 64.8 million kWh would be needed to operate the potline scrubber annually. This is equivalent to adding over 6,000 new households to the community.[5] Table B-2 in Appendix B summarizes the impacts analysis.

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[5] Calculated based on 2001 average energy usage per household for the U.S. as reported by the Department of Energy. See http://www.eia.doe.gov/emeu/reps/enduse/er01_us_tab1.html.

Cost of anode grade coke is predicted to continue to rise in the future, as discussed in the previous pollution prevention section. Both increasing demand by the aluminum industry and the need of refineries to move toward using higher sulfur containing crude oil stocks drive Intalco's prediction. US Gulf calcined anode grade coke increased from $118.50/mt to $244.75/mt between 1994 and 2006. The future rate of cost increase is anticipated to be greater due to the reasons discussed in the pollution prevention section.

2.1.2 PM Control Options

Fabric Filters

Fabric filters generally provide high collection efficiencies for both coarse and fine (submicron) particles. They are relatively insensitive to fluctuations in gas stream conditions. Efficiency is relatively unaffected by large changes in inlet dust loadings. Filter outlet air is very clean.[6] Collected material is dry, which usually simplifies processing or disposal. Fabric filters are currently applied for controlling PM emissions from the potrooms at Intalco.

Electrostatic Precipitators

Electrostatic Precipitators (ESPs) are capable of very high removal efficiencies for large and small particles.[7] They offer control efficiencies that are comparable to fabric filters. Because of their modular design, ESPs, like fabric filters, can be applied to a wide range of system sizes. The operating parameters that influence ESP performance include particulate mass loading, particle size distribution, particulate electrical resistivity, space velocity, and precipitator voltage and current.

Dusts with high resistivities are not well-suited for collection in dry ESPs because the particles are not easily charged. An ESP is technically feasible for control of PM from the potrooms at Intalco.

Fabric filtration with dry alumina scrubbing has been widely used in the primary aluminum industry. Most smelters constructed within the past 20 years have used dry alumina scrubbing (either alumina injection or fluidized bed) with fabric filters to control particulate and fluoride emissions from potlines. A few plants use control systems consisting of ESPs to collect PM followed by spray towers to scrub gaseous fluoride. Wet systems have many disadvantages, such as corrosion by hydrofluoric acid, scaling, and acidic wastewater. ESPs and wet systems are no longer installed on new smelters in the U.S.

[6] EPA 2003, "Air Pollution Control Technology Fact Sheet–Fabric Filter," EPA-452/F-03-025, August 7.
[7] EPA 2003, "Air Pollution Control Technology Fact Sheet–Dry Electrostatic Precipitator," EPA-452/F-03-028, August 7.

Cyclones, Inertial Separators, and Wet Scrubbers

Cyclones and inertial separators are used for collection of medium-sized and coarse particles. Wet scrubbers generally remove large particles and can remove small particles with the use of high-pressure drops. However, none of these devices are as effective at removing small and submicron particles as fabric filters and ESPs.[8]

Cost and Other Impacts of Feasible Particulate Potline Controls

Fabric filters are currently used on Intalco's potlines. Since fabric filters have high control effectiveness similar to ESPs, are widely used for potline particulate control in the aluminum industry, and have process advantages relative to ESPs, no benefit was seen to switch from fabric filters to ESPs for PM control. Because no benefit was seen, no cost analysis of switching to an ESP-based particulate control was done.

2.1.3 NO_X Control Options

Potentially applicable NO_X emission controls include combustion controls and post-combustion controls. The pots are heated solely through the action of the electric reduction process. There is no combustion of fuel. There are also no large sources of nitrogen in the raw materials. This makes use of traditional combustion controls like staged combustion or low NO_X burners not applicable to the potlines. The temperature of the potroom exhaust is approximately 180°F and the NO_X concentration is less than one parts per million (ppm).

Possible post combustion controls include Selective Non-Catalytic Reduction (SNCR) and Selective Catalytic Reduction (SCR). Both involve injecting ammonia or urea into the gas stream to react with NO_X to produce nitrogen and water. SNCR requires an operating temperature of 1,600°F to 2,100°F and inlet NO_X concentrations typically from 200 to 400 ppm to be about 30-50 percent effective. SCR uses a catalyst to reduce the operating temperature requirement to between 500°F to 800°F, and can achieve up to 90 percent reduction of inlet NO_X concentrations to as low as 20 ppm.

Since there is no external fuel or combustion zone in the smelting cells, there are no technically feasible pre-combustion NO_X controls. Low temperature and NO_X concentration make both SNCR and SCR post process NO_X controls technically infeasible.

2.1.4 Intalco's BART Proposal for the Potlines

For potline SO_2 emissions, Intalco proposed BART to be the current level of control, which includes a maximum of three percent sulfur in the coke used to manufacture anodes. Use of wet scrubbing technology to reduce potline SO_2 emissions was rejected as BART due to excessive costs: total cost effectiveness of $7,500 per ton of SO_2 removed and capital and total annualized

[8] AWMA 2000, "Air Pollution Engineering Manual," Second Edition.

costs of $234.5 million. A potline wet scrubber would also have substantial non air quality impacts, including increased energy usage, added water consumption, and solid waste generation.

For PM emissions, Intalco proposed BART to be the current level of control, which is the use of baghouses to control PM emissions from the alumina dry scrubbers, and wet roof scrubbers to control secondary PM emissions from the potroom roofs.

For NO_X emissions, Intalco proposed BART to be no controls.

2.2 Anode Bake Furnace Control Options

The anode bake furnace process is discussed in Section 1.3.2 of this report. Emissions due to anode coke and pitch are similar to those from the potlines, so the same BART control options considered for the potlines are applicable to the bake furnace emissions exhaust. It is smaller, with only about 12 percent of the airflow volume of the combined potlines emission scrubber. It is natural gas fired rather than electrically heated, so it has products of combustion including NO_X.

2.2.1 SO_2 Control Options

A wet scrubber was identified as a technically feasible add-on pollution control option for the anode bake furnace. The anode bake furnace is a smaller source than the potlines and has a lower exhaust gas flow rate. A separate vendor cost proposal was not obtained for the anode bake furnace, but an SO_2 removal efficiency of 95 percent is assumed to be feasible. Wet scrubber costs for the anode bake furnace were scaled from the LSFO potline wet scrubber vendor quotes.

The estimated installed capital cost to add a wet scrubber to remove 95 percent of the SO_2 from the anode bake furnace exhaust would be approximately $29.5 million with an annualized cost of $6.3 million per year. The wet scrubber cost effectiveness is $36,400 per ton of SO_2 removed. The wet scrubber also has an energy impact of 6,570,000 kW-hr/yr as well as solid waste impacts associated with disposal of gypsum sludge from the scrubber and water use impacts from scrubber operation. The impacts are summarized in Table B-2 of Appendix B.

The pollution prevention option of reducing the sulfur content of the anode coke is available for the anode bake oven as well as the potlines. See the potline pollution prevention discussion in Section 2.1.1.

2.2.2 PM Control Options

Dry alumina injection with fabric filtration is currently used for PM control on the anode bake furnace. An ESP is also a technically feasible control, with a similar fine particulate PM capture efficiency. As described in Section 2.1.2, cyclones, inertial separators, and wet scrubbers are not as effective at removing small and submicron particles as fabric filters and ESPs.

2.2.3 NO_X Control Options

Advanced firing system: NO_X emissions from anode baking depend on operating practices and burner controls. The traditional methods of preventing NO_X formation using staged combustion or low NO_X burners are not applicable because of the unique configuration of an anode baking ring furnace, with fuel injected at several points in narrow flues. However, advanced firing systems that measure and regulate fuel flow precisely using a computerized control system can reduce total fuel usage. This will also reduce NO_X emissions. Prevention of NO_X formation using a more efficient advanced firing control system is technically feasible for the anode bake furnace at Intalco. Total gas usage is projected to be reduced by 20 percent, which would result in a corresponding 20 percent reduction in NO_X emissions, or approximately 27 tons/year.

The LoTO$_X$™ system is the patented technology of BOC Gases. In this NO_X removal system, ozone is injected into the exhaust gas stream in order to oxidize insoluble NO_X to soluble nitrogen compounds, including N_2O_5. N_2O_5 is highly soluble and reacts with moisture in the gas stream to form nitric acid. A scrubber is required downstream of the LoTOx™ system to remove the nitric acid formed by the reaction of N_2O_5 and moisture in the gas stream. The ozone is typically generated on site and on demand. Since LoTOx™ is a low temperature system, it does not require heat input and the low operating temperature (150 to 250°F) allows for stable and consistent control even with variations in flow, load, and NO_X concentrations.[9]

Use of the LoTOx™ system has not been demonstrated at an aluminum plant. Research indicates that application of the LoTOx™ technology has been limited to a sulfuric acid regeneration plant, a lead smelting reverbatory furnace, a stainless steel plant, a coal-fired electric generation unit, and two fluidized-bed catalytic cracking units (FCCU) at refineries.[10] [11] Reported NO_X removal efficiencies for the LoTOx™ system are on the order of 90 to 95 percent.

The temperature of the anode baking emission exhaust (approximately 200°F) is within the temperature range where LoTOx™ could be used. Although this technology has not been demonstrated on an anode bake furnace, low-temperature oxidation technology may be technically feasible for reducing anode bake furnace NO_X emissions. At a control efficiency of 90 percent for NO_X emissions when combined with wet scrubbing, the resulting reduction in NO_X emissions would be 122 tons/year.

Intalco made the case that cost data for the LoTOx™ system was not readily available. To show some cost estimation, Intalco noted that the LoTOx™ system would also require a scrubber

[9] BOC Process Gas Solutions, 2001, Low Temperature Oxidation System Demonstration at RSR Quemetco, Inc., City of Industry, California, June 28. See www.arb.ca.gov/research/icat/projects/boc.pdf.
[10] EPA, February 2005, "Using Non-Thermal Plasma to Control Air Pollutants," EPA-456/R-05-001. See www.epa.gov/ttn/catc/dir1/fnonthrm.pdf.
[11] EPA RACT/BACT/LAER Clearinghouse (RBLC) database.

similar to the one described earlier for SO_2 control. That would make the cost of the entire LoTOx™ system installation more than the previously estimated SO_2 scrubber cost of $29.5 million. NO_X emissions are lower than SO_2 emissions for the anode bake furnace, so the cost per ton values for NO_X would be higher than the $36,400 estimated for SO_2. Since cost for the LoTOx™ system itself was not available, it is not possible to calculate a cost per ton for the total system based on both NO_X and SO_2. To give a sense of the possible minimum cost, if the LoTOx™ system were free, the cost would be greater than $18,000 per ton of total pollutants removed.

2.2.4 Intalco's BART Proposal for the Anode Bake Furnace

Intalco proposed that the existing potline SO_2 control pollution prevention limit of three percent sulfur in the coke to be BART for anode bake furnace SO_2 emissions. The cost effectiveness of wet scrubbing to reduce SO_2 emissions was determined to be excessive at $36,400 per ton of SO_2 removed. As discussed below in Section 3, addition of a wet scrubber to the anode bake furnace would reduce the visibility impact on Olympic National Park by only 0.024 dv.

The existing level of control (based on baghouses on the alumina dry scrubbers) was proposed to be BART for PM emissions.

BART for anode bake furnace NO_X emissions was proposed to be no additional controls. The use of an advanced firing system for reduced energy use was rejected as BART because the 20 percent reduction in NO_X emissions would result in a negligible 27 ton per year NO_X reduction and visibility improvement. Emissions of all pollutants (SO_2 and NO_X) from the anode bake furnace are responsible for only about one percent of the visibility impact on Olympic National Park; the most impacted Class I Area (see Section 3 below). The use of LoTOx™ was rejected as BART because the technology is not available or demonstrated in practice for aluminum anode bake furnace exhausts.

2.3 Aluminum Holding Furnaces

2.3.1 Aluminum Holding Furnaces Control Options

The 12 holding furnaces at Intalco are heated by natural gas burners, and vary in size, with the largest of these furnaces having a natural gas rated burner capacity of 22 MMBtu/hr. Emissions come from combustion of natural gas in the burners. There is currently no emission controls associated with the aluminum furnaces at Intalco.

2.3.2 Intalco's BART Proposal for the Aluminum Holding Furnaces

Intalco proposed that BART for the aluminum holding furnaces was no controls. The proposal rejected additional controls as BART because the modeling analysis discussed in Section 3 below showed that any visibility improvement would be negligible because the existing burners have a negligible contribution to visibility impacts.

2.4 Material Handling and Transfer Operations

2.4.1 Material Handling and Transfer Operations and Other Miscellaneous Operations Control Options

The remaining emission units are various material handling and transfer operations, natural gas, diesel, and propane combustion, and other small miscellaneous sources that support the potlines and anode bake furnace. Aside from emissions from natural gas combustion, emissions from most of the support operations consist of relatively small amounts of PM that are controlled by fabric filter control devices.

2.4.2 Intalco's BART Proposal for the Material Handling and Transfer Operations

Intalco showed that PM emissions from the BART-eligible material handling and transfer operations were all controlled using fabric filter technology. This existing level of emissions control was proposed to be BART for these material handling and transfer operations.

3. VISIBILITY IMPACTS AND DEGREE OF IMPROVEMENT

A baseline Class I area visibility impact analysis was performed on the BART-eligible emission units at Intalco using the CALPUFF model with four kilometer grid spacing as recommended by the Oregon/Idaho/Washington/EPA-Region 10 BART modeling protocol. The modeled or projected 98^{th} percentile visibility impacts for the entire facility exceed the 0.5 deciview (dv) contribution threshold in seven Class I areas as shown in Table 3-1.

Table 3-1. BASELINE VISIBIITY MODELING RESULTS

Class I Area	2003		2004		2005	
	Modeled 98^{th} Percentile (deciview)	Number of Days Exceeding 0.5 dv	Modeled 98^{th} Percentile (deciview)	Number of Days Exceeding 0.5 dv	Modeled 98^{th} Percentile (deciview)	Number of Days Exceeding 0.5 dv
Alpine Lakes Wilderness Area	1.244	36	0.965	37	0.881	23
Goat Rocks Wilderness Area	0.500	8	0.579	10	0.317	3
Glacier Peak Wilderness Area	1.161	37	1.156	38	0.736	23
Mount Adams Wilderness Area	0.456	7	0.472	6	0.357	2
Mount Rainier National Park	0.843	22	1.052	26	0.629	15
North Cascades National Park	1.376	65	1.395	56	1.138	32
Olympic National Park	2.363	59	1.858	53	2.136	45
Pasayten Wilderness Area	0.866	30	0.871	33	0.659	13

Intalco's modeling consultant evaluated the effects of the different emission sources at the Intalco facility to determine which operations resulted in the greatest visibility impacts. This analysis indicated that the potlines are responsible for 98 percent of the visibility impact on the most impacted Class I area, and 96 percent of that impact is from the SO_2 emissions. Of the remaining two percent of the visibility impact, the anode bake furnace is the next largest source at about one percent of the impact. The other sources in total are the sources of the remaining one percent of the impact.

An evaluation of the potential improvement in visibility that would result from application of feasible pollution prevention/add-on control options was done. CALPUFF modeling was performed for two control scenarios: one with wet SO_2 scrubbing applied to the potline and one with wet SO_2 scrubbing applied to the anode bake furnace. In general, this modeling was the same as the baseline modeling except stack data and emission data associated with the application of the feasible add-on controls were used as model inputs. Emission information for both baseline and control scenario modeling is found in Appendix B.

The addition of a potline wet scrubber reduced modeled visibility impacts in all Class I areas. For example, the baseline modeling results indicate that the highest 98^{th} percentile visibility impact from Intalco's BART-eligible sources at Olympic National Park estimated that wet scrubbers installed on the potlines would provide up to 1.172 dv of visibility improvement. The modeled visibility improvements from adding a wet scrubber at the anode bake furnace only are much smaller. The post-control modeling results for the anode bake furnace indicate visibility might be improved by up to 0.024 dv at Olympic National Park.

4. ECOLOGY'S BART DETERMINATION

Ecology's BART determination for Intalco is given in Table 4-1. A more detailed description of each decision follows.

Table 4-1. BART DETERMINATION FOR INTALCO

Pollutant	BART Determination
	Potlines
SO_2	Use of the current level of control, which is a pollution prevention limit of 3% sulfur in the coke used to manufacture anodes.
PM	Use of the current level of control, which is the use of baghouses to control PM emissions from the alumina dry scrubbers, and wet roof scrubbers to control secondary PM emissions from the potroom roofs.
NO_X	No control
	Anode Bake Furnace
SO_2	Use of the current level of control, which is a pollution prevention limit of 3% sulfur in the coke used to manufacture anodes.
PM	Use of the current level of control, which is the use of a baghouse.
NO_X	No control
	Aluminum Holding Furnaces
SO_2	No control

Pollutant	BART Determination
PM	No control
NO_X	No control
	Material Handling and Transfer Operations
SO_2	No control
PM	Use of the current level of control, which is use of fabric filters.
NO_X	No control

Aluminum Potlines

Ecology determined that for SO_2 emissions from the potlines, BART is the current level of control, which is a pollution prevention limit of three percent sulfur in the coke used to manufacture anodes.

Ecology agrees with Intalco that a pollution prevention limit based on coke sulfur content below three percent is infeasible as BART based on an evaluation of the future availability of petroleum coke with lower sulfur content.

Ecology rejected the use of wet scrubbing technology as BART to reduce potline SO_2 emissions because of its excessive costs. For the proposed two absorption tower design, the annualized cost was $7,500 per ton of SO_2 removed. The capital and total annualized costs were estimated to be $234.5 million and $46.8 million per year, respectively.

A single absorption tower design option was included in one of the two original Tennessee plant scrubber system proposals (by Babcock), but not evaluated in Intalco's BART proposal. This design would cost less, but would eliminate having a backup scrubber tower. If the scrubber tower needed to be taken down for maintenance, the emission gasses would need to be bypassed, creating the same emissions as the current operation. Babcock estimated that the single tower design reduced the Total Capital Investment Costs (TCIC) by 28.1 percent, or to 71.9 percent of their two scrubber system proposal. Ecology scaled this cost reduction to the Intalco cost estimate, and included additional cost reductions in annual operating labor and maintenance labor as much as practical. The resulting capital and total annualized costs were $185.1 million and $38.7 million respectively. This gave a cost effectiveness of $6,145 per ton of SO_2 removed assuming an identical SO_2 removal rate. Any direct venting of the emission gasses would lower the SO_2 tons removed and increase this dollars/ton cost effectiveness estimate. Ecology determined these costs to be not cost effective also.

A potline wet scrubber would also have substantial energy and non air quality impacts, including increased energy usage of 64,824,000 kWh of electricity per year, added water consumption of 183 million gallons per year, and solid waste generation of 27,000 tons/year.

Ecology determined that for PM emissions from the potlines, BART is the current level of control, which is the use of baghouses to control PM emissions from the alumina dry scrubbers, and wet roof scrubbers to control secondary PM emissions from the potroom roofs.

Ecology determined that there are no feasible technologies for the control of NO_X from the potlines. BART for NO_X is determined to be no controls.

Anode Bake Furnace

Ecology determined that the petroleum coke sulfur limit accepted as BART for the potlines is also BART for anode bake furnace SO_2 emissions. The cost of wet scrubbing to reduce SO_2 emissions would be excessive at $36,400 per ton of SO_2 removed while providing minimal visibility improvement.

Ecology determined that the existing level of control (based on baghouses on the alumina dry scrubbers) is BART for PM emissions.

Ecology determined that BART for anode bake furnace NO_X emissions is no controls. The use of an advanced firing system for reduced energy use was rejected as BART because the technology would result in a negligible emission reduction and visibility improvement. Similarly, the use of LoTOx™ was rejected as BART because the cost of the technology would be excessive and it has not been demonstrated in practice on aluminum plant anode bake furnaces.

Aluminum Holding Furnaces

Ecology determined that BART for the aluminum holding furnaces is no controls. The use of additional controls was rejected as BART because any visibility improvement would be negligible due to the low level of emissions from the natural gas-fired burners.

Material Handling and Transfer Operations

Ecology determined that since PM emissions from the BART-eligible material handling and transfer operations are all controlled using fabric filter technology, the existing level of emissions control is BART for these material handling and transfer operations.

Ecology determined that BART for NO_X and SO_2 emissions from material handling and transfer operations is no controls. Material handling and transfer operations are a negligible source of NO_X and SO_2 emissions. Additional control of these pollutants would provide negligible visibility improvement.

APPENDIX A

DESCRIPTION OF AVAILABLE SO_2 POTLINE CONTROL OPTIONS

Technology	Description
Limestone Slurry Forced Oxidation (LSFO)	Limestone slurry forced oxidation (LSFO) is used extensively in the utility flue gas desulphurization (FGD) market. It has not been used on an aluminum smelter. The raw material is finely ground limestone. The most commonly used equipment is an open, multi-level, countercurrent spray tower scrubber equipped with spray nozzles to inject the limestone slurry droplets into the gas stream. Liquor is collected at the bottom of the tower and sparged with air to oxidize the calcium sulfite to calcium sulfate to enhance the settling properties of the calcium sulfate. Recirculation pumps circulate the scrubbing liquor to the spray nozzles. SO_2 removal efficiencies of 90% have been achieved. The bleed from the scrubber is sent to a dewatering system to remove excess moisture. For an aluminum smelter, the process will produce either solid gypsum waste or commercial-grade gypsum suitable for reuse as a cement additive if a cement production facility is available and willing to accept the material. Only a very small purge or blowdown stream is required.
Limestone Slurry Natural Oxidation (LSNO)	Limestone slurry natural oxidation (LSNO) is very similar to LSFO. The major difference is the absence of an oxidation stage. The gypsum/calcium sulfite product is essentially a waste product with limited possibilities of use for agricultural purposes.
Conventional Lime Wet Scrubbing	Conventional lime wet scrubbing is also similar to LSFO except that the raw material is hydrated lime or quick lime that is either slaked on-site or purchased in the slaked form. The system typically uses forced oxidation, although natural oxidation is possible. The process will produce either solid gypsum waste or commercial-grade gypsum suitable for reuse as a cement additive if a cement production facility is available and willing to accept the material.
Seawater Scrubbing	Seawater scrubbing is a method for controlling SO_2 emissions in which seawater is used to absorb SO_2 in exhaust gases. Seawater is slightly alkaline (with a pH of approximately 8). SO_2 has a high solubility in seawater. Absorbed SO_2 is subsequently oxidized to sulfates by the use of aeration and the pH is adjusted by the addition of additional seawater. There are three main steps in this process: absorption, oxidation, and neutralization. Seawater is passed countercurrent through the gaseous exhaust stream, typically using a spray column in the aluminum industry. SO_2 preferentially dissolves in the seawater. Removal efficiencies of 85 to 95% have been measured in practice. The clean

Technology	Description
	exhaust gas is de-misted prior to release to the atmosphere. The acidified seawater is then passed to an oxidation basin in which air is blown through the effluent. The additional oxygen ensures that the dissolved SO_2 is converted to sulfates. Finally, additional fresh seawater is added to raise the pH to neutral (or slightly alkaline) and the seawater is discharged back into the ocean. The effluent from this process will typically have a temperature increase of about 1°C and will have a change in sulfate concentration of approximately 2 to 5% above background.[12] [13] Scrubbing of the potline emissions also adds fluoride and trace amounts of polycyclic aromatic hydrocarbons (PAHs) to the effluent seawater. The volume of seawater required varies with exhaust flow rate and SO_2 loading in the gaseous exhaust stream. At Intalco, the volumetric flow rate needed was estimated to be approximately 2.2 million gallons per hour. A global review of feasible control technologies identified seawater scrubbing as having been installed at seven aluminum smelters, none of which are in the U.S. Even though this technology has been identified as a control technology in operation at six primary aluminum ore reduction plants in Norway and one primary aluminum ore reduction plant in Sweden, there are two reasons why this technology is not feasible at Intalco: 1. Federal Clean Water Act Section 304(b) effluent limitations guidelines would not allow discharge of the scrubber solutions to the nearby salt water without extensive treatment to remove the sulfides, fluorides, and other pollutants. Removal of potline fluoride from the seawater scrubber effluent may be feasible, but would also require precipitation of many other naturally occurring salts in the seawater (chlorides, sulfates, other fluorides, etc.), resulting in the unnecessary generation of large amounts of sludge for land disposal. Seawater scrubbing is, therefore, not a viable alternative for smelters in the U.S., especially when compared with other scrubbing technologies that use fresh water and require treatment/disposal for only those salts present in the potline exhaust. 2. The portion of Puget Sound where seawater would be withdrawn and discharged has been included as part of the Cherry Point

[12] Information from the ALSTOM Seawater FGD–Environmental Impact website at www.environment.power.alstom.com/home/power/seawater_fgd/environmental_impact.htm.
[13] Kwawaji, Akili D., et al. 2005. "Seawater Scrubbing for the Removal of Sulfur Dioxide in a Steam Turbine Power Plant." Proceeding of the PWR2005 ASME Power Conference. April 5-7. Chicago, IL.

Technology	Description
	Aquatic Reserve that was established in 2000. The construction of intake and/or discharge structures within the Cherry Point Aquatic Reserve would require an impact analysis, assessment, and DNR authorization of any environmental impacts associated with a seawater scrubbing system. Since more than seven years have passed since Cherry Point was designated as an aquatic reserve and the initial SEPA evaluation has yet to be completed, the time required to complete an analysis of the environmental impacts associated with a seawater scrubbing system and obtain the requisite authorizations for a system that withdraws seawater from and discharges scrubber liquor into the Cherry Point Aquatic Reserve would make this technology infeasible for BART compliance.
Dual Alkali Sodium/Lime Scrubbing (dilute mode)	Dual alkali sodium/lime scrubbing (dilute mode) uses a caustic sodium solution in the scrubber tower. A portion of the scrubbing liquid is discharged to a neutralization stage where lime slurry is used to regenerate the caustic, which is returned to the scrubber. The bleed from the scrubber is sent to a dewatering system to produce a gypsum byproduct. The process will produce either solid gypsum waste or commercial-grade gypsum suitable for reuse as a cement additive. Dual alkali sodium/lime scrubbing (dilute mode) is not currently marketed by major FGD vendors because the system is too complicated and expensive. Because of lack of availability and anticipated excessive cost, dual alkali sodium/lime scrubbing is determined to be not technically feasible.
Conventional Sodium Scrubbing	Conventional sodium scrubbing has been installed in at least 12 aluminum smelters around the world. No installations are in the U.S. An alkaline solution of either soda ash or sodium hydroxide is pumped into the scrubbing tower and recirculated through a network of spray nozzles. Atomized droplets contact the up-flowing gas containing SO_2. Where this technology has been deployed, the liquid effluent containing dissolved salts, including sodium and fluorides, has been discharged into a large receiving stream or an open body of water without treatment. As discussed earlier, untreated discharge is not feasible for Intalco, so conventional sodium scrubbing is determined to be not technically feasible.
Dry Injection	In dry injection, a reactive alkaline powder is injected into a furnace, ductwork, or a dry reactor. Typical removal efficiencies with calcium adsorbents are 50 to 60% and up to 80% with sodium base adsorbents. However, as with wet scrubbing, disposal of waste using sodium adsorbents must consider their high solubility in water compared to

Technology	Description
	those from calcium adsorbents. The temperature range over which scrubbing has been used is 300 to 1,800°F; the minimum temperature is 300 to 350°F. Dry systems are rarely used and according to EPA, only 3% of FGD systems installed in the U.S. are dry systems.[14] The dry waste material is removed using particulate control devices such a fabric filter or an electrostatic precipitator (ESP).
Semi-Dry Scrubbing	Semi-dry scrubbing is more commonly referred to as spray drying. Calcium hydroxide slurry (lime mixed with water) is introduced into a spray dryer tower. Sodium compounds can be used, but as with the dry scrubber, the high solubility of the sodium-based waste products in water complicates disposal of the waste. The slurry is atomized and injected into a reactor with the exhaust gases, where droplets react with SO_2 as the liquid evaporates. This system is categorized as a semi-dry system because the end product of the SO_2 conversion reaction is a dry material. The dry waste product is collected in the bottom of the spray dryer reactor and a fabric filter or ESP downstream of the spray dryer removes the $CaSO_3$, $CaSO_4$, and unreacted lime. This air pollution control system uses water for evaporative cooling and for the SO_2 reaction. It operates in a temperature range of 300 to 350°F because the temperature of the gases must be high enough to evaporate the water portion of the slurry. Approximately 12% of the FGD systems installed in the U.S. are spray-dry systems[15] with typical SO_2 removal efficiencies in the range of 80 to 90 percent. Unlike a wet scrubbing system, there is no liquid blow-downstream from the dry system and the collected solids are typically land filled.

[14] EPA 2003, "Air Pollution Control Technology Fact Sheet–Flue Gas Desulfurization," EPA-452/F-03-034.
[15] Ibid.

APPENDIX B. LSFO SCRUBBER CONTROL SCENARIOS–EMISSIONS AND IMPACTS

Table B-1. EMISSION RATES FOR SO_2 CONTROL SCENARIOS[1]

Control Scenario	SO_2 Control Technology Evaluated	SO_2		NO_2		$PM_{2.5}$		PM_{10}	
		Emissions (tons/yr)	% Reduction (increase)[2]	Emissions (tons/yr)	% Reduction (increase)[2]	Emissions (tons/yr)	% Reduction (increase)[2]	Emissions (tons/yr)	% Reduction (increase)[2]
Current Allowable Emissions	Operating Limit of 3% Sulfur in Coke	7,076		136		693		869	
Scenario 1	Plus LSFO Scrubber Only for Potlines	854	88	136	0	984	(42)	1,113	(28)
Scenario 2	Plus LSFO Scrubber Only for Anode Bake Furnace	6,904	2	136	0	747	(8)	921	(6)

1. Total emission rate for the potline primary control system, the potline secondary control system emissions, and the anode bake furnace.
2. Compared with current potential emissions. Intalco's BART technical analysis provides information on increases in emissions of particulates due to LSFO scrubbers. Because sulfate dominates visibility impacts on Class I areas, these small increases in particulates were not a factor in the BART determination.

Table B-2. SUMMARY OF THE IMPACTS ANALYSIS FOR SO_2 CONTROL SCENARIOS

Control Scenario	SO_2 Control Technology Evaluated	SO_2 Emission Rate[1] (tons/yr)	SO_2 Emission Reductions[2] (tons/yr)	Installed Capital Cost	Total Annualized Control Costs	Cost Effectiveness (per ton SO_2 removed)	Energy Impact (kW-hr/yr)	Non-Air Quality Environmental Impacts
Current Allowable Emissions	Operating Limit of 3% Sulfur in Coke	7,076						
Scenario 1	Plus LSFO Scrubber Only for Potlines	854	6,223	$234,531,049	$46,820,000	$7,500	64,824,000	27,130 tons/yr of solid waste disposal 182.5 million gallons/yr makeup water
Scenario 2	Plus LSFO Scrubber Only for Anode Bake Furnace	6,904	172	$29,482,194	$6,227,000	$36,400	6,570,000	639.5 tons/yr of solid waste disposal 12.8 million gallons/yr makeup water

1. Total emission rate for the potline primary control system, the potline secondary control system, and the anode bake furnace.
2. Compared with current potential emissions.

APPENDIX C. ACRONYMS/ABBREVIATIONS

BACT	Best Available Control Technology
BART	Best Available Retrofit Technology
dv	Deciview(s)
CO	Carbon Monoxide
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ESPs	Electrostatic Precipitators
Intalco	Alcoa Intalco Works
LSFO	Limestone Slurry Forced Oxidation
LSNO	Limestone Slurry Natural Oxidation
mt	Metric Ton
NO_X	Nitrogen Oxides
PM	Particulate Matter
PM_{10}	Particulate Matter (with a mean diameter less than 10 microns)
ppm	Parts per Million
PSCAA	Puget Sound Clean Air Agency
SIP	Regional Haze State Implementation Plan
SO_2	Sulfur Dioxide
VOC	Volatile Organic Compound