BASIS AND PURPOSE DOCUMENT FOR THE DEVELOPMENT OF PROPOSED STANDARDS FOR THE PRIMARY ALUMINUM INDUSTRY

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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1.0 BACKGROUND

The EPA developed this proposed air emissions rule through a rulemaking process known as the Share-A-MACT Program. Participants in the pilot program include State regulators, tribal governments, industry representatives, and associated groups including the Aluminum Association and STAPPA/ALAPCO (State and Territorial Air Pollution Program Administrators Association/Association of Local Air Pollution Control Officials). The partnership process included a cooperative effort in identifying data needs; collecting available data; conducting emission testing with shared funding from the EPA, Washington Department of Ecology, and the industry; and meeting with these representatives to share technical information.

The proposed MACT standard for primary aluminum plants limits emissions of hazardous air pollutants (HAPs), primarily hydrogen fluoride (HF) and polycyclic organic matter (POM), from aluminum production, paste production, and anode bake furnaces.

The overall effect of the proposed rule would be to raise the control performance of nearly half of the industry to the level of control achieved by the best performing plants. Currently, over 11,000 tons per year (tpy) of total fluoride (TF) and POM and emitted nationwide; these emissions would be reduced by more than 50 percent. In addition, emissions of total particulate matter would be reduced by 16,000 tpy. The benefits of these reductions will be lower ambient air concentrations of these pollutants, and consequently, lower levels of exposure. The deposition of fluorides and POM on waters, such as the Great Lakes, would also be reduced. These benefits will be achieved with no plant closures predicted and without any significant adverse economic impacts on the industry.

The proposed standard is based on a combination of control techniques that either prevent the escape of emissions in the first place or that capture the pollutants and return them to the process. Over the past 20 years, many plants have already implemented these control techniques both to reduce emissions and to recover valuable fluorides, which reduces the operating costs of the emission control systems.

For the control of fugitive emissions, enhanced work practices and operating procedures are used to prevent the escape of emissions. Emissions that are collected by primary control systems are routed to dry alumina scrubbers (for potlines or bake furnaces) or dry coke scrubbers (for paste production) where the pollutants are captured and returned to the production process. Several plants will achieve emission reductions well beyond the nationwide average of 50 percent by replacing less efficient wet scrubbers with more efficient dry scrubbers and by installing emission controls on those anode bake furnaces and paste production operations that currently have no emission controls.

The proposed rule also provides flexibility in its requirements for monitoring the performance of the control techniques while ensuring the MACT level of control is achieved on a continuing basis. It contains provisions for reducing the frequency of sampling at those plants that show consistent performance below the level of the standard, which reduces the cost of monitoring. Provisions are also included to allow the use of innovative continuous emission monitors (CEMs) for hydrogen fluoride (HF) as an alternative measurement method for TF emissions. These new CEMs have shown promise for monitoring emission control and can also be used as a process tool to reduce operating costs by improving work practices and operating procedures. The rule also contains provisions for emission averaging, which provides owners or operators an opportunity to find the most cost-effective way to meet the limits at their particular plant.

The proposed rule has negligible adverse effects on energy consumption and secondary environmental impacts. When one plant replaces wet scrubbers with the highly-efficient dry scrubbers, the generation of sludge (solid waste) that requires disposal and the discharge of contaminated water will be eliminated.

The MACT level for new sources will have the effect of either discouraging the construction of Soderberg potlines, which emit much more of the carcinogenic POMs than do prebake potlines, or encouraging process changes for Soderberg potlines that will reduce POM and fluoride emissions to levels achieved by the best controlled prebake potlines.

The following sections of this report provide additional information on the standards development process for MACT standards; the industry and its regulatory history; the rationale for selection of the source category, emission sources, emission limits, and monitoring and compliance requirements; and the impacts of the proposed requirements.

1.1 National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Categories

Section 112 of the Clean Air Act as amended requires the development of NESHAP for the control of emissions of HAPs from both new and existing major or area sources. The statute requires the standard to reflect the maximum degree of reduction in emissions of HAP's that is achievable taking into consideration the cost of achieving the emission reduction, any nonair quality health and environmental reduction, and energy requirements. This level of control is commonly referred to as the maximum achievable control technology (MACT).

Emission reductions may be accomplished through application of measures, processes, methods, systems or techniques including, but not limited to: (1) Reducing the volume of, or eliminating emissions of, such pollutants through process changes, substitution of materials, or other modifications, (2) enclosing systems or processes to eliminate emissions, (3) collecting, capturing, or treating such pollutants when released from a process, stack, storage or fugitive emissions point, (4) design, equipment, work practice, or operational standards (including requirements for operator training or certification) as provided in subsection (h), or (5) a combination of the above [section 112(d)(2)].

1.2 Selection of Source Category

Section 112 specifically directs the EPA to develop a list of all categories of all major and area sources as appropriate emitting one or more of the 189 HAP's listed in section 112(b). The EPA published an initial list of source categories on July 16, 1992 (57 FR 31,576) and may amend the list at any time. A schedule for promulgation of standards for each source category was published on December 3, 1993 (58 FR 63941). Primary aluminum production is one of the 174 categories of sources listed. As defined in the EPA report documenting the selection of the source categories, this category consists of plants engaged in producing primary aluminum by electrolytically reducing alumina, including but not limited to, the following process units: (1) carbon mix plants, (2) reduction plants, (3) anode bake plants, (4) holding furnaces in the casting area, (5) casting processes, and (6) refining processes.[1] The listing was based on the Administrator's determination that primary aluminum plants may reasonably be anticipated to emit several of the 189 listed HAP's in sufficient quantity to be designated as major sources. The EPA subsequently decided to include carbon mix plants, reduction plants, and anode bake furnaces in the primary aluminum source category and placed the other sources in a separate source category for secondary aluminum production.

[1] Documentation for Developing the Initial Source Category List: Final Report. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards. EPA-450/3091-030. July 1992. Pages 3-4 and A-6.

1.3 Primary Aluminum Plants

Primary aluminum plants produce aluminum metal through the electrolytic reduction of aluminum oxide (alumina) by direct current voltage in an electrolyte (called "cryolite") of sodium aluminum fluoride. A total of 23 primary aluminum plants are currently located in 14 States. A majority of these plants are concentrated in the Northwest in close proximity to hydroelectric power sources.

New source performance standards (NSPS) for primary aluminum reduction plants (40 CFR part 60, Subpart S) were originally promulgated in 1976 (41 FR 3826, January 26, 1976) and amended in 1980 and 1989 (45 FR 44202, June 30, 1980; 54 FR 6669, February 14, 1989). The NSPS limits emissions of gaseous and particulate fluorides, measured as total fluorides (TF), from all potroom groups and anode bake furnaces constructed, modified, or reconstructed after October 23, 1974. Emissions are limited to 1.0 kg/Mg (2.0 lb/ton) of aluminum produced for potroom groups at Soderberg plants, 0.95 kg/Mg (1.9 lb/ton) of aluminum produced for potroom groups at prebake plants, and 0.05 kg/Mg (0.1 lb/ton) of aluminum equivalent for anode bake plants. Higher, never-to-be-exceeded limits, are allowed for potrooms at prebake plants (2.5 lb/ton) and Soderberg plants (2.6 lb/ton) if the owner or operator can establish that a proper control system was installed and operated and maintained in an exemplary manner.

Monthly performance tests are required by the NSPS to verify compliance; less frequent testing of the anode bake plant or the primary control system for the potroom may be permitted if the owner/operator can demonstrate low emissions variability. A monitoring device to determine the daily weight of aluminum and anode produced also is required to provide information used to compute the emission rate of TF based on the weight of metal tapped during a 30-day period. Visible emissions exiting potroom roof monitors, determined by Method 9 observations, are limited to 10 percent opacity for potroom groups and 20 percent opacity for any anode bake plant. A total of five potlines at four plants are subject to the NSPS.

Existing facilities are subject to varying **State emission regulations for TF developed pursuant to section 111(d)** of the Act. A limited number of States also impose limits specific to sulfur dioxide (SO_2) and particulate matter (PM). In some States, more stringent TF limits (in addition to limits for SO_2 and PM) are applicable to new or modified facilities subject to requirements for the prevention of significant deterioration (PSD). Additional information on State regulations is included in the Technical Support Document.

As a result of Federal and State regulations, emission controls are in place at all plants for the reduction cells and at many plants for materials handling, paste production, and anode bake furnaces. Emissions from materials handling are typically controlled by hoods and closed systems ducted to baghouses as a result of the NSPS for metallic mineral processing plants (40 CFR part 60, Subpart LL) or State rules. Emissions from reduction cells, paste production, and bake furnaces are captured by hooding and enclosure systems evacuated to a control device (or series of control devices) for removal of gaseous and particulate emissions using dry scrubbers with baghouses, wet scrubbers, or wet scrubbers with electrostatic precipitators. Thus the majority of emissions are secondary emissions from the reduction cells that escape capture by primary control systems.

The aluminum industry also is subject to effluent guidelines and standards set pursuant to the **Clean Water Act.** The EPA's effluent limitations for primary aluminum production (40 CFR part 421, Subpart B) apply to fluorides and other metals, toxic organics, and other pollutants in wastewater generated from wet air pollution control systems for paste production plants, anode bake plants, and potlines or potrooms; as well as from anode contact cooling, cathode reprocessing, and aluminum casting operations. The discharge rules require either lime treatment of a bleed stream off the scrubber loop or cryolite recovery with lime treatment of the cryolite bleed stream if wet control technology is used.

Under the **Resource Conservation and Recovery Act (RCRA)** regulations, spent potliner from primary aluminum reduction is a listed hazardous waste (K088) under 40 CFR 261.32, Hazardous Wastes from Specific Sources, due to the presence of iron cyanide complexes and must meet applicable RCRA requirements. Treatment standards for newly-listed spent aluminum potliner were proposed on March 2, 1995 (60 FR 11704). Hydrogen fluoride (HF) and spent potliner are designated as hazardous substances under section 102(a) of the **Comprehensive Environmental Response, Compensation, and Liability Act** and under section 311(b) of the **Clean Water Act.** In general, any unallowable release or discharge exceeding 100 pounds of HF (or one pound of spent potliner) is subject to notification requirements under 40 CFR Parts 302 and 355. If more than 500 pounds of HF are present at the facility, EPA rules in 40 CFR Part 370 and 40 CFR 372 implementing the **Emergency Planning and Right-to-Know-Act** also may require companies to prepare material data safety sheets and submit annual toxic chemical release reports.

The **Occupational Safety and Health Administration** limits the concentration of fluoride dust in air to a time-weighted average (TWA) of 2.5 milligrams per cubic meter of air (mg/m^3)

for an 8-hour work day, 40 hour week; the concentration of HF is limited to 3.0 ppm. The concentration of coal tar pitch volatiles (benzene soluble fraction), including anthracene, benzo(a)pyrene, phenanthrene, acridine, chrysene, and pyrene (all POM components) is limited to 0.2 mg/m^3. Particulates not otherwise regulated (including all inert or nuisance dusts whether mineral, inorganic, or organic not listed specifically by substance name) are limited to 15 million particles per cubic foot of air (mppcfa) and 15 mg/m^3 for the respirable fraction and 50 mppcfa and 15 mg/m^3 for total dust (58 FR 35338, June 30, 1993).

2.0 RATIONALE FOR THE PROPOSED STANDARDS

2.1 Source Category to be Regulated

Typically, primary aluminum plants are components of larger facilities that prepare a variety of finished products. Under the proposed standard, the primary aluminum source category excludes holding furnaces, casting, and refining processes because emissions from these sources are being regulated within the secondary aluminum source category. The EPA schedule for promulgation of the MACT standards (58 FR 63941, December 3, 1993), requires rules for both the primary and secondary aluminum source category to be promulgated by November 15, 1997. If MACT standards for this source category are not promulgated by May 15, 1999 (18 months following the promulgation deadline), Section 112(j) of the Act requires States or local agencies with approved permit programs to issue permits or revise existing permits containing either an equivalent emission limitation or an alternate emission limitation for HAP control. (See *Guidelines for MACT Determinations under Section 112(j)*, EPA 453/R-94-026, May 1994). For additional information on the secondary aluminum source category, contact Juan Santiago, Metals Group, Emission Standards Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-1084.

2.2 Affected Sources

2.2.1 Selection of Affected Sources. The proposed standard defines the affected sources as each individual potline, each individual anode bake furnace, and each paste production plant. Several factors were considered in the selection of the affected sources, such as ensuring that: (1) MACT is determined appropriately with respect to the MACT control technology and its performance, (2) the proposed MACT standard is implemented in a manner consistent with the way it was derived from the data base, (3) it is consistent with the development of subcategories, (4) it permits a clear distinction between new and existing sources and is appropriately related to the General Provisions, and (5) it provides adequate flexibility for implementation (e.g., emissions averaging).

For the aluminum reduction process, the EPA considered several options for defining the affected source, including groups of similar potlines at a plant, all potlines at a given plant, and each individual potline. For bake furnaces, the options included all bake furnaces and each bake furnace individually. For paste plants, the only option considered was for each paste production plant because no facility has more than one paste production operation. The options under consideration for potlines and bake furnaces were important because they affect how the MACT floor and MACT are determined from the available data, the applicability of the new source MACT standard (what constitutes a new or reconstructed source), and implementation of emissions averaging.

The selection of each potline, bake furnace, and paste plant as the affected sources ensures that the MACT control technologies, which are different for each of the affected sources, are implemented. This approach is consistent with the way measurements were made and the type of data that were submitted, i.e., to characterize the emission control performance of each individual potline, each bake furnace, and each paste plant. The subcategories for aluminum production were based most reasonably on types and characteristics of individual potlines rather than groups of potlines. This permitted the MACT floor to be determined based on the average (median) performance of the top five potlines in each subcategory. The MACT determination would have been more difficult and less effective if it had been based on the entire group of potlines at each of the plants. This approach also ensures that if a new potline, bake furnace, or paste plant is built, it would be subject to MACT for new sources, which is consistent with the way the new source limit was derived. This approach does not limit the flexibility in implementing emissions averaging, which has been included as a provision of the rule.

There was concern that the selection of the affected source as an individual potline could subject an existing potline that is rebuilt to the new source MACT, even if it were infeasible for the rebuilt potline to meet the standard. However, the General Provisions address this by stating that a source is not considered reconstructed and subject to new source MACT unless "it is technologically and economically feasible for the reconstructed source to meet the relevant standard." Consequently, if the owner or operator of an existing potline that is rebuilt shows that it is technologically or economically infeasible to met the new source MACT, the potline would not be considered to be reconstructed and would not be subject to the new source limit.

If a new potline (or bake furnace) is built, it would reasonably be expected to have no technical or economical problem with achieving new source MACT. Consequently, the definition of each individual potline (or bake furnace) as the affected source ensures that new potlines (or bake furnaces) must meet the more stringent limits for new sources. If the affected source had been defined as the group of potlines at a plant, a potline of entirely new construction would not necessarily have to meet new source limits.

After considering all of these factors, the individual potline, bake furnace and paste plant were selected as the affected sources. The major considerations were consistency with the available data, data analysis, and subcategorization (by potline); a clear and reasonable distinction between existing and new or reconstructed sources, and no loss of flexibility in implementing the rule.

2.2.2 HAPs from Affected Sources. Potlines of reduction cells comprise the largest source of HAP emissions in the primary aluminum category. HF, one of the major HAPs of concern, is generated from the fluoride compounds used in aluminum production. Emissions that are not collected by the primary system are released in the potroom where they mix with the ventilation air and escape through the roof monitor at most plants. The basic process operations that create secondary emissions include charging alumina to the bath, periodically removing the molten aluminum ("tapping"), replacing the anode, and correcting "anode effects", usually by adding more alumina and mixing the bath. Approximately 6,400 tpy of TF are emitted from potlines. POM and other organic compounds are introduced into the process primarily by the use of coal tar pitch in the anodes. POM emissions (measured as methylene chloride extractables) are estimated at 3,300 tpy.

During the MACT test program, additional analyses were made to quantify 20 individual POM compounds. Tests at two Soderberg plants showed these compounds were emitted at a rate of 0.5 to 0.6 pound per ton (lb/t) compared to levels less than 0.01 lb/t from tests at two prebake plants.[2] Additional emission tests also were performed by the industry and provided to the Agency for analysis.

The anode paste plant (also known as the "green mill") produces anode paste or briquettes for Soderberg cells, cathode paste, or green pressed anodes (baked in the anode furnace) for prebake cells. In prebake plants, multiple anodes are formed and baked prior to use and the anodes are consumed in the reduction process. In the Soderberg process, a single mass of paste or briquettes of coke and pitch forms the anode. Because the anode is baked in place, plants using the Soderberg process do not have anode bake furnaces.

To make the paste, solid raw materials (calcined petroleum coke, anthracite coal, and pitch, as required for the various

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[2] Primary Aluminum Industry - Draft Technical Support Document for Proposed MACT Standards (Preliminary Review Draft). U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards. February 1995.

types of pastes) are received in bulk and transported to carbon plant storage. Dry solids are drawn from the sized mix bins in controlled proportions either in weighed batches for batch mixers or continuously for continuous mixers. Mixers are jacketed and heated with either steam or oil. For baked anode pastes, the mixer feed contains either solid crushed coal tar pitch or hot liquid pitch as a binder. The prebake paste is then transferred to the anode molds for forming by hydraulic or vibratory compaction. For Soderberg paste, a liquid pitch is metered to the mixers and the hot paste is discharged to transfer cars for transfer to the potrooms or cooled and formed into briquettes. POM is the major HAP emitted from paste production with nationwide emissions (measured as methylene chloride extractables) estimated at 230 tpy. Testing at two paste plants showed that uncontrolled emissions of the 20 targeted POM compounds were about 0.07 lb/t of paste.

Paste production and bake furnaces may be together in the same building, in separate buildings or series of separate buildings, or off-site. Under the proposed rule, an independent manufacturer of anodes with a paste production or an anode bake furnace located off-site may be subject to the requirements of the rule if HAPs are emitted at level constituting a major source.

Nearly all of the anodes produced for prebake plants are baked in open-top ring furnaces. Each ring furnace consists of a number of indirectly fired sunken ovens or open-topped, brick pits arranged in rows. Some of the spaces in the brickwork are mortared while others are left open intentionally. A large pipe or duct circles the furnace and leads to an exhaust fan. Double-sealed manholes (at least one per furnace section) are spaced along the top of the duct. The pits are filled with green anodes and petroleum coke or other insulating material is placed over the anodes from an overhead hopper to cover and insulate the anodes. After firing and cooling, the packing coke is removed from the pits by vacuuming or other means and reused.

HF and POM are the major HAPs emitted from the anode bake furnace stack. HF emissions originate from the recycling of anode butts when fluorides not removed during cleaning of the butts are volatilized in the furnace and removed with the flue gas stream. The amount of HF emitted depends on the quantity of anode butts recycled, the cleanliness of the butts, and the efficiency of the emission control device (if present). The amount of particulate matter emitted can vary widely, dependent on the type of furnace, fuel (gas or liquid), the age of the brickwork, packing material, and firing conditions. Particulate matter released consists mainly of condensed tar attached to dust released through openings in the brick work or from the placement and removal of packing coke. POM emissions originate from the coal tar pitch used as the binder and evolve as the green anode is baked in the furnace. Anode bake furnaces emit about 700 tpy of TF (the vast majority of which is gaseous or hydrogen fluoride from uncontrolled bake furnaces) and 550 tpy of POM measured as methylene chloride extractables. Tests at two bake furnaces showed that the 20 targeted POM compounds were generated at a rate of 0.3 to 0.9 lb/t of anode prior to control by dry alumina scrubbers.

2.3 Pollutants for Regulation

2.3.1 Health Effects. Hydrogen fluoride is a very corrosive and toxic inorganic acid that can be in gas or liquid in anhydrous form or in aqueous solution (with water). Liquid HF can severely burn the skin and eyes. Skin contact with anhydrous HF (liquid or gaseous) or solutions above 50 percent produce immediate pain and tissue damage as the fluoride ion can penetrate the skin and attack underlying tissues and bone. Inhalation is particularly hazardous because HF readily dissolves in the mucous membranes of the upper respiratory tract, nose, and throat. Hydrogen fluoride also is highly reactive, and in many cases, the reaction products also are hazardous.[3]

While the human health effects of inhaling moderate amounts or the very low concentrations of HF that are typical at modern, well-controlled primary aluminum plants are not well known, animal tests have shown that exposure through inhalation for several months can result in damage to kidneys and nervous system changes such as learning problems. Inhalation of HF or fluoride-containing dusts for longer periods (e.g. several years) can also result in bone disease, known as skeletal fluorosis. Inhalation of large amounts can be harmful to the heart and lungs or fatal.[4]

The Agency for Toxic Substances and Disease Registry (ASTDR) reports in their 1993 toxicological profile that acute inhalation in combination with dermal exposure has resulted in pulmonary edema, pulmonary hemorrhagic edema, and tracheobronchitis.
In one study cited, a significant population (about 20 percent) exposed to airborne HF near an aluminum plant reported nausea

[3] Hydrogen Fluoride Study: Report to Congress under section 112(n)(6) of the Clean Air Act as amended. EPA 550-R-93-001. September 1993.

[4] Toxicological Profile for Fluorides, Hydrogen Fluoride, and Fluorine. U.S. Department of Health and Human Services. Public Health Service. TP-91/17. April 1993.

and diarrhea. The ASTDR has not established a minimal risk level (MRL) for inhalation or oral exposure to HF for any exposure duration or system category because exposure data in humans is not well quantified. However, existing data indicate that subsets of the population may be unusually susceptible to the toxic effects of fluoride and its compounds, including the elderly, persons with deficiencies of calcium, magnesium, or vitamin C, and people with cardiovascular and kidney problems.[5]

The EPA oral reference dose (RfD) assessment and inhalation reference concentration (RfC) assessment for HF are currently undergoing Agency review[6]. Additional information on the health effects of HF and related gases can be found in the literature review contained in the EPA report, "Summary Review of Health Effects Associated with Hydrogen Fluoride and Related Compounds."[7]

In the 1974 NSPS background information document, EPA reported documented evidence showing that fluorides emitted from industrial plants are responsible for damage to commercially grown flowers, fruits, and vegetables. However, even at the reduced levels emitted today, fluorides in low concentrations can be absorbed by grasses and plants and by animals that feed on the forage. Hydrogen fluoride also is a corrosive gas capable of property damage. For these reasons, several States require plants to monitor for fluoride damage in areas surrounding the plants. Additional information on the damage to vegetation, soil, wildlife, and livestock (and the critical load limit needed to prevent new damage) is available in the recent "Effects Study" conducted by Norwegian aluminum plants and the Norwegian Research Council.[8]

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[5] Reference 4.

[6] Integrated Risk Management System (IRIS). Hydrogen Fluoride and Fluorine. U.S. Environmental Protection Agency. Printout dated March 8, 1995.

[7] Summary Review of Health Effects Associated with Hydrogen Fluoride and Related Compounds: Health Issue Assessment. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. EPA-600/8-89-002F. December 1988.

[8] The Norwegian Aluminum Industry and the Local Environment: Summary Report on the Project to Study the Effects of Industrial Emissions from Primary Aluminum Plants in Norway. Hydro Aluminum, Elkem Aluminum, and Sor-Norge Aluminum in cooperation with the Norwegian Research Council. ISBN 82-993305-0-5. November 1994.

Deposition of POM on waters such as the Great Lakes and Chesapeake Bay from aluminum plants also is of concern as discussed in the Great Waters Report to Congress.[9] In the report, major aluminum plants are identified as significant sources of polycyclic aromatic hydrocarbons (PAH), including those aluminum plants located adjacent to or near the Great Lakes and those at long distances from the waterbody. Primary aluminum plants also are identified as one of the MACT source categories potentially emitting Great Waters pollutants of concern.

The term "coal tar pitch volatiles" denotes the complete class of fused polycyclic hydrocarbons that volatilize from pitch. These compounds are high molecular weight polycyclic aromatic compounds (four, five, and six benzene rings) whose normal state is particulate rather than gaseous. As such they are part of a larger class of compounds called POM (defined in the Act as including organic compounds with more than one benzene ring and which have a boiling point greater than or equal to 100°C.) Emission test results reveal that POM compounds may include a combination of known HAPs such as anthracene, benzo(a)pyrene, and naphthalene, among others. POM is introduced into the process primarily by coal tar pitch. The pitch is produced from the refining of coal tar and is recovered as a 40- to 60-percent bottoms fraction of heavy organics with very high boiling points.

Many of the compounds found in POM also are known (and sometimes measured as) PAH. PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, and other organic substances. However, all 15 compounds considered to be PAH in the 1990 ASTDR toxicological profile[10] were found in the analytical results of POM emission tests for potlines, bake furnaces, and paste production. The ASTDR study confirms the presence of PAH at aluminum production plants and states:

> ... Several of the PAHs, including

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[9] Deposition of Air Pollutants to the Great Waters: First Report to Congress. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards. EPA-453/R-93-055. May 1994.

[10] Toxicological Profile for Polycyclic Aromatic Hydrocarbons. U.S. Department of Health & Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry. TP-90-20. December 1990. Pages 3, 15, 58, 96.

> benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene, have caused tumors in laboratory animals when they ate them, when they were applied to their skin, or when they breathed them in the air for long periods of time. Reports on humans show that individuals exposed by breathing or skin contact for long periods of time to mixtures of other compounds and PAH can also develop cancer.[11]

And,

> Evidence exists to indicate that certain PAHs are carcinogenic in humans and animals. The evidence in humans comes primarily from occupational studies where workers involved in such processes as coke production, roofing, oil refining, or coal gasification are exposed to mixtures containing PAHs... Cancer associated with exposure to PAH containing mixtures in humans occurs predominately in the lung and skin following inhalation and dermal exposure, respectively....[12]

The report also discusses the presence of respiratory tract tumors observed in rats that inhaled a combination of benzo(a)pyrene (a component of POM) and SO_2. The study results indicated that benzo(a)pyrene is carcinogenic to animals when inhaled and that "the carcinogenicity can be enhanced with concurrent exposure to gases and particulates commonly found in the environment."[13]

Specific populations that may be susceptible to the toxic effects produced by exposure to PAHs include: the unborn, people with nutritional deficiencies, genetic diseases, immunodeficiency due to age or disease, people who smoke, those with a history of excessive sun exposure, people with liver and skin disease, and women, especially of child-bearing age. There may be an increased risk of developing lung cancer following prolonged inhalation of PAH-contaminated air and skin cancer following concurrent dermal exposure to PAHs and sunlight.[14] The

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[11] Reference 10. Pages 3, 15, 58, 96.

[12] Reference 10. Pages 3, 15, 58, 96.

[13] Reference 10. Pages 3, 15, 58, 96.

[14] Reference 10. Pages 3, 15, 58, 96.

EPA is currently in the process of reviewing a carcinogenicity assessment for POM.[15]

2.3.2 Measurement. Historically, the combination of gaseous and particulate fluorides emitted from aluminum plants have been measured and regulated as emissions of total fluoride or "TF". Methods 13A and 13B, originally promulgated in 1975, have been used for TF sampling and analyses, along with Method 14 which specifies the equipment and sampling procedures for emission testing of potroom roof monitors.

Traditionally, fluoride captured by the front-half filter has been called "particulate fluoride," and fluoride captured in the back-half impingers has been called "gaseous fluoride" (GF). However, the method has been validated only as a measure of TF expressed as the sum of the front-half and back-half catches. Thus, TF has been used for many years as a surrogate to represent this mixture of gaseous and particulate fluorides, and most emissions data currently available result from sampling and analysis for TF.

During the development of the proposed standards, EPA discussed with State and industry representatives various options for measuring gaseous HF, the listed HAP, and the use of GF or TF as surrogate measures for HF. Several factors were considered in these discussions that led to the choice of TF as a measure of emission control performance. A major consideration was the absence of a validated, accurate method for the measurement of HF or GF. EPA studies in the development of Method 13 identified problems in attempts to obtain an accurate split between particulate and gaseous fluoride. Hydrogen fluoride is highly reactive and reacts with glass in the sampling probe to form silicon tetrafluoride. The reactivity of HF has also been a problem in developing an analytical standard; currently, there is no EPA analytical standard that can be used to determine the accuracy of attempts to measure HF. During sampling, particulate matter in the front half of the train adsorbs GF, where it is then measured as particulate fluoride. Fine particulate matter that passes through the filter is measured as GF in the back half of the train. These factors produce confounding effects in attempts to measure HF or GF with biases in different directions. In addition, the quantity of HF or GF that is formed is affected by humidity and the water content of raw materials.

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[15] Integrated Risk Management System (IRIS). Polycyclic Organic Matter. U.S. Environmental Protection Agency. March 10, 1995.

A large historical data base for TF was available to characterize the emission control performance of the industry, to identify the best controlled potlines, and to develop the MACT floor and MACT level of control. There was a discussion among many different parties as to whether the MACT performance standard should be based on TF or GF, and EPA concluded that TF provides the most defensible basis to ensure that the MACT level of control is achieved. However, EPA recognizes the importance of identifying the contribution of gaseous HF to adverse health effects when exposure modeling is performed in the future. Consequently, the split between particulate and gaseous fluoride from Methods 13A and 13B will continue to be reported, and an attempt will be made to improve the accuracy and consistency of this determination. In addition, EPA is encouraging the development and application of HF CEMs as an improved monitoring tool for HF emissions.

The choices for measuring POM included expensive sampling and analysis to identify and quantify each of the numerous individual compounds that might be present or to develop a reasonable surrogate measure for POM. During the MACT test program jointly funded by the EPA, the State of Washington Department of Ecology, and the industry, sampling and analysis were performed for both individual species and for a surrogate measure. The surrogate approach uses methylene chloride extractables from both the front and back halves of a modified Method 5 procedure. The testing program indicated that methylene chloride extractables provided an adequate surrogate measure of the total POM species at a fraction of the cost associated with speciation. Consequently, the MACT level of POM control was defined from data for methylene chloride extractables, and the method developed during the test program is being proposed for POM compliance determinations.

2.3.3 Other Pollutants. Primary aluminum plants also discharge significant quantities of nonHAP pollutants such as SO_2, PM, and greenhouse gases (such as tetrafluoromethane, hexafluoroethane, and carbon dioxide).

Sulfur is introduced into the aluminum production process primarily by the coke and pitch used to produce anodes; consequently, most plants limit SO_2 emissions by specifying the maximum sulfur content they will accept in these raw materials. Two plants use SO_2 scrubbers following the dry alumina scrubbers of the primary control system to obtain additional SO_2 control, and four plants use wet roof scrubbers that provide some control of SO_2 in secondary (fugitive) emissions. These plants and control devices for SO_2 would not be affected by the proposed standard. Four plants use wet systems for their primary control device to limit emissions of fluorides, POM, other particulate matter, and SO_2. If these plants install dry alumina scrubbers to meet the MACT standard and do not keep a wet scrubber following the alumina scrubber, an increase in SO_2 emissions would be expected. However, this analysis assumes that current SO_2 requirements will remain in place even if dry alumina scrubbers were installed at these four plants.

The greenhouse gases tetrafluoroethane and hexafluoroethane are generated during anode effects in the reduction cell. Reducing the frequency and duration of anode effects will decrease fluoride emissions as well as emissions of these greenhouse gases. The EPA's Global Change Division in the Office of Atmospheric Programs has a voluntary program underway and is working with the aluminum industry to reduce emissions of these greenhouse gases.

2.4 Selection of MACT

2.4.1 Background. After EPA has identified the specific source categories or subcategories of major sources to regulate under section 112, it must set MACT standards for each category or subcategory. Section 112 establishes a minimum baseline or "floor" for standards. For new sources, the standards for a source category or subcategory cannot be less stringent than the emission control that is achieved in practice by the best-controlled similar source. [Section 112(d)(3)]. The standards for existing sources can be less stringent than standards for new sources, but they cannot be less stringent than the average emission limitation achieved by the best-performing 12 percent of existing sources for categories and subcategories with 30 or more sources, or the best-performing 5 sources for categories or subcategories with fewer than 30 sources.

After the floor has been determined for a new or existing source in a source category or subcategory, the Administrator must set MACT standards that are no less stringent than the floor. Such standards must then be met by all sources within the category or subcategory.

In establishing the standards, EPA may distinguish among classes, types, and sizes of sources within a category or subcategory [section 112(d)(1)]. For example, the Agency could establish two classes of sources within a category or subcategory based on size and establish a different emissions standard for each class, provided both standards are at least as stringent as the MACT floor for that class of sources.

The next step in establishing MACT standards is traditionally the investigation of regulatory alternatives. With MACT standards, only alternatives at least as stringent as the floor may be selected. Information about the industry is analyzed to develop model plant populations for projecting national impacts, including HAP emission reduction levels, costs, energy, and secondary impacts. Several regulatory alternative levels (which may be different levels of emissions control, different levels of applicability, or both) are then evaluated to select the regulatory alternative that best reflects the appropriate MACT level.

The selected alternative may be more stringent than the MACT floor, but the control level selected must be technically achievable. In selecting a regulatory alternative that represents MACT, EPA considers the achievable emission reductions of HAP's (and possibly other pollutants that are co-controlled), cost and economic impacts, energy impacts, and other environmental impacts. The objective is to achieve the maximum degree of emissions reduction without unreasonable economic or other impacts [section 112(d)(2)]. The regulatory alternatives selected for new and existing sources may be different because of different MACT floors, and separate regulatory decisions may be made for new and existing sources.

Under the Share-A-MACT approach applied during the development of the proposed standards, EPA met with representatives from State agencies, tribal governments, and industry groups to discuss the regulatory alternatives and associated issues. This approach to standards development allows EPA to select an alternative based on consensus with State partners and the sharing of technical data and analyses with other partners. For this pilot project, EPA met on several occasions with different groups in different locations to seek their views and selected an alternative using a mixture of analytical and consensus-based decisions.

2.4.2 Subcategorization. Primary aluminum operations are differentiated by the type of anode used and the method by which the anode is introduced into the reduction cell. In the prebake process, used by 17 plants, pots are classified as center-worked prebake (CWPB) or side-worked prebake (SWPB), depending on where the pot working (crust breaking and alumina addition) takes place. Soderberg pots are differentiated by the position of the current carrying studs in the anodes, which may be inserted vertically (VSS) or horizontally (HSS). Emission data reveal there is a clear difference in the level of POM emissions from prebake and Soderberg plants.

Section 112(d) of the Act requires EPA to establish emission standards for each category or subcategory of major and area sources. Section 112(d)(1) of the Act states that "the Administrator may distinguish among classes, types, and sizes of sources within a category...in establishing such standards...." In establishing subcategories, EPA has considered factors such as air pollution control engineering differences, process operations (including differences between batch and continuous operations), emission characteristics, control device applicability, and opportunities for pollution prevention. For the subcategories of potlines, the distinctions are based primarily on differences in the process operation, process equipment, emissions, and the applicability of control devices.

The EPA's analysis of existing aluminum production process and operations resulted in the designation of seven subcategories for potlines. These are: (1) CWPB1 potlines; (2) CWPB2 potlines; (3) CWPB3 potlines; (4) SWPB potlines; (5) VSS1 potlines; (6) VSS2 potlines, and (7) HSS potlines. Additional information on the subcategorization is included in Appendix A to this document.

Prebake and Soderberg are two distinctly different processes for aluminum reduction that present different challenges for capturing emissions from the aluminum reduction cells. These two processes also have different characteristics, especially with respect to POM emissions. A major difference between the two processes is that the anodes used in the prebake process have been formed and baked in a separate process operation (i.e., the anode bake furnace), whereas the Soderberg process bakes the anode in the reduction cell as part of the production operation. This difference directly affects emissions and results in larger quantities of organic compounds such as POM being emitted from the Soderberg process.

Other differences between the two processes also affect emissions and their control. In the prebake process, spent anodes are periodically removed and replaced, and this operation directly affects secondary (fugitive) emissions. Conversely, "green" paste (a mixture of unbaked coke and pitch) is added in a semi-continuous manner to the Soderberg reduction cell to allow it to be baked in place and to replace the anode as it is consumed. In addition, there are differences in the type and efficiency of hooding used for the two processes. In general, the hoods used for the Soderberg process have lower capture efficiencies because the gases evolving from the Soderberg cell are more difficult to capture.

Within the prebake process, center-worked (CWPB) and side-worked (SWPB) units have significant differences in design of the equipment, its operation, and applicable emission controls, especially in the capture of primary emissions. The process and operational differences include the placement of the anodes, the type of side shields, the method of alumina addition, and how the reduction cells are worked.

In the SWPB process, alumina is added along the sides of the reduction cell and the anodes are set close together near the center line. In the CWPB process, alumina is added down the center of the pot and the anodes are closer to the side. Consequently, the covers and hoods for the primary collection system are different for these two types of units because of the design, placement of anodes, and working the bath from the center versus from the side. In addition, the newer CWPB units can be equipped with computer-controlled crust breakers and point feeders, which often allow them to be worked without removing the side shields.

The design and operational differences between SWPB and CWPB result in different design considerations for the primary system. In general, emissions from the CWPB reduction cells can be captured with a higher efficiency than those from SWPB cells.

The investigation of the CWPB process indicates that there are two different designs that directly affect the ability of the operator to control emissions. One group is composed of CWPB reduction cells that are larger, generally newer, and operate at higher amperages (called CWPB1) than the older and smaller CWPB units (labeled CWPB2). The major factor affecting the difference in emissions and controls for the two types of units is the number of anode changes required.

Data were obtained from industry surveys on the frequency of changing anodes.[16] These data indicate that the older and smaller CWPB2 cells have more frequent anode changes per ton of aluminum than do the newer and larger CWPB1 cells. More frequent anode changes result in greater quantities of secondary (fugitive) emissions that are difficult to capture and control.

There are two other differences between the large and small CWPB units that affect emissions and their capture. Access is required more often to the smaller units because they are generally more unstable and are less likely to have computer controls. More frequent access means the shields of the primary collection system are opened more frequently and perhaps for longer periods, which results in poorer emission capture and higher emissions. Another factor is the smaller units generally have more anodes per reduction cell, which affects the design and capture efficiency of the hooding. These combinations of factors indicate that the larger CWPB units have lower emissions

[16] K. Ours, Research Triangle Institute, to Docket. Memorandum on Summary of Information for ICR-1 and ICR-2. September 30, 1993.

per ton of aluminum produced and that less emissions escape capture by the primary collection system.

Four center-worked prebake potlines with wet primary control systems were assigned a separate subcategory (CWPB3). These potlines produce a high purity aluminum for a specialized market, and they can do so only because metal impurities are removed with the sludge from the wet scrubbers. If these potlines were required to install dry alumina scrubbers, the contaminants would be returned to the reduction cell and contaminate the aluminum. The company claims that if they must meet MACT for the prebake subcategory of modern potlines with dry alumina scrubbers, they could lose their market for high purity aluminum. The EPA is requesting comments on the issue of a separate subcategory for plants that produce high purity aluminum.

There are two distinct designs used in the Soderberg process: horizontal (HSS) and vertical stud (VSS). The VSS design has steel studs that carry electrical current vertically through the unbaked paste and into the baked portion of the anode. In the HSS design, the studs project horizontally. The differences in design and operation result in different types of hooding and evaluation rates, both of which affect emissions and controls. In the VSS cells, the stationary anode casing and vertical projection of the studs through the anode allow the installation of a gas collection skirt between the anode casing and bath. The collected gases are ducted to burners where carbon monoxide, tars, and other hydrocarbons are burned prior to the primary control device.

The design of the HSS cell prevents the installation of an integral gas collection device because the anode casing is formed by removable channels that support the studs, and these channels must be periodically changed as the anode moves downward. Consequently, the hooding for the HSS cell is restricted to a canopy suspension, which results in air infiltration and dilution. The collected gases from the HSS cell are too dilute to support combustion in burners. For comparison, a typical VSS cell has an evacuation rate on the order of 500 ft^3/min compared to a range of 3,500 of 5,000 ft^3/min for an HSS cell.

Two VSS plants with five potlines use wet roof scrubbers to control secondary emissions, and the third plant also with five potlines uses work practices for secondary emission control. Consequently, EPA investigated the use of wet roof scrubbers as the MACT floor technology for all VSS plants. However, data obtained from one plant with wet roof scrubbers indicated that their scrubbers were shut down in periods of cold weather to avoid damage to the scrubbers and water treatment plant. The data indicated that the scrubbers were shut down due to cold weather an average of 36 days per year (a range of 19 to 48 days per year from 1986 to 1993). This represents a down time of 10 percent, i.e., they operated about 90 percent of the year. The procedure is to shut the scrubbers down when the temperature reaches 27°F and the temperature is predicted to drop further.

The VSS plant without wet roof scrubbers is located in northern Montana where the weather is much colder. Data obtained from the National Weather Service indicated that the normal daily average temperature was below 27°F about 21 percent of the time and the normal daily low temperature was below 27°F about 40 percent of the year. Consequently, the use of wet roof scrubbers based on the other plant's experience suggests that scrubbers installed in northern Montana could be shut down on the order of 20 to 40 percent of the time. Consequently, EPA determined that wet roof scrubber technology has not been adequately demonstrated for very cold climates.

The EPA believes that the technical feasibility of emission controls is an important consideration when evaluating the need to develop subcategories. For this case, EPA concluded that wet roof scrubbers were not applicable or feasible as the MACT floor technology for the VSS plant in Montana. Consequently, a separate subcategory (VSS2) was created for the five potlines at the plant in Montana, and the MACT floor for this subcategory would be determined by the average emission limitation achieved by these five potlines.

Because of the air pollution control engineering differences, including consideration of the variations in process operation, emission characteristics, and control device applicability, EPA developed separate MACT floors for each of these subcategories of potlines.

The vast majority of anode bake furnaces are similar in emissions potential and the applicability of emission control devices. One exception that exists is an anode bake furnace that is not located on the same site as the primary aluminum production facility. This facility does not have access to alumina for use in the dry alumina scrubber, and it does not have potlines that can use the reacted alumina generated by a dry alumina scrubber. On the other hand, bake furnaces co-located with the primary aluminum potlines have access to alumina, the basic raw material used for aluminum production, and can transfer the reacted alumina from the dry scrubber to the reduction cells. Consequently, a separate subcategory was created for this off-site bake furnace because the emission control technology (dry alumina scrubbers) would not be applicable.

2.4.3 MACT Floor Technologies. In general, the control option for primary emissions is the installation of highly-efficient dry alumina scrubbers at those plants that do not have them. Dry alumina scrubbers use alumina ore to adsorb gaseous pollutants and a baghouse to remove particulate pollutants and the alumina. This system controls 99.5+ percent of the fluoride emissions and 90 to 99 percent of the POM emissions at the best controlled plants. Consequently, this control device represents the MACT floor technology and the best control for primary emissions.

The MACT floor technology associated with the control of secondary emissions includes the use of wet roof scrubbers for SWPB and VSS1 potlines and, for all subcategories, adherence to specific work practices such as high draft on open pots, operating conditions, equipment inspection, maintenance, and repair.

Several control devices are currently in use for the control of emissions from paste production. Dry coke scrubbers are used at five plants to control POM emissions, and the other plants use various types of controls for specific emission points in paste production. The dry coke scrubber is the most effective of these control devices (shown to achieve up to 99.8 percent control of POM emissions) because the coke (carbon) provides a condensation point for the organic vapors generated during paste production, and a baghouse is used to control fine particulate matter and to remove coke fines. The coke can be returned directly to the paste production operation. Given that there are less than 30 plants, EPA examined the top five best performing plants. Based on the top five plants, the dry coke scrubber was identified as the MACT floor technology for paste production.

The most common and effective control device currently used for anode bake furnaces located at primary aluminum plants is the dry alumina scrubber, used by 12 of the 17 plants with anode bake furnaces. Two plants use an electrostatic precipitator (ESP) and three plants do not use a control device. The dry alumina scrubber is the most effective of these control devices because the alumina is an adsorbent for the HF gas generated during the baking process and provides a condensation point for tars (POM); a baghouse is used to control fine particulate matter containing fluorides and POM. The dry alumina scrubber has been shown to achieve 99 to 99.6 percent control of TF emissions and 94 to 98 percent control of POM emissions. For the bake furnace that is not located at a primary aluminum plant, the MACT floor technology is an electrostatic precipitator.

2.4.4 Beyond MACT Floor Evaluation. The EPA's analysis of control options for new and existing sources revealed that the control technologies chosen to represent the MACT floor (described above) were the most efficient for the control of HAP's among the various control devices used in the industry. No additional control options were identified that had been demonstrated to be more effective than the MACT floor technologies at a reasonable cost or that would achieve significant additional reductions in HAP emissions. Consequently, the technologies associated with the MACT floor were also determined to represent the MACT technology.

For example, the retrofit of wet roof scrubbers was considered as a control option to reduce further the secondary emissions from the potlines. The analysis (see Appendix C) indicated that only a nominal additional emission reduction would be achieved on a nationwide basis by wet roof scrubbers at a very high additional cost. Consequently, wet roof scrubbers were determined not to represent the MACT control technology for potlines that do not have them based on consideration of nationwide impacts (such as the high cost relative to nominal reductions in emissions). The "beyond-the-floor" analysis focuses on the technology basis for determining MACT; it does not consider the potential effects on risk or other health considerations for a specific plant. Consequently, this analysis does not conclude that wet roof scrubbers are not applicable or reasonable for a specific plant if site-specific health considerations can be determined and are factored into the decision. However, an analysis of residual risk and the need to reduce it will be evaluated later (within 8 years of promulgation of the MACT standard). At that time, a consideration of health effects and potential reductions for a specific plant could indicate the wet roof scrubbers are warranted.

3.0 PROPOSED STANDARDS

3.1 Emission Limits

Emission data from primary aluminum plants were solicited through two series of EPA information collection requests (ICR), from the industry trade association, from State agencies, and from individual plants. In addition, several primary aluminum plants were surveyed to collect additional detailed information on sources and processes. Emission tests also were conducted at seven plants as part of the MACT Test Program, which was funded jointly by EPA, the State of Washington Department of Ecology, and the industry. Additional emission test data also were submitted by individual plants.

The available data were evaluated to identify the "MACT" potrooms, anode bake furnaces, and paste production operations. The sampling and analytical procedures used historically by the plants were investigated and any differences from EPA procedures were evaluated. For each subcategory, the median potline was identified from the top 5 performing potlines to represent the performance associated with the MACT floor technology (i.e., the average emission limitation achieved by the top 5). Additional emission testing was performed for these potlines as needed to supplement the historical data, to characterize the emission control performance, and to obtain data on POM emissions.

Analysis of these available data leads EPA to conclude that the emission levels shown in Table 1 represent existing source MACT. These emission limits for potlines are in the same format as the NSPS (kg/Mg or lb/ton of aluminum). The proposed standard retains this format for anode bake furnaces, but uses lb/ton of anode rather than lb/ton aluminum equivalent as in the NSPS.

The limits for bake furnaces in Table 1 apply to bake furnaces located on the same site as the primary aluminum plant. For the one bake furnace not located with a primary aluminum plant, the limits do not apply because the MACT control technology determined for the other bake furnaces (dry alumina scrubber) does not apply. However, the Louisiana Department of Environmental Quality has developed MACT standards for this plant under an approved State program. For this particular anode bake furnace plant, EPA is adopting the State's MACT determination. This approach is consistent with EPA's approach of working with the States, adopting MACT determinations from State programs when appropriate, and avoiding regulatory duplication.

For paste plants, the EPA concluded that it was not feasible to prescribe or enforce an emission standard;

consequently, an equipment standard was developed for this source [section 112(h)]. The evaluation of the POM data for paste plants

TABLE 1. SUMMARY OF PROPOSED EMISSION LIMITS FOR EXISTING SOURCES

Source	Emission Limit
Potlines	TF Emission Limits 0.95 kg/Mg (1.9 lb/ton) of aluminum produced for CWPB1[a] potlines 1.5 kg/Mg (3.0 lb/ton) of aluminum produced for CWPB2[a] potlines 1.25 kg/Mg (2.5 lb/ton) of aluminum produced for CWPB3[a] potlines 0.80 kg/Mg (1.6 lb/ton) of aluminum produced for SWPB[a] potlines 1.1 kg/Mg (2.2 lb/ton) of aluminum produced for VSS1[a] potlines 1.35 kg/Mg (2.7 lb/ton) of aluminum produced for VSS2[a] potlines 1.35 kg/Mg (2.7 lb/ton) of aluminum produced for HSS[a] potlines
	POM Emission Limits 2.35 kg/Mg (4.7 lb/ton) of aluminum produced for HSS potlines 1.2 kg/Mg (2.4 lb/ton) of aluminum produced for VSS1 potlines 1.85 kg/Mg (3.7 lb/ton) of aluminum produced for VSS2 potlines

Paste Production	POM Emission Limit Install, operate, and maintain equipment for capture of emissions and vent emissions to a dry coke scrubber.
Anode Bake Furnace (located with a primary aluminum plant)	TF Emission Limit 0.10 kg/Mg (0.20 lb/ton) of anode
	POM Emission Limit 0.09 kg/Mg (0.18 lb/ton) of anode

[a] Abbreviations defined:

CWPB1 =Center-worked prebake potline with the most modern reduction cells; includes all center-worked prebake potlines not specifically identified as CWPB2 or CWPB3
CWPB2 =Center-worked prebake potlines located at Alcoa in Rockdale, Texas; Kaiser Aluminum in Mead, Washington; Ormet Corporation in Hannibal, Ohio; Ravenswood Aluminum in Ravenswood, West Virginia; Reynolds Metals in Troutdale, Oregon; and Vanalco Aluminum in Vancouver, Washington
CWPB3 =Center-worked prebake potline that produces very high purity aluminum, has wet scrubbers as the primary control system, and is located at the primary aluminum plant operated by NSA in Hawesville, Kentucky
HSS =Horizontal stud Soderberg potline
SWPB = Side-worked prebake potline
VSS1 = Vertical stud Soderberg potline at Northwest Aluminum in The Dalles, Oregon, or at Columbia Aluminum in Goldendale, Washington
VSS2 = Vertical stud Soderberg potlines at Columbia Falls Aluminum in Columbia Falls, Montana

concluded that it was not practical to set an emission limit because there were too few data to characterize the control performance that could be achieved by the various types of paste plants and because of uncertainty in the limited existing data. The high level of uncertainty would cause EPA to set a standard that could be impractical on a technological basis. The EPA considered drafting a standard that would require each owner or operator to conduct measurements to set limits on a case-by-case basis; however, the cost of this approach was not considered to be reasonable, especially given the reasonableness and effectiveness of specifying a design and equipment standard. Consequently, the proposed rule requires the installation of a capture system that collects and vents emissions to a dry coke scrubber (or equivalent alternative control device) for all paste production plants. If the owner or operator prefers to develop an applicable emission limit rather than comply with the equipment and design standard, this option is available under provisions for an alternative standard in section 112(h)(3).

In developing the emission limits, EPA considered different statistical approaches and different upper percentiles of performance. The industry generally recommended a level at least as high as the 99th percentile, and State representatives recommended using the 95th percentile. The EPA analyzed the data and considered the statistical approaches as well as examining the levels that had been achieved by the MACT floor plants. An important consideration in developing the proposed emission limits was that the monthly averages of the MACT floor potline must show that the limit has been achieved.

For cases with adequate historical data to determine the limit that had been achieved (e.g., TF from potlines), the MACT floor limits were determined from the highest monthly averages in the data base. In cases with no historical data (e.g., POM limits for all sources), the EPA used a statistical approach to estimate the MACT floor levels that had been achieved. Additional details on the data analysis are given in Appendix B, and a complete listing of the data is given in Appendix D.

Based on data submitted by the affected plant, EPA determined that the CWPB3 potlines could have their wet primary control systems upgraded and improve control of secondary emissions to achieve a limit of 2.5 lb TF/ton as the MACT level of control, which has been the historic NSPS level for prebake potlines. Information supplied by NSA indicated that upgrading their wet scrubber system enabled them to meet a limit of 2.5 lb TF/ton.[17]

[17] Memorandum from W. Hill, Southwire Company, to M. McKeever, EPA:ESD, May 23, 1995. Docket Item II-D-85.

The POM limits for HSS potlines were determined from the data collected during the MACT Test Program. The 95th percentile was used to determine the POM limit for the HSS subcategory for both the primary control system and secondary emissions. The POM limits for VSS1 are based on the limited test data available from one potline at Columbia-Goldendale and one potline at Northwest Aluminum. The results from these two potlines were combined to provide enough data to assess performance and to represent the MACT floor. These two potlines achieved a level of 2.4 lb/ton. There were no validated POM data available for the VSS2 subcategory; however, POM data for the VSS1 subcategory before the wet roof scrubbers represent the same process configuration as that for VSS2. Consequently, the VSS1 POM data were used to derive limits for VSS2. The POM emissions at the inlet to the wet roof scrubbers did not exceed 3.7 lb/ton. Additional details are provided in Appendix B and Appendix D.

For anode bake furnaces located at primary aluminum plants, POM limits were developed from the two best performing furnaces in the industry with the MACT technology (dry alumina scrubbers), which were the only ones for which EPA had adequate data to determine the MACT level of control. The emission limit for TF from anode bake furnaces was based on data from Noranda's bake furnace, which supported a level equal to the NSPS level of control. Eight bake furnaces currently are subject to the NSPS, and the NSPS level has been achieved by an older bake furnace that is not subject to the NSPS.

Emission limits are also proposed for new and reconstructed potlines and anode bake furnaces. [See Table 2.] These emission limits are based on data from the best controlled potline and bake furnace. An equipment standard (dry coke scrubber) is proposed for new paste plants. MACT for new sources applies to all new and reconstructed potlines, and no distinction is made for the different subcategories that were developed for existing potlines. As provided in the definition of "reconstruction" in the proposed rule, two criteria must be met for a source to be considered reconstructed and subject to new source MACT: (1) all of the major components of the source must be replaced (for example, the major components of a potline include the raw material handling system, reduction cells, superstructure, hooding, ductwork, etc.), and (2) it must be technically and economically feasible for the reconstructed source to meet new source MACT.

The EPA believes that it is unlikely that an existing potline could be reconstructed in such a manner that it would be technically feasible for the potline to meet new source MACT unless the criteria described above are met. For example, the conversion of a Soderberg potline to a prebake potline, while retaining some of the major components of the original potline, is expected to subject the source to emission limits for existing prebake potlines rather than triggering new source MACT. Similarly, if an existing potline is modified to increase capacity (e.g., by adding more reduction cells), the modified potline would continue to be subject to MACT for existing sources.

Another example is the conversion of a SWPB potline to a CWPB potline, which is not expected to be a reconstruction if some of the major components of the original potline are retained. However, when an existing potline is changed in such a manner that the applicable subcategory changes, the changed potline must meet the applicable limit for the original subcategory or the applicable limit for the new subcategory, whichever is more stringent. In other words, an existing potline cannot qualify for less stringent emission limits associated with another subcategory as a result of changes to its operation.

TABLE 2. SUMMARY OF PROPOSED EMISSION LIMITS FOR NEW SOURCES

Source	Emission Limit
Potlines	TF Emission Limit 0.6 kg/Mg (1.2 lb/ton) of aluminum produced POM Emission Limit 0.32 kg/Mg (0.63 lb/ton) of aluminum produced
Paste Production	POM Emission Limit Install and operate equipment for the capture of emissions and vent emissions to a dry coke scrubber
Anode Bake Furnace	TF Emission Limit 0.01 kg/Mg (0.02 lb/ton) of anode
	POM Emission Limit 0.025 kg/Mg (0.05 lb/ton) of anode

3.2 Monitoring and Compliance Requirements

The EPA identified and analyzed several different options for enhanced monitoring of primary and secondary emissions from new and existing plants. The major HAPs of interest from the primary aluminum industry include HF and POM. Currently, there is no known continuous emission monitor (CEM) for POM; however, devices are available for the continuous monitoring of HF emissions. These devices can be used to monitor both primary and secondary HF emissions from the potlines and for HF emissions from the anode bake furnace. A continuous opacity monitor also could be used for visible emission observations to ensure proper operation of the control system.

Most plants currently perform emission tests as often as once to three times per month for pollutants such as particulate matter (PM) and TF. Currently, very little sampling and testing is performed for POM emissions. Methods 13 and 14 can be used to determine the quantity of TF from aluminum production. The analysis adds particulate and gaseous fluoride (GF) captured in the front half filter to GF from the back-half impingers to determine total fluoride. In addition, a method has been developed to provide a surrogate measure of POM emissions (Method 315). This method uses a gravimetric determination of methylene chloride extractables from both the front and back halves of the sampling train. Methylene chloride extracts that portion of the particulate matter that is POM; however, it is a surrogate because it also extracts some material that is not POM. Options for manual sampling include sampling at different frequencies; manual sampling for each potline; or sampling one potline to represent a group of similar potlines.

Parametric monitoring also is an option and includes monitoring of certain parameters associated with the production process, the control device, or both to ensure proper operation of the control system. These parameters may be monitored on a more frequent basis than periodic manual sampling to supplement the manual sampling. Examples of possible monitoring parameters for a dry alumina scrubber include the alumina flow rate, air flow rate, pressure drop, and inlet gas temperature. For a wet scrubber and secondary emissions, parameters could include the scrubbing liquor flow rate, the pressure drop across the scrubber, and air flow. Parameters for secondary emissions also could include inspections to observe work practices; the condition of the hoods and shields; the number of shields removed; the frequency of removal, and the duration. Visual observations of opacity, a bag break detection system, and periodic inspection of fabric filters for tears or gaps also could be made.

The EPA considered the various options for monitoring and concluded that the provisions selected for proposal (see Table 3)

TABLE 3. PROPOSED MONITORING AND COMPLIANCE REQUIREMENTS

Source	Requirement
Potlines	1. Monthly sampling for TF secondary emissions from each potline plus quarterly POM sampling for Soderberg potlines. May sample one potline to represent a similar potline(s). 2. If one potline represents one or more similar potlines, the owner or operator must monitor the similar potline(s) with an HF CEM or an Alcan cassette sampler. These devices must meet certain Method 14 criteria, and an enforceable limit for these devices must be established based on simultaneous performance testing using Methods 13 and 14. 3. An HF CEM or Alcan cassette sampler can be used instead of manual sampling if the owner or operator correlates or demonstrates them to be equivalent to Methods 13 and 14 to the satisfaction of the regulatory authority. 4. Annual sampling of TF and POM (for Soderberg potlines only) from each primary control system. 5. Monitor control device parameters. 6. Install monitoring device to measure weight of aluminum produced. 7. Compute a monthly average from at least 3 runs for secondary emissions and the 12-month average of tests of the primary control system (at least 3 runs per year). Using the monthly average and 30-day average production rate, compute TF emissions in lb/ton to determine compliance. POM emissions are determined in a similar manner (for Soderbergs only) on a quarterly basis from at least one run for secondary emissions per month and 3 runs annually for emissions from the primary control system.

Source	Requirement
Paste Production	1.Install required equipment. 2.Monitor process parameters for control device.
Anode Bake Furnace	1.Monitor process parameters for control device. 2.Install monitoring device for weight of green anodes placed in the bake furnace. 3.Annual sampling for TF and POM from furnace stack. Compute average of at least 3 runs and weight of anodes to determine compliance.

represented a cost-effective approach to determine emission control performance. Periodic manual sampling was chosen to measure emissions instead of an HF CEM because CEMs have not been adequately demonstrated and validated. However, the EPA encourages the development and future use of HF CEMs for secondary emissions because they show promise for improved measurement of HF emissions and as a tool for improved process control. In addition to periodic manual sampling, monitoring of control device parameters is proposed to ensure that the control device is operated properly on a continuous basis. Additional details on the monitoring requirements are given in the following sections; highlights are given in Table 3.

3.2.1 Potlines. The proposed rule would require compliance monitoring for each new and existing potline (or similar potline). For secondary emissions of TF from each potline (or group of similar potlines) exiting the roof monitor, the proposed rule would require the owner or operator to perform at least three runs each month by Methods 13 and 14. If wet roof scrubbers are used, the owner or operator would measure emissions using methods approved by the regulatory authority. For POM emissions from Soderberg potlines, the owner or operator would perform one run per month (three runs per quarter) using a Method 14 sampling manifold and procedures and Method 315 (proposed as part of this rulemaking) for POM analyses.

Plants may sample secondary emissions from one potline to represent similar potlines rather than perform manual sampling on each potline. To show that a potline is similar, the owner or operator must demonstrate (to the satisfaction of the regulatory authority) that the level of emission control is the same for all of the potlines in the group. An HF CEM or Alcan cassette sampler may be used to demonstrate compliance by similar potlines that are not manually sampled. An emission limit for the device must be established based on a minimum of 9 simultaneous runs using Methods 13/14 and the alternative monitoring device. The alternative limit may be based on a mathematical correlation of the results and the applicable TF limit or it may be based on the highest reading of the alternative device that corresponds to a Method 13/14 result that is in compliance with the applicable TF limit. The similar potline must be monitored with the HF CEM or Alcan cassette on the same frequency as that required for manual sampling. Exceeding the emission limit established for the alternative device would be a violation. Procedures are also included to develop alternative methods for POM determinations.

The industry has requested and EPA is considering work practice inspections as a monitoring alternative to show similar levels of control for similar potlines. This approach may be feasible. However, this issue is unresolved because every specific work practice and its corresponding effect on emissions are difficult to identify and quantify, and there is no evidence that a work practice "score" is relatable to emission rates. Consequently, there have been difficulties in developing work practice inspections as an acceptable alternative compliance approach.

Methods other than manual sampling using Methods 13 and 14 may be approved on a case-by-case basis by the regulatory authority. The EPA is encouraging the development and use of HF CEMs to monitor secondary emissions because they show promise for improved monitoring, lower costs, and better process control of fluoride losses. Alternative methods must be correlated with Method 13 and 14 results to the satisfaction of the regulatory authority. Alternative methods must account for or include gaseous fluoride and cannot be based on measurement of particulate matter or particulate fluoride alone because HF, the HAP of interest, is in gaseous form. For example, the use of the Alcan cassette has been approved for TF measurements at one plant in the CWPB1 subcategory based on a demonstrated correlation to the results from Method 14. Demonstrations would be required to obtain approval to use the Alcan cassette for potlines in other subcategories (such as the Soderberg subcategories) because of potential differences in emission characteristics, including the effects of higher levels of particulate matter.

For the primary control system, the proposed rule would require the owner or operator to sample each primary control device on an annual basis (at minimum) for TF emissions using Method 13 and for POM (from Soderberg potlines only) using Method 315. For both the TF and the POM tests, at least three runs are required. If there are multiple primary control devices or stacks, the owner or operator must rotate sampling or sample representative stacks to ensure that each primary control device is sampled during the year (i.e., at least one run per control device). If the primary control system is tested more than once during the previous 12-month period, the average of all runs for the 12-month period is used to determine the contribution from the primary control device.

The owner or operator also would install, operate, and maintain a device for the monitoring and recording of process parameters to ensure proper operation of the control system. For dry alumina scrubbers, the devices must monitor and record the alumina flow and the air flow of the device. For wet scrubbers used as primary control devices, the device must monitor and record the water flow rate to the scrubber and the air flow rate. Plants using electrostatic precipitators must install devices to monitor voltage and secondary current. In addition, the stacks of all primary control systems must be visually inspected each day for indication of abnormal operation. Plants with wet roof scrubbers that control secondary emissions must monitor total water flow and inspect each scrubber each day to ensure each one is operating properly. If an emission control device other than one of those described above is used, the owner or operator must include recommended monitoring parameters in the part 70 permit application.

Using data from the initial performance test and historical performance tests, the owner or operator would use these monitoring devices to determine the upper and/or lower operating limits, as appropriate, for each parameter. The owner or operator may redetermine the upper and/or lower operating limits, as appropriate, based on historical data or other information and submit an application to the regulatory authority to change the applicable limits.

The monitoring parameter limit(s) would be used as the baseline against which subsequent readings would be compared to ensure normal operation of the control device. A corrective action program would be triggered if the control device is operating outside of the acceptable range for the specified parameters. Failure to initiate corrective actions within one hour after exceeding the limit is a violation. A violation also occurs if the operating limit for a parameter is exceeded more than 6 times in any semiannual reporting period. For the purpose of determining the number of exceedances, no more than one exceedance would be attributed in any given 24-hour period. The EPA limited the number of times the monitoring parameter(s) could be exceeded without a violation (no more than 6 times in a semiannual period) to ensure that the control equipment is properly repaired under the corrective action program. The semiannual period also provides the owner or operator adequate time to submit a request to redetermine the limit(s) as described earlier if historical data or other information shows that the original monitoring parameter limits are no longer appropriate.

To determine compliance with the single emission limit for primary and secondary emissions from the potline, the plant owner or operator would compute the monthly average (minimum of three runs per month) for secondary emissions of TF and quarterly emissions of POM (from a minimum of one run per month for Soderberg potlines) from each potline. Using the emission test results (the average of at least 3 runs for secondary emissions and the most recent annual test or 12-month average of the primary control system) and the 30-day average production rate for aluminum production, the owner or operator would calculate the emissions in a kg/Mg (lb/ton) format to compare to the emission limits in the rule. The results of the secondary emission tests and the most recent compliance test for the primary control system are added together and compared to the emission limit. If the average value is less than the applicable emission limit, the potline (or group of similar potlines) is in compliance.

Compliance with the standard must be demonstrated at startup for new sources and within 2 to 3 years of the effective date of the final rule for existing sources, depending on the changes needed at a given plant to meet the standards. All plants have at least 2 years to comply. Plants that demonstrate that more time is needed to install control equipment for a specific source will be given three years to comply for that source. The owner or operator must submit semiannual reports of excess emissions and semiannual reports of startups, shutdowns, and malfunctions (if applicable).

3.2.2 Anode Bake Furnaces. The proposed rule would require the owner or operator to sample TF emissions from new and existing anode bake furnaces using Method 13 and to sample POM emissions using Method 315. Both pollutants must be sampled annually; at least three runs must be performed. The provisions for establishing monitoring parameter limits, monitoring of control device parameters, corrective actions, etc. are the same as those described earlier for potlines.

3.2.3 Paste Production. The proposed rule would require the owner or operator to install and operate a capture system vented to a dry coke scrubber (or equivalent alternative control device) for new and existing paste plants. There were only limited data[18,19] available to characterize the performance of dry coke scrubbers, and after review of the data, the EPA determined that a control efficiency of 90 percent was achievable for batch mixers and 95 percent was achievable for continuous mixers. Consequently, if a control device other than a dry coke scrubber is used, the proposed rule requires that the alternative control achieve a POM reduction efficiency of at least 95 percent for continuous paste mixing operations and at least 90 percent for batch operations. In addition, the owner or operator must install, calibrate, maintain, and operate a monitoring device to measure and record the coke flow rate and the air flow rate to the scrubber (or other parameters for an approved alternative device). If other control devices are used, the owner or operator must include recommended monitoring parameters in the part 70 permit application. The provisions for monitoring of control device parameters, corrective actions, etc. are the same as those described earlier for potlines.

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[18] Emissions Measurements Test Report - Northwest Aluminum Company. Prepared by Entropy, Inc. June 1994. 77 p.

[19] Kaiser Aluminum and Chemical Corporation Method 5/POM and 13B Testing - Mead, Washington - March 15-24, 1994. Prepared by AmTest Air Quality, Inc. November 9, 1994. pp. 1 to 99.

3.2.4 Emission Averaging. The proposed rule contains provisions for the averaging of TF emissions from potlines and anode bake furnaces. Emission sources not located on the plant site or not within the same State or permitting jurisdiction would not be eligible for emissions averaging and averaging would be limited to TF emissions from like sources. For example, TF emissions from one potline can be averaged with the TF emissions from another potline at the same plant. Each emission point used in emission averaging must be sampled to ensure an accurate accounting of emissions. Averaging would not be allowed between two different pollutants (e.g., TF and POM). Emissions averaging would not be allowed in any State that selects to exclude this option from their operating permits program under the provisions of the proposed rule. To conduct the emissions averaging, the owner or operator would include an Averaging Plan in their part 70 permit application identifying each potline or group of potlines in the average, and the assigned TF emission limit for each potline or similar potline.

The option that was developed for emission averaging is a monthly average for TF and a quarterly average for POM for the group of sources that ensures emissions are less than the level achieved by the limit for individual sources. The limit for averaging is lower than the limit for individual sources and was calculated by estimating the decrease in standard deviation (variability) when multiple potlines are included in the average. The applicable emission limits for emissions averaging for the possible combinations of sources at existing plants are given in Table 4. The emission limits decrease as the number of sources included in the average increases because of the lower variability when more sources are included. Additional details on the derivation of emission limits for emissions averaging are given in Appendix B.

For plants choosing to use emission averaging, at least three runs must be made each month for TF for secondary emissions from each potline to determine the average emissions from each potline. The sum of emissions from each potline (including both the primary system and secondary emissions) for the month is divided by the total aluminum production from all of the potlines for the month to determine the monthly emissions in lb/ton for comparison to the limit. The approach is the same for POM from Soderberg potlines except that three runs are made each quarter (one run per month) instead of three runs each month.

Options were also developed for emissions averaging for POM using the same basic procedure described for TF. The proposed limits for POM for emissions averaging are also given in Table 4.

Emissions averaging limits were also developed for bake furnaces for plants with multiple furnaces that must be sampled annually and are presented in Table 5. The limits for TF were based on the results for Noranda's bake furnace and the limits for POM were developed from the tests of the Kaiser-Mead bake furnace. The same procedures used for developing limits for potlines were used for bake furnaces and are described in Appendix B.

TABLE 4. POTLINE TF AND POM LIMITS FOR EMISSIONS AVERAGING

Type	Monthly TF limit (lb/ton) for given number of potlines						
	2 lines	3 lines	4 lines	5 lines	6 lines	7 lines	8 lines
CWPB1	1.7	1.6	1.5	1.5	1.4	1.4	1.4
CWPB2	2.9	2.8	2.7	2.7	2.6	2.6	2.6
CWPB3	2.3	2.2	2.2	2.1	2.1	2.1	2.1
VSS1	2.0	1.9	1.8	1.7	1.7	1.7	1.7
VSS2	2.6	2.5	2.5	2.4	2.4	2.4	2.4
HSS	2.5	2.4	2.4	2.3	2.3	2.3	2.3
SWPB	1.4	1.3	1.3	1.2	1.2	1.2	1.2
	Quarterly POM limit (lb/ton) for number of potlines						
HSS	4.1	3.8	3.7	3.5	3.5	3.4	3.3
VSS1	2.1	2.0	1.9	1.9	1.8	1.8	1.8
VSS2	3.4	3.2	3.2	3.1	3.1	3.0	3.0

TABLE 5. BAKE FURNACE EMISSION LIMITS FOR EMISSIONS AVERAGING

Number of furnaces	Limit (lb/ton of anode)	
	TF	POM
2	0.11	0.17
3	0.090	0.17
4	0.077	0.17
5	0.070	0.17

The owner or operator may submit an application to the regulatory authority to revise their averaging plan. In addition, owners or operators who do not choose to use emission averaging for initial compliance may submit a request to implement averaging after the initial compliance date.

3.2.5 Reduced Sampling Frequency. The proposed rule also contains provisions for reduced sampling frequency for both TF and POM. The owner or operator may petition the regulatory authority to establish an alternative testing requirement that requires less frequent testing for secondary emissions, the primary control system, or the anode bake plant. If the owner or operator shows that the emissions from these sources have low variability during normal operations, the regulatory authority may establish an alternative testing requirement. The alternative testing requirement must include a testing schedule and the method to be used to measure emissions for the purpose of performance tests.

Guidance is provided to the owner or operator and the regulatory authority for evaluating alternative sampling frequencies in the EPA report, *Primary Aluminum: Statistical Analysis of Potline Fluoride Emissions and Alternate Sampling Frequency* (EPA-450/3-86-012, October 1986). Plants that have received approval for an alternate sampling frequency under the NSPS may continue this alternate frequency under the proposed NESHAP.

3.3 Recordkeeping and Reporting Requirements

The proposed standards would incorporate nearly all notification, recordkeeping, and reporting requirements in the General Provisions to Part 63. These include: (1) initial notifications, notification of performance test, notification of compliance status, and (2) a report of performance test results, semiannual report of startup, shutdown, and malfunctions (if applicable), and semiannual reports of excess emissions. The General Provisions also require the owner or operator to develop a startup, shutdown, and malfunction plan. Table 6 shows the recordkeeping and reporting requirements in the General Provisions and the applicability of these requirements to the requirements in the proposed rule.

In addition to the records required by the General Provisions to part 63, the proposed rule would require new and existing aluminum plants to maintain records of daily production rates for aluminum and anodes. This information is needed to document the 30-day average production rate used in compliance equations. The proposed standard also would require the owner or operator choosing to use emission averaging as a means of compliance to develop and submit an Averaging Plan to the applicable regulatory authority, who would review and approve or disapprove the plan based on specified criteria within a specified time frame.

3.4 Delegation of Authority

Following promulgation, EPA will delegate authority to States to implement and enforce the rule. As proposed, the rule includes provisions allowing States to choose whether to include provisions for emission averaging in their program and in permits issued under their program.

TABLE 6. APPLICABILITY OF GENERAL PROVISIONS
(40 CFR Part 63, Subpart A) TO SUBPART LL

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.1(a)(1)	Applicability	Yes	
63.1(a)(2)		Yes	
63.1(a)(3)		Yes	
63.1(a)(4)		Yes	
63.1(a)(5)		No	[Reserved]
63.1(a)(6)-(a)(8)		Yes	
63.1(a)(9)		No	[Reserved]
63.1(a)(10)		Yes	
63.1(a)(11)		Yes	
63.1(a)(12)-(a)(14)		Yes	
63.1(b)(1)		Yes	
63.1(b)(2)		Yes	
63.1(b)(3)		Yes	
63.1(c)(1)	Applicability After Standard Established	Yes	
63.1(c)(2)		No	All are major sources
63.1(c)(3)		No	[Reserved]
63.1(c)(4)		Yes	
63.1(c)(5)		Yes	
63.1(d)		No	[Reserved]
63.1(e)	Applicability of Permit Program	Yes	
63.2	Definition of "Reconstruction"	No	Defined in Subpart LL
63.2	All Other Definitions	Yes	Additional definitions in § 63.841

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.3(a)-(c)	Units and Abbreviations	Yes	
63.4(a)(1)-(a)(3)	Prohibited Activities	Yes	
63.4(a)(4)		No	[Reserved]
63.4(a)(5)		Yes	
63.4(b)-(c)		Yes	
63.5(a)(1)	Construction/ Reconstruction	Yes	
63.5(a)(2)		Yes	
63.5(b)(1)	Existing, New, Reconstructed	Yes	
63.5(b)(2)		No	[Reserved]
63.5(b)(3)		Yes	
63.5(b)(4)		Yes	
63.5(b)(5)		Yes	
63.5(b)(6)		Yes	
63.5(c)		No	[Reserved]
63.5(d)(1)	Approval of Construction/ Reconstruction	Yes	
63.5(d)(2)		Yes	
63.5(d)(3)		Yes	
63.5(d)(4)		Yes	
63.5(e)		Yes	
63.5(f)(1)		Yes	
63.5(f)(2)		Yes	
63.6(a)	Compliance for Standards and Maintenance	Yes	
63.6(b)(1)		Yes	

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.6(b)(2)		Yes	
63.6(b)(3)		Yes	
63.6(b)(4)		Yes	
63.6(b)(5)		Yes	
63.6(b)(6)		No	[Reserved]
63.6(b)(7)		Yes	
63.6(c)(1)	Compliance Date for Existing Sources	No	Subpart LL specifies compliance date for existing sources
63.6(c)(2)		Yes	
63.6(c)(3)-(c)(4)		No	[Reserved]
63.6(c)(5)		Yes	
63.6(d)		No	[Reserved]
63.6(e)(1)-(e)(2)	Operation & Maintenance	Yes	
63.6(e)(3)	Startup, Shutdown Malfunction Plan	Yes	
63.6(f)(1)	Compliance with Emission Standards	Yes	
63.6(f)(2)		Yes	
63.6(f)(3)		Yes	
63.6(g)(1)-(g)(3)	Alternative Standard	Yes	
63.6(h)	Opacity/VE Standards	No	Subpart LL does not require COMS, VE or opacity standards

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.6(i)(1)-(i)(14)	Extension of Compliance	Yes	
63.6(i)(15)		No	[Reserved]
63.6(i)(16)		Yes	
63.6(j)	Exemption from Compliance	Yes	
63.7(a)(1)-(a)(3)	Performance Testing Requirements	Yes	
63.7(b)	Notification	Yes	
63.7(c)	Quality Assurance/Test Plan	Yes	
63.7(d)	Testing Facilities	Yes	
63.7(e)(1)	Conduct of Tests	Yes	
63.7(e)(2)		Yes	
63.7(e)(3)		Yes	
63.7(e)(4)		Yes	
63.7(f)	Alternative Test Method	Yes	
63.7(g)	Data Analysis	Yes	
63.7(h)	Waiver of Tests	Yes	
63.8(a)(1)	Monitoring Requirements	Yes	
63.8(a)(2)		Yes	
63.8(a)(3)		No	[Reserved]
63.8(a)(4)		Yes	
63.8(b)(1)	Conduct of Monitoring	Yes	
63.8(b)(2)		Yes	

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.8(b)(3)		Yes	
63.8(c)(1)	CMS Operation/ Maintenance	Yes	
63.8(c)(2)		Yes	
63.8(c)(3)		Yes	
63.8(c)(4) - (c)(8)	CMS Operation/ Maintenance	No	Subpart LL does not require COMS/CMS or CMS performance specification
63.8(d)	Quality Control	No	
63.8(e)	Performance Evaluation for CMS	No	
63.8(f)(1)-(f)(5)	Alternative Monitoring Method	Yes	
63.8(f)(6)	Alternative to RATA Test	Yes	
63.8(g)	Data Reduction	Yes	
63.9(a)	Notification Requirements	Yes	
63.9(b)(1)	Initial Notifications	Yes	
63.9(b)(2)		Yes	
63.9(b)(3)		Yes	
63.9(b)(4)		Yes	
63.9(b)(5)		Yes	
63.9(c)	Request for Compliance Extension	Yes	
63.9(d)	New Source Notification	Yes	

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
	for Special Compliance Requirements		
63.9(e)	Notification of Performance Test	Yes	
63.9(f)	Notification of VE/Opacity Test	No	
63.9(g)	Additional CMS Notifications	No	Subpart LL does not include VE/opacity standard
63.9(h)(1)-(h)(3)	Notification of Compliance Status	Yes	
63.9(h)(4)		No	[Reserved]
63.9(h)(5)-(h)(6)		Yes	
63.9(i)	Adjustment of Deadlines	Yes	
63.9(j)	Change in Previous Info.	Yes	
63.10(a)	Recordkeeping/ Reporting	Yes	
63.10(b)	General Requirements	Yes	
63.10(c)(1)	Additional CMS Recordkeeping	Yes	
63.10(c)(2)-(c)(4)		No	[Reserved]
63.10(c)(5)-(c)(6)		Yes	
63.10(c)(7)-(c)(8)		Yes	
63.10(c)(9)		No	[Reserved]
63.10(c)(10)-(11)		Yes	
63.10(c)(12)-(14)		Yes	

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.10(c)(15)		Yes	
63.10(d)(1)	General Reporting Requirements	Yes	
63.10(d)(2)	Performance Test Results	Yes	
63.10(d)(3)	Opacity or VE Observations	No	Subpart LL does not require COM or limits for VE/opacity
63.10(d)(4)		Yes	
63.10(d)(5)	Startup, Shutdown, Malfunction Reports	Yes	
63.10(e)(1)	Additional CMS Reports	Yes	
63.10(e)(2)	Reporting Performance Evaluations	No	Performance evaluation not required
63.10(e)(3)	Excess Emissions and CMS Perfor-mance Reports	Yes	Exceedances of parameter limits are excess emissions
63.10(f)	Waiver for Recordkeeping/ Reporting	Yes	
63.11(a)-(b)	Control Device Requirements	No	Flares not applicable
63.12(a)-(c)	State Authority and Delegations	Yes	
63.13(a)-(c)	State/Regional Addresses	Yes	
63.14(a)-(b)	Incorporation by Reference	Yes	

General Provisions Citation	Requirement	Applies to Subpart LL	Comment
63.15(a)-(b)	Availability of Information	Yes	

4.0 SUMMARY OF ENVIRONMENTAL, COST, ENERGY, AND ECONOMIC IMPACTS

Currently, there are 23 primary aluminum plants, owned by 11 companies, are located in 14 States. The EPA estimates of the 23 plants, 19 would need to upgrade controls on at least one process to reduce emissions. All plants would be subject to the recordkeeping and reporting requirements.

4.1 Air Quality Impacts

Nationwide emissions from primary aluminum production operations are estimated at 6,400 tpy of TF. After implementation of the proposed standards, these emissions would decrease by almost 50 percent, to 3,400 tpy. POM emissions would be reduced by about 45 percent, from 3,200 tpy to 1,800 tpy. TF emissions from the anode bake furnaces are estimated at 700 tpy; POM emissions are estimated at 555 tpy. After control of all bake furnaces, TF emissions would be reduced by 97 percent and an 84-percent reduction would be achieved for POM emissions. POM emissions from paste production plants, estimated at 147 tpy at baseline, would be reduced by about 130 tpy, to about 16 tpy -- an 89-percent reduction from current levels. Emissions of other HAP included in the TF and POM emissions would also be reduced, as would nonHAP pollutants such as PM. For example, PM emissions would be reduced by 16,000 tpy.

4.2 Solid Waste Impacts

Solid waste is generated by wet air emission control devices, such as wet scrubbers and wet ESPs, and the accompanying wastewater treatment. Dry alumina scrubbing techniques do not generate any solid wastes because all captured solids are returned to the process. Wet scrubbers and wet ESPs generate from 6,000 to 15,000 tpy of solid waste, depending on the size of the plant. When dry scrubbers are used and all the captured solids are returned to the process, solid waste generation could be reduced by 6,000 to 15,000 tpy for a typical plant. None of the other control options has a significant impact on the generation of solid waste.

4.3 Cost Impacts

The estimated nationwide capital and annual costs of the proposed standards for all sources is $160 million and $40 million per year, respectively. The major components of the total costs are the control costs for potlines, which are estimated as $104 million in capital with a total annual cost of $23 million per year. The major cost impacts expected arise from the installation of dry alumina scrubbers for the primary control system at one plant and work practices, operating procedures, maintenance and repair, and equipment modifications at most plants. A few plants may incur capital costs to upgrade wet scrubbers used for primary control, to replace or upgrade hoods or doors, and to install automated equipment for improved emission control.

The cost estimates for paste production assume that the 18 plants without dry coke scrubbers for the control of POM emissions will install one. However, some plants may be able to meet the proposed performance standard with dry alumina scrubbers or other control devices, or they may be able to utilize many of the components of their existing system. The total capital cost is estimated at $26 million and the estimated total annualized cost is $6.1 million per year.

A dry alumina scrubber system similar to that used for the aluminum production process removes fluoride, POM, and fine particulate from the anode baking furnace exhaust gases. The system consists of a dry alumina fluidized bed scrubber, a baghouse, and the associated duct work and fans to collect and move the gases from the furnace. The scrubber adsorbs fluorides and POM, which are removed with other particulate matter in the baghouse. The spent alumina is then recycled to the potlines and the cleaned gases are released through a stack. The total capital cost, estimated at $20.6 million, assumes that all plants without a dry alumina scrubber (5 of 17) must install one. The total annualized cost is estimated at $6.2 million per year.

The direct operating costs for paste production and anode bake furnaces were estimated by averaging the operating costs for the dry coke or dry alumina scrubbers that were reported by the industry in survey responses. The operating costs reported by the industry were converted into 1994 dollars and resulted in an annual direct operating cost of $1.16 per ton of paste and $4.81 per ton of anode.

The EPA examined several options for enhanced monitoring, ranging from requiring the use of the HF continuous emission monitor to requiring monitoring of process parameters with annual emission tests. The EPA, in conjunction with States and industry representatives, selected monthly monitoring of secondary TF emissions, quarterly sampling on secondary POM emissions, and annual sampling of controlled primary emissions, coupled with monitoring of process parameters, as the most reasonable approach consistent with current State practices.

Currently, about one-third of existing potlines are sampled for TF on a regular basis. Because of the flexibility provided in the rule, many plants are expected to take advantage of the use of HF CEMs and Alcan cassettes for similar potlines, both of which are much less expensive than manual sampling using Methods 13 and 14. The nationwide capital cost estimate of $7 million for monitoring equipment includes new Method 14 manifolds, HF CEMs, and Alcan cassettes. The total annualized cost of monitoring is estimated as about $4 million per year once all plants comply with the rule. These costs may be reduced significantly as plants qualify for reduced sampling frequency (e.g., quarterly instead of monthly). The CEM will have value as a process monitoring tool, in addition to its use for monitoring to determine compliance.

4.4 Economic Impacts

The goal of the economic impact analysis was to estimate the market response to the proposed rule and determine whether there would be adverse impacts associated with it. To assess the industry-wide impacts of control costs, the market price increase resulting from the proposed rule was estimated for the primary aluminum industry. The market price increase estimate was derived by aggregating the control costs for all existing primary aluminum facilities and dividing the sum by industry revenue. This increase may be thought of as an average price increase required to recover control costs within the industry. After estimating the market price increase, the expected reduction in industry output was then calculated, using additional information regarding price elasticity estimates. The impact on industry-wide employment was also calculated, assuming that employment is proportional to output.

The market price increase calculation indicated that implementation of the controls will result in a primary aluminum market price increase of less than one percent. As a result of the low market price increase and relatively inelastic demand, the corresponding changes in output, employment, and total revenue were also low (all less than one percent). Therefore, the economic impact analysis estimates that the proposed rule will not result in significant economic impacts for the primary aluminum industry.

4.5 Non-air Quality Health and Environmental Impacts

4.5.1 Deposition. Fluoride and POM deposition on waters, such as the Great Lakes, is of mounting concern. Several references to this problem are included in the Report to Congress on the Great Waters Program. Implementation of the program recommendations would reduce emissions at many of the plants by 50 percent, including plants near the Great Lakes and those in the Midwest, which also are contributors due to the long-distance air transport of pollutants.

4.5.2 Water. A wet primary control system generates about 0.1 pound of fluorides per ton of aluminum and 0.2 pounds of total suspended solids per ton of aluminum. Four plants use scrubbers in their primary control system, and one plant plans to replace the existing wet systems with dry alumina scrubbers. As discussed above, the dry scrubbers do not control SO_2. Assuming that SO_2 requirements are not changed and these plants continue to use wet SO_2 scrubbers following the dry alumina scrubber, no significant decrease is expected in the quantity of wastewater generated by implementation of the proposed standard. Wastewater quality may be improved because most of the fluorides and particulates will be recovered by the dry scrubber and returned to the process.

4.5.3 Solid Waste. Solid waste generated from air emissions control in this industry is a direct result of wet air emission control devices and the accompanying wastewater treatment. Wet scrubbers and wet ESPs generate 120 to 154 pounds of solid waste per ton of aluminum, which results in 6,000 to 15,000 tpy for model plants ranging in size from 100,000 to 200,000 tpy. Because all the captured solids are returned to the process with dry scrubbers, the MACT standard has the potential to reduce solid waste generation by the same amount.

4.6 Energy Impacts

The electrical consumption to produce aluminum is estimated at 6 to 7 kwh per ton of aluminum (12,000 to 14,000 kwh/ton). The increase in energy consumption is estimated as an average of 145 kwh/ton for four plants. No significant effect on energy consumption for anode baking and paste production is expected to occur when control devices are replaced, although consumption will increase for those plants that have no controls.

APPENDIX A

TECHNICAL NOTE: RATIONALE FOR SUBCATEGORIES OF SOURCES FOR THE PRIMARY ALUMINUM INDUSTRY

1.0Purpose

The purpose of this note is to identify the subcategories of sources to be used in determinations of maximum achievable control technology (MACT) for the primary aluminum industry and to provide the rationale for subcategorization.

2.0 Summary

The analysis of aluminum production processes and their operation resulted in the seven subcategories for the aluminum smelting operation given in Table 1.

TABLE 1. ALUMINUM SMELTING SUBCATEGORIES

Subcategory	Number of	
	Potlines	Plants
Large center-worked prebake - CWPB1	24	8
Small center-worked prebake - CWPB2	36	6
Center-worked prebake (producing high purity aluminum) - CWPB3	4	1
Side-worked prebake- SWPB	5	2
Vertical stud Soderberg (in moderate climates)- VSS1	5	2
Vertical stud Soderberg (in cold climates)- VSS2	5	1
Horizontal stud Soderberg- HSS	12	3
Totals	91	23

The criteria used in developing these subcategories are based on air pollution control engineering differences and include consideration of the variations in process operation, emission characteristics, and control device applicability. Details are provided in the following sections.

3.0 Approach

Section 112(d) of the Clean Air Act (as amended on November 15, 1990) requires the Administrator to establish emission standards for each category or subcategory of major sources and area sources of hazardous air pollutants listed for regulation. The criteria used to develop subcategories are based on air pollution control engineering differences. The criteria include consideration of process operations (including differences between batch and continuous operations), emission characteristics, control device applicability and costs, safety, and opportunities for pollution prevention.

The approach used in this analysis is based on characterizing differences among aluminum smelting processes and control device applicability and evaluating these differences with respect to the criteria given above for developing subcategories.

4.0 Details

There are significant differences among several aluminum smelting processes that affect control device applicability, especially the hooding for the primary collection system and its capture efficiency, and emission characteristics. The rationale for the specific subcategories is provided step by step in the following sections, and the approach is illustrated schematically in Figure 1. The criteria and applicability are summarized in Table 2.

4.1 Prebake and Soderberg Processes

Prebake and Soderberg are two distinctly different processes for smelting that present different challenges for capturing emissions from the aluminum reduction cells. These two processes also have different emission characteristics, especially with respect to polycyclic organic matter (POM). A major difference between the two processes is that the anodes used in the prebake process have been formed and baked in a separate process operation (i.e., the anode bake furnace), whereas the Soderberg process bakes the anode in the reduction cell as part of the smelting operation.[i] This process difference directly affects emissions and results in larger quantities of organic compounds such as POM being emitted from the Soderberg process during smelting. In the prebake process, significant quantities of these organics are removed during the separate anode baking step, which results in lower POM emissions from the reduction cell.

Other differences between these two processes also affect emissions and their control. In the prebake process, spent anodes are periodically removed and replaced, and this operation directly affects secondary (fugitive) emissions. Conversely, "green" paste (a mixture of unbaked coke and pitch) is added in a semi-continuous manner to the Soderberg reduction cell to allow it to be baked in place and to replace the anode as it is consumed. In addition, there are differences in the type and efficiency of hooding used for the two processes. In general,

TABLE 2. SUMMARY OF CRITERIA USED TO DEVELOP SUBCATEGORIES

Types of processes compared	Criteria-differences in the following:[a]		
	Process operation[b]	Emissions quantity	Capture and control equipment[c]
Prebake vs. Soderberg	yes	yes	yes
CWPB vs. SWPB	yes	yes	yes
CWPB1 vs. CWPB2	yes	yes	yes
CWPB1 vs. CWPB3	no	yes	yes
VSS vs. HSS	yes	yes	yes
VSS1 vs. VSS2	no	yes	yes

[a]These columns indicate if there are differences between the processes with respect to the given criterion. Other criteria (cost, safety, pollution prevention opportunities) were not judged to be significant for the subcategories.

[b]Differences in process operation that affect emissions or their control.

[c]The differences are primarily in the type of capture system that can be used and its resulting capture efficiency.

CWPB = center-worked prebake
SWPB = side-worked prebake
HSS = horizontal stud Soderberg
VSS = vertical stud Soderberg

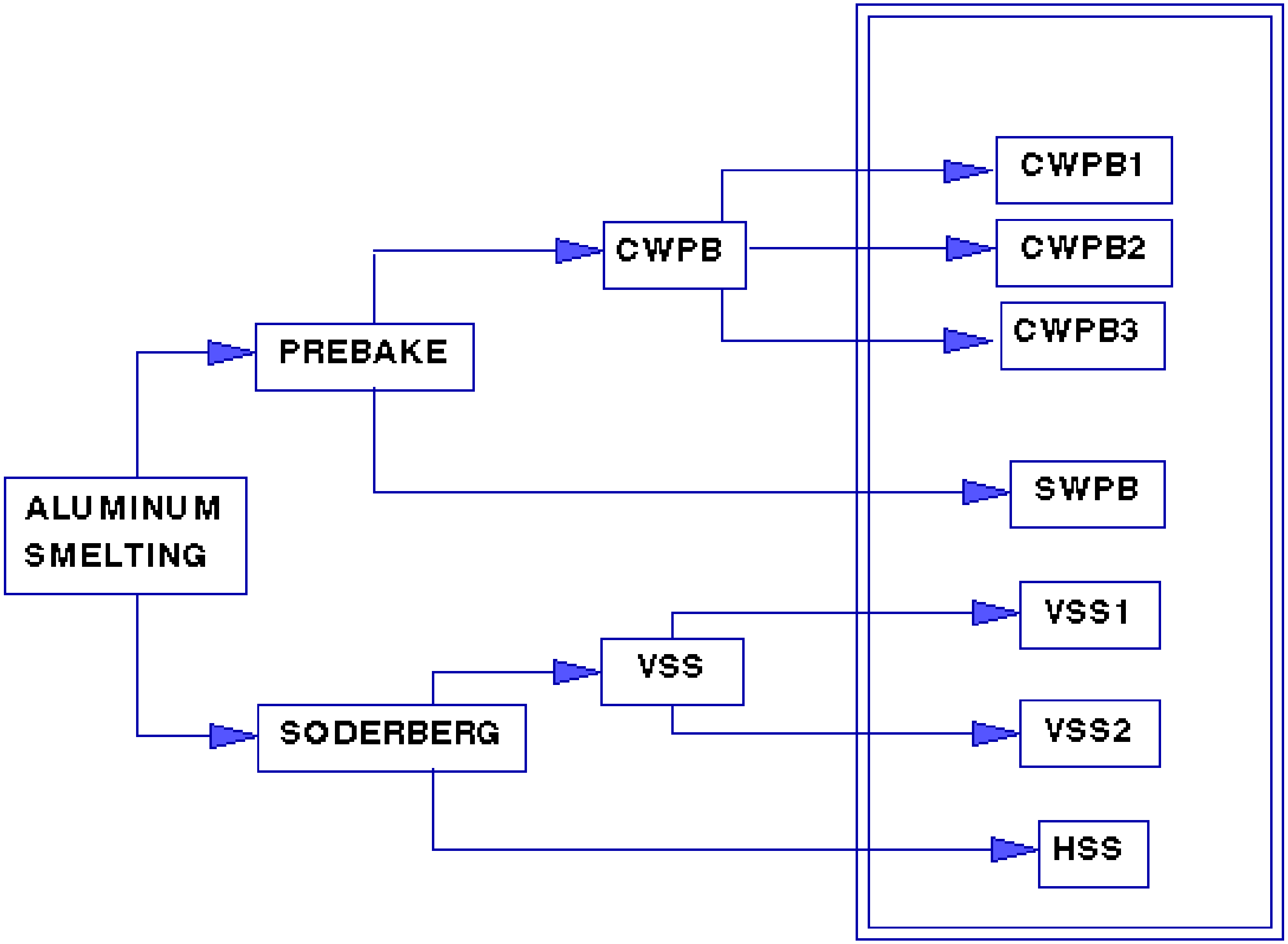

FIGURE 1. PRIMARY ALUMINUM SMELTING SUBCATEGORIZATION

the hoods used for the Soderberg process have lower capture efficiencies because the gases evolving from the Soderberg cell are more difficult to capture.[ii]

4.2 Center-Worked and Side-Worked Prebake

Within the prebake process, center-worked (CWPB) and side-worked (SWPB) units have significant differences in design of the equipment, its operation, and applicable emission controls, especially in the capture of primary emissions. The process and operational differences include the placement of the anodes, the type of side shields used, the method of alumina addition, and how the reduction cells are worked.[iii]

In the SWPB process, alumina is added along the sides of the reduction cell and the anodes are set close together near the center line. In the CWPB process, alumina is added down the center of the pot and the anodes are closer to the side. Consequently, the covers and hoods for the primary collection system are different for these two types of units because of the design, placement of anodes, and working the bath from the center versus from the side. In addition, the newer CWPB units can be equipped with computer-controlled crust breakers and point feeders, which often allow them to be worked without removing the side shields.

The design and operational differences between SWPB and CWPB result in different design considerations for the primary collection system. In general, emissions from the CWPB reduction cells can be captured with a higher efficiency than those from SWPB cells.[iv]

4.3 Subcategories for Center-Worked Prebake

The investigation of the CWPB process indicates that there are two different designs that directly affect the ability of the operator to control emissions. One group is composed of CWPB reduction cells that are larger, generally newer, and operate at higher amperages than the older and smaller CWPB units. The major factor affecting the difference in emissions and controls for the two types of units is the number of anode changes required. More frequent anode changes result in greater quantities of secondary (fugitive) emissions that are difficult to capture and control.

There are other differences between the large and small CWPB units that affect emissions and their capture.

Access is required more often to the smaller units because they are generally more unstable and are less likely to have computer controls. More frequent access means the shields of the primary collection system are opened more frequently and perhaps for longer periods, which results in poorer emission capture and higher emissions. Another factor is the smaller units generally have more anodes per reduction cell, which affects the design and capture efficiency of the hooding.[v] These combinations of factors indicate that the larger CWPB units have lower emissions per ton of aluminum produced and that less emissions escape capture by the primary collection system.

A separate subcategory was developed for four center-worked prebake potlines with wet primary control systems (CWPB3). These potlines produce a high purity aluminum for a specialized market, and they can do so only because metal impurities are removed with the sludge from the wet scrubbers. If these potlines were required to install dry alumina scrubbers, the contaminants would be returned to the reduction cell and contaminate the aluminum. The company claims that if they must meet MACT for the prebake subcategory of modern potlines with dry alumina scrubbers, they could lose their market for high purity aluminum. The EPA is requesting comments on the issue of a separate subcategory for plants that produce high purity aluminum.

4.4 Horizontal and Vertical Stud Soderberg

There are two distinct designs used in the Soderberg process: horizontal stud (HSS) and vertical stud (VSS). As the names imply, in one case the steel studs that carry current project vertically through the unbaked paste and into the baked portion of the anode, and in the other case the studs project horizontally. The differences in design and operation result in different types of hooding and evacuation rates, both of which affect emissions and controls. In the VSS cell, the stationary anode casing and vertical projection of the studs through the anode allow the installation of a gas collection skirt between the anode casing and bath. The collected gases are ducted to burners where carbon monoxide, tars, and other hydrocarbons are burned prior to the primary control device.[vi]

The design of the HSS cell prevents the installation of integral gas collection because the anode casing is formed by removable channels that support the studs, and these channels must be periodically changed as the anode moves downward. Consequently, the hooding for the HSS cell is restricted to a design that results in air infiltration and dilution. The gases from the HSS cell are too dilute to support combustion in burners.[vii] A typical VSS cell has an evacuation rate on the order of 500 ft^3/min compared to a range of 3,500 to 5,000 ft^3/min for an HSS cell.[viii]

4.5 Vertical Stud Soderberg with and without wet roof scrubbers

Two VSS plants with five potlines use wet roof scrubbers to control secondary emissions, and the third plant also with five potlines uses work practices for secondary emission control. Consequently, the EPA investigated the use of wet roof scrubbers as the MACT floor technology for all VSS plants. However, data obtained from Intalco Aluminum (in Ferndale, WA) on their wet roof scrubber operation indicated that their scrubbers were shut down in periods of cold weather to avoid damage to the scrubbers and water treatment plant.

The data from Intalco indicated that their scrubbers were shut down due to cold weather an average of 36 days per year (a range of 19 to 48 days/year from 1986 to 1993). This represents a down time of 10 percent, i.e., they operate about 90 percent of the year. The procedure used at Intalco is to shut the scrubbers down when the temperature reaches 27°F and the temperature is predicted to drop further.

The VSS plant without roof scrubbers in located in northern Montana where the weather is much colder than that in Ferndale. Data obtained from the National Weather Service for Kalispell, MT, which is near the location of Columbia Falls' VSS plant, indicated that the normal daily average temperature was below 27°F about 21 percent of the time and the normal daily low temperature was below 27°F about 40 percent of the year. Consequently, the use of wet roof scrubbers based on Intalco's experience suggests that scrubbers installed in northern Montana could be shut down on the order of 20 to 40 percent of the time.

In assessing the achievability of a technology-based standard, EPA must show that a standard is capable of being met under most adverse conditions that can reasonably be expected to occur. The EPA determined that wet roof scrubber technology has not been adequately demonstrated for very cold climates and is not applicable as the MACT floor technology for the VSS plant in Montana. Consequently, a separate subcategory (VSS2) was created for the five VSS potlines in Montana, and the MACT floor for this subcategory would be determined by the average emission limitation achieved by these five potlines.

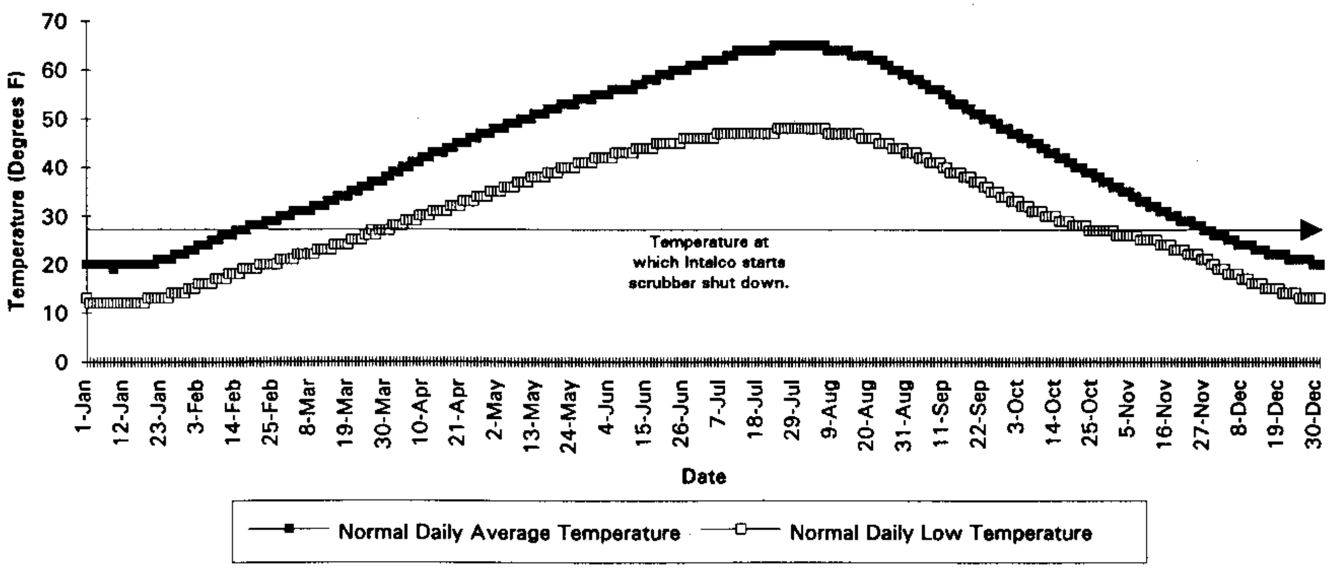

FIGURE 3. NORMAL DAILY AVERAGE AND LOW TEMPERATURES FOR KALISPELL, MT

5.0 References

i. Primary Aluminum: Guidelines for Control of Fluoride Emissions from Existing Primary Aluminum Plants. EPA-450/2-78-049b. December 1979.

ii. Reference 1.

iii. Reference 1.

iv. Reference 1.

v. Memorandum from Ours, K. D., Research Triangle Institute, to W. S. Fruh, EPA/ISB. June 10, 1994. Summary of Meeting with Aluminum Industry Representatives. 10 pp.

vi. Reference 1.

vii. Reference 1.

viii. Compiled from responses by each plant in the industry to Information Collection Requests issued under Section 114 of the Clean Air Act Amendments.

APPENDIX B: MACT FLOOR DETERMINATIONS

I. **Purpose**:

The purpose of this technical note is to explain how emission limits for the MACT floor sources were developed.

II. **Approach**:

The averages of the top five potlines were used as the basis for determining the MACT floor because there were fewer than 30 sources in each category or subcategory. For potlines, the median potline (i.e., the third best performing among the five best performing) was chosen to represent the average emission limitation achieved by the top five. Historical data for total fluoride for the MACT floor potlines were used and were supplemented by additional data collected during the MACT test program, especially for polycyclic organic matter (POM). The data are given in EPA's rulemaking docket for primary aluminum and are also listed in Appendix D of this document.

The overall approach included evaluating historical data when available, identifying any values not representative of normal operation, and determining the level of control that had been achieved by the MACT floor potline. When historical data were not available (e.g., for POM), a statistical approach based on estimation of upper confidence levels was used to determine the level of control that had been achieved.

III. **Results**:

A. Total Fluoride from Potlines

The historical data for total fluoride (TF) were reviewed and discussed with the various companies to identify and delete "outliers", which are values that are not representative of normal operation. The historical data were then analyzed in the way the rule will be implemented -- as monthly averages. The emission limits for the MACT floor for TF were chosen from the review of the data from the highest monthly averages in the data set. This approach ensures that the limits for TF associated with the MACT floor have been achieved by the MACT floor potlines on which they are based. [See Appendix D for the listing of monthly averages for the MACT floor potlines.]

Adequate historical data for TF were available to characterize the MACT floor for the following subcategories of potlines as identified in Appendix A: CWPB1, CWPB2, SWPB, HSS, VSS1, and VSS2. The results (MACT floor limits) are summarized in Table 1.

There were very few historical data available for the CWPB3 subcategory, and the plant that comprises the subcategory indicated that major improvements had been made or were underway

TABLE 1. SUMMARY OF MACT FLOOR DATA FOR POTLINES (lb TF/ton)

Plant	N	Mean[a]	Standard deviation	MACT floor limit	Comments
Noranda Line 3 (CWPB1)	46	1.13	0.32	1.9	45 monthly averages, 1/89-12/92, plus MACT program results
Kaiser-Mead Line 1 (CWPB2)	13	2.18	0.49	3.0	12 monthly averages (generally 4 runs per month) 8/93-7/94, plus MACT program results
Intalco Line C (SWPB)	45	0.97	0.26	1.6	45 monthly averages, 1/90-12/93; Monthly roof and 12-mo average for primary
Kaiser-Tacoma Line 2 (HSS)	23	2.07	0.36	2.7	22 monthly averages, 3/93-12/94, plus MACT program results
Columbia-Goldendale Line 1 (VSS1)	31	1.31	0.42	2.2	30 monthly averages, 1/92-6/94, plus MACT program results
Columbia Falls (VSS2)	7	2.22	0.31[b]	2.7	7 averages of 3 runs, 10/94-12/94
Mt. Holly A & B	26	0.81	0.14	1.2	26 monthly averages 1/89-12/92

[a] These mean values also include emissions from the primary control system.
[b] The standard deviation was obtained from historical data submitted by the company.

to reduce both secondary emissions and emissions from the wet scrubbers used for the primary control system. The available data and information from the plant indicated that a study of their system showed they had achieved a level of performance that would ensure that they are meeting a monthly limit of 2.5 lb/ton.[20] Consequently, the EPA determined that a TF limit of **2.5 lb/ton** represented the MACT floor for CWPB3.

B. POM from Soderberg Potlines

The results of the analysis of POM emissions from HSS potlines are summarized in Table 2. For the HSS subcategory, the MACT floor was determined from the 95th percentiles for the averages of 3 runs for both primary and secondary POM emissions. The result was a MACT floor level of **4.7 lb POM/ton** from the sum of 2.7 (secondary emissions) and 2.0 lb/ton (primary system emissions).

The POM limits for VSS1 are based on the limited test data available from one potline at Columbia-Goldendale and one potline at Northwest Aluminum. The results from these two potlines were combined to provide enough data to assess performance and to represent the MACT floor. These two potlines achieved a level of 2.4 lb/ton. There were no validated POM data available for the VSS2 subcategory; however, POM data for the VSS1 subcategory before the wet roof scrubbers represent the same process configuration as that for VSS2. Consequently, the VSS1 POM data were used to derive limits for VSS2. The POM emissions at the inlet to the wet roof scrubbers did not exceed 3.7 lb/ton.

C. POM Limit for New Potlines

A POM limit was derived for new potlines based on the data from sampling at Noranda's Line 3. The average POM from roof sampling was 0.106 lb/ton, and the values from the primary system were 0.426, 0.115, and 0.088. The roof emissions were added to the primary system results to obtain three data points with an average of 0.316 and a standard deviation of 0.188. The 95th percentile was chosen as the MACT floor for new potlines:

95th percentile = 0.316 + 1.645 * 0.188 = **0.63 lb/ton**

D. POM and TF Emissions from Anode Bake Furnaces

[20] Memorandum from W. Hill, Southwire Company, to M. McKeever, EPA/OAQPS/ESD, dated May 23, 1995.

Data for anode bake furnaces are given in Table 3 for both TF and POM. The results for anode bake furnaces were converted

TABLE 2. SUMMARY OF MACT FLOOR POM DATA FOR HSS POTLINES (lb/ton)

Plant	N	Mean	Standard deviation	MACT floor[a]	Comments
Kaiser-Tacoma Line 2 (HSS): secondary (roof) emissions	5	1.82	0.52	2.7	Based on averages of 3 runs from MACT program results
Kaiser-Tacoma Line 2 (HSS): primary system emissions	3	0.781	0.756	2.0	Based on averages of 3 runs from MACT program results

[a] Based on the 95th percentile from (mean + 1.645 * standard deviation).

TABLE 3. SUMMARY OF MACT FLOOR DATA FOR BAKE FURNACES (lb/ton of anode)

Plant	N	Mean	Standard deviation	Comments
Noranda -- TF	33	0.070	0.118	Averages of 3 runs (96 individual runs 9/83-7/93 plus 4 runs from MACT test program)
Alumax- Mt. Holly -- TF	9	0.0071	0.0065	9 individual runs 1992-1994
	3	0.0071	0.0056	Averages of 3 runs
Kaiser-Mead -- TF	3	0.013	0.007	3 individual runs, MACT test program
Noranda -- POM	3	0.025	0.012	3 individual runs, MACT test program
Kaiser-Mead -- POM	3	0.16	0.011	3 individual runs, MACT test program

from lb/ton of aluminum to lb/ton of anode by multiplying by 2.

There are eight bake furnaces currently subject to the NSPS level of 0.20 lb/ton anode, and these bake furnaces include the top 5 best performing in the industry. A review of the available data indicated that the NSPS level represented the average limit achieved by the top five, and it also represented a level of control demonstrated by the data as achievable. Consequently, the EPA determined that 0.20 lb/ton anode represented the MACT floor for TF emissions from bake furnaces.

The MACT floor for POM from bake furnaces was based on data collected at Kaiser-Mead during the MACT floor test program, which indicated a level of **0.18 lb POM/ton** had been achieved. The TF limit for new bake furnaces was based on data from Alumax that showed a level of **0.02 lb TF/ton** had been achieved (at the 99th percentile). The best-performing bake furnace for which POM data were available was Noranda's furnace that showed a level of **0.05 lb POM/ton** had been achieved (at the 99th percentile).

IV. Emissions Averaging

A. Total fluoride from potlines

An approach is presented here to develop a mechanism to allow emissions averaging across multiple potlines. The approach attempts to provide a rough estimate of the standard deviation when averaging across multiple potlines for comparison to a monthly average limit. When averaging is used, the variability (standard deviation) decreases. Consequently, the approach attempts to derive limits that will ensure that emissions do not increase above the levels expected if each potline had to comply with the monthly limit for an individual line.

The approach is based on reducing the standard deviation for the MACT floor potlines by the square root of "N" (i.e., dividing by the square root of N), where N is the number of potlines that will be used for emission averaging at a specific plant. The mean and standard deviation used for each subcategory are given in Table 4. These values were used in the equation given below to calculate limits for emission averaging for each subcategory for different numbers of potlines that might be used in the averaging approach. The results are summarized in Table 5.

$$\text{Averaging limit} = \text{mean} + z^*(sd/N^{0.5})$$

where:

"z" is the constant representing the 95th (1.645) or 99th (2.326) percentile,
"sd" is the standard deviation from Table 4, and
"N" is the number of potlines used in averaging.

For example, the average for CWPB2 (Kaiser-Mead) was 2.18 lb/ton and the standard deviation was 0.49. For the case of averaging across 3 potlines, the limit is calculated as:

$$\text{Limit (3 lines)} = 2.18 + 2.326*(0.49)/3^{0.5} = 2.8 \text{ lb/ton.}$$

For the CWPB3 category for which there were no useful historical data, the single potline limit of 2.5 lb/ton was assumed to represent the 99th percentile and the standard deviation was assumed to be similar to that for CWPB1. The mean that would be needed to achieve a limit of 2.5 lb/ton was then calculated from:

$$\text{Mean} = 2.5 - 2.326*0.32 = 1.8 \text{ lb/ton.}$$

TABLE 4. SUMMARY OF VALUES USED FOR CALCULATING EMISSION AVERAGING LIMITS FOR TF

Subcategory	Total fluoride (lb/ton)		z
	Mean	Standard deviation	
CWPB1	1.13	0.32	2.326
CWPB2	2.18	0.49	2.326
CWPB3	1.80	0.32	2.326
SWPB	0.97	0.26	2.326
HSS	2.07	0.36	1.645*
VSS1	1.31	0.42	2.326
VSS2	2.22	0.31	1.645*

* The constant for the 95th percentile is used for these subcategories to be consistent with the derivation of the single line limit and to ensure that emissions do not increase from averaging emissions.

TABLE 5. POTLINE TF AND POM LIMITS FOR EMISSIONS AVERAGING

Type	Monthly TF limit (lb/ton) for given number of potlines						
	2 lines	3 lines	4 lines	5 lines	6 lines	7 lines	8 lines
CWPB1	1.7	1.6	1.5	1.5	1.4	1.4	1.4
CWPB2	2.9	2.8	2.7	2.7	2.6	2.6	2.6
CWPB3	2.3	2.2	2.2	2.1	2.1	2.1	2.1
VSS1	2.0	1.9	1.8	1.7	1.7	1.7	1.7
VSS2	2.6	2.5	2.5	2.4	2.4	2.4	2.4
HSS	2.5	2.4	2.4	2.3	2.3	2.3	2.3
SWPB	1.4	1.3	1.3	1.2	1.2	1.2	1.2
	Monthly POM limit (lb/ton) for number of potlines						
HSS	4.1	3.8	3.7	3.5	3.5	3.4	3.3
VSS1	2.1	2.0	1.9	1.9	1.8	1.8	1.8
VSS2	3.4	3.2	3.2	3.1	3.1	3.0	3.0

B. POM from potlines

Emission averaging limits for POM are derived for Kaiser-Tacoma and the HSS subcategory in the same manner described earlier. The mean and standard deviations from Table 2 are used in the example calculations given below:

Monthly limit when averaging across 3 potlines:

Primary control system

Limit = 0.781 + 1.645 (0.756)/(3)$^{0.5}$ = **1.5 lb/t**

Secondary emissions

Limit = 1.82 + 1.645 (0.52)/(3)$^{0.5}$ = **2.3 lb/t**

For the VSS1 subcategory, the approach is based on the test results for POM from the wet roof scrubbers with an average of 1.42 lb/ton and a standard deviation of 0.92. The value of "z" was calculated from the mean, standard devation, and the single line limit of 2.4 lb/ton:

$$z = (2.4 - 1.42)/0.92 = 1.065.$$

This value of z was then used to calculate emission averaging limits as in the example when averaging across 3 potlines:

Limit = 1.42 + 1.065 (0.92)/(3)$^{0.5}$ = **2.0 lb/t**

For the VSS2 subcategory, the approach is based on the test results for POM at the inlet to the wet roof scrubbers with an average of 2.63 lb/ton and a standard deviation of 1.04. The value of "z" was calculated from the mean, standard devation, and the single line limit of 3.7 lb/ton:

$$z = (3.7 - 2.63)/1.04 = 1.029.$$

This value of z was then used to calculate emission averaging limits as in the example when averaging across 3 potlines:

Limit = 2.63 + 1.029 (1.04)/(3)$^{0.5}$ = **3.2 lb/t**

C. Total fluoride from bake furnaces

Emissions averaging limits for fluoride from bake furnaces were derived from the data for Noranda's bake furnace and are based on a log normal distribution. The log average was -3.467 and the standard deviation (log form) was 1.154. An example calculation is given below for averaging across 3 bake furnaces:

Limit = exp $[-3.467 + 1.645\ (1.154)/(3)^{0.5}]$=exp[-2.37] = **0.09 lb/t**

Repeating this process for different numbers of bake furnaces gives the limits listed in Table 6.

D. POM from bake furnaces

POM limits for bake furnaces were derived from the data from the tests at Kaiser-Mead. The very small standard deviation resulted in emissions averaging limits with the same value as that for a single bake furnace (0.17 lb/ton). These results are also summarized in Table 6.

TABLE 6. EMISSIONS AVERAGING LIMITS FOR BAKE FURNACES

Number of furnaces	Averaging limits (lb/t of anode)	
	TF	POM
2	0.12	0.17
3	0.09	0.17
4	0.08	0.17
5	0.07	0.17

APPENDIX C: EVALUATION OF WET ROOF SCRUBBERS AS A CONTROL OPTION FOR SECONDARY EMISSIONS--BEYOND THE FLOOR

I. Purpose:

The purpose of this note is to estimate the impacts of installing wet roof scrubbers for the control of secondary emissions from aluminum smelting. Wet roof scrubbers are being considered as an option for a level of control that is more stringent than the MACT floor (i.e., "beyond the MACT floor").

II. Approach:

Estimates are provided for three cases: 1) a plant that already has wet roof scrubbers installed, 2) retrofitting the scrubbers at a vertical stud Soderberg (VSS) plant that has good control of secondary emissions through improved operation and maintenance, and 3) installing the scrubbers on a new center-worked prebake (CWPB) plant that has good control of secondary emissions through improved operation and maintenance, new hooding, and automated controls. Estimates of impacts are presented for emission reductions and costs, and the effects on solid waste generation and wastewater are discussed.

III. Estimates of Emission Reduction

Northwest Aluminum currently has wet roof scrubbers on their VSS potrooms and was chosen to represent the first case (evaluation of a plant that already has wet roof scrubbers). Emission testing was conducted at this plant for EPA in August 1993.[1] Table 1 is a summary of the test results for controlled and uncontrolled emission rates and control efficiency for the wet roof scrubbers.

The control efficiencies for the different pollutants from the tests at Northwest Aluminum are used in this analysis to estimate the potential for emission reduction if wet roof scrubbers were retrofitted at an existing facility or included in the construction of a new facility. For these two cases, the actual percent emission reduction may be less than that from Northwest Aluminum because these other plants would have lower concentrations of pollutants entering the scrubbers.

Columbia Falls Aluminum Company (CFAC) is a VSS plant that controls secondary emissions using improved operation and maintenance without wet roof scrubbers. This plant will be used to represent the second case of retrofitting wet roof scrubbers at an existing plant. CFAC reported TF emission rates of 2.1 lb/ton and gaseous fluoride rates of 1.0 lb/ton from testing the potrooms using Methods 13 and 14.[2]

TABLE 1. TEST RESULTS FOR THE WET ROOF SCRUBBERS AT NORTHWEST ALUMINUM

Pollutant	Inlet (lb/ton)	Outlet (lb/ton)	Percent control	Reduction (lb/ton)
Particulate matter	38.7	17.5	55	21.2
Polycyclic organic matter	3.7	1.8	51	1.9
Gaseous fluoride	3.0	0.39	87	2.6
Total fluoride	10.4	2.0	80	8.4

POM emissions from CFAC are estimated from the ratio of POM:GF entering the scrubbers from the Northwest Aluminum test (1.2). Particulate matter emissions for CFAC are based on the ratio of PM:TF measured at Northwest Aluminum (3.7).

Table 2 presents the TF and GF emission rates reported by CFAC and the PM and POM emission rates estimated from the ratios. The reduction in emissions that would be achieved by retrofitting wet roof scrubbers is estimated from the control efficiencies measured at Northwest Aluminum. [Note: For this analysis, estimates of gaseous fluoride are based on the back-half analysis of fluoride that passes through the front-half filter.]

TABLE 2. ESTIMATED EMISSION REDUCTIONS FROM RETROFIT OF WET ROOF SCRUBBERS AT COLUMBIA FALLS ALUMINUM

Pollutant	Inlet (lb/ton)	Outlet (lb/ton)	Percent control	Reduction (lb/ton)
PM	7.8	3.5	55	4.3
POM	1.2	0.6	51	0.6
GF	1.0	0.13	87	0.87
TF	2.1	0.4	80	1.7

Alumax of South Carolina is a relatively new and well controlled CWPB plant without wet roof scrubbers. This plant was chosen for the evaluation of wet roof scrubbers on new plants. Alumax reported TF and GF data from their potrooms as shown in Table 3.[3] The POM emissions were estimated as less than 0.3 lb/ton from the test results at Noranda[4], which is also an NSPS CWPB plant. PM emissions were estimated from the ratio of PM:TF (3.3) measured at another CWPB plant (Kaiser, Mead).[5]

Table 3 presents the reported TF and GF emission rates for Alumax and the estimated PM and POM emission rates from the ratios from other tests. The table also gives the estimated the reduction in emissions that might be achieved from wet roof scrubbers (assuming the same control efficiencies as those reported in the Northwest Aluminum test).

TABLE 3. ESTIMATED EMISSION REDUCTIONS FROM RETROFIT OF WET ROOF SCRUBBERS AT ALUMAX

Pollutant	Inlet (lb/ton)	Outlet (lb/ton)	Percent control	Reduction (lb/ton)
PM	2.4	1.1	55	1.3
POM	<0.3	<0.15	51	<0.15
GF	0.37	0.05	87	0.32
TF	0.73	0.15	80	0.58

IV. Cost Estimate:

In 1975, Columbia Falls Aluminum Company estimated the cost of installing SF-type multiventuri wet roof scrubbers and a wastewater treatment system to be $20,540,000. The Marshall & Swift Equipment Cost Index published in Chemical Engineering Magazine was used to convert the 1975 cost estimate into 1994 dollars, which is $45,319,000 or $245 per ton of annual capacity.

In 1970 Northwest Aluminum installed wet roof scrubbers at a total cost of $5,255,000. In 1990, the same plant installed a water treatment pond at a cost of $2,400,000. The total cost in 1994 dollars is approximately $19,556,000 or about $223 per ton of annual capacity.

The average of the two capital costs is $234 per ton of annual capacity. For an estimated life of 30 years, the capital recovery factor is 0.081, which yields an annual cost of capital of $19/ton.

Operating costs provided from responses to information collection requests averaged about $8.57/ton aluminum for those plants that currently have wet roof scrubbers. Adding the operating cost to the annual cost of capital gives a total annualized cost of about $27.60/ton.

V. Estimate of Cost Effectiveness:

The estimate of total annualized cost is used in Table 4 along with the annual emission reduction developed earlier to estimate the cost effectiveness for the three cases. Cases 2 and 3 are of primary interest because they represent the cost effectiveness of retrofitting wet roof scrubbers at an existing plant (Case 2) and incorporating wet roof scrubbers into the construction of a new plant (Case 3). The cost effectiveness for HAPs ranges from about $38,000 to over $120,000/ton for these two cases.

TABLE 4. ESTIMATES OF COST EFFECTIVENESS OF WET ROOF SCRUBBERS

	Case 1 (existing VSS)	Case 2 (retrofit to VSS)	Case 3 (new CWPB)
Capacity (t/yr)	88,000	185,000	200,000
Capital cost ($)	20,600,000	43,000,000	47,000,000
Total annualized cost ($/yr)	2,400,000	5,100,000	5,500,000
PM reduction (t/yr)	930	400	130
POM* reduction (t/yr)	84	56	<15
GF* reduction (t/yr)	114	80	32
TF reduction (t/yr)	370	157	58
HAP* reduction (t/yr)	198	136	47
Cost effectiveness for PM ($/ton PM)	2,600	13,000	42,000
Cost effectiveness for POM ($/ton POM)	29,000	91,000	>370,000
Cost effectiveness for GF ($/ton GF)	21,000	64,000	170,000
Cost effectiveness for TF ($/ton TF)	6,500	32,000	95,000
Cost effectiveness for HAPs ($/ton GF + POM)	12,000	38,000	120,000

*GF is assumed to be primarily hydrogen fluoride for the purpose of estimating emissions of HAPs. POM are represented by using methylene chloride extractables as a surrogate.

VI. <u>Other Impacts</u>:

The use of wet roof scrubbers increases the use of electricity and water, and the scrubbers generate a sludge and wastewater stream. Data from two plants with wet roof scrubbers indicated that sludge is generated at a rate of 9 to 26 lb/t aluminum and wastewater is generated at a rate of 100 to 600 gal/min.[6] Using a midrange value of 18 lb/t for solid waste generation, the quantity of sludge produced for the three example plants ranges from about 800 to 1,800 t/yr (for capacities of 88,000 to 200,000 t/yr). Increased electrical usage is estimated as 300 kwh/t aluminum for the operation of wet roof scrubbers and lime treatment of the water.[7]

VII. References:

1. Emissions Measurement Test Report - Northwest Aluminum Company. Prepared by Entropy, Inc. June 1994. 77 p.

2. Data provided by Don Ryan, Columbia Falls Aluminum, Montana, to Steve Fruh, EPA. January 1995.

3. Data submitted by the Aluminum Association: "Total Fluoride Emission Assessment." Covers the period from January 1989 through December 1992.

4. Noranda Aluminum, Inc. Method 5/POM and 13B Testing - New Madrid, Missouri - September 14-20, 1994. Prepared by AmTest Air Quality, Inc. January 10, 1994. pp. 1 through 62.

5. Kaiser Aluminum and Chemical Corporation Method 5/POM and 13B Testing - Mead, Washington - March 15-24, 1994. Prepared by AmTest Air Quality, Inc. November 9, 1994. pp. 1 through 99.

6. Compiled from responses by each plant in the industry to information collection requests.

7. Primary Aluminum: Guidelines for Control of Fluoride Emissions from Existing Primary Aluminum Plants. U.S. Environmental Protection Agency. Report No. EPA-450/2-78-049b. December 1979. p. 9-33.

APPENDIX D. COMPLETE LISTING OF MACT FLOOR DATA

MACT FLOOR DATA

A brief description of the tables is given below. In general, the analysis focused on the monthly averages (generally 3 to 4 runs per month) for secondary (roof) emissions except for plants with wet roof scrubbers. The monthly averages for wet roof scrubbers were composed of tests of 3 to 6 fans per month.

Table 1: The data for Mt. Holly Lines A and B were provided by the Aluminum Association in a submittal commonly referred to as the "blue book" data.[1] Alumax provided corrections for several data points for Line B.[2] Results are for both primary and secondary emissions.

Table 2: The data for Columbia-Goldendale were submitted by the company[3] and are the monthly averages from sampling four fans each month.

Table 3: The data for Noranda were submitted by the company and represent individual runs for secondary emissions.[4] The results of a test conducted for the MACT test program (labeled "Amtest") were also added to the data set.[5]

Table 4: The Columbia Falls data (secondary emissions only) were collected by EPA Methods 13/14 and submitted by the company.[6] The original data submitted by the Aluminum Association were based on a method developed by the company (i.e., not EPA methods).

Table 5: The data for Kaiser-Tacoma (secondary emissions only) were submitted by the company and were collected by EPA Methods 13/14.[7] The results of a test conducted for the MACT test program (labeled "Amtest") were also added to the data set.[8] Data submitted prior to this were not based on EPA methods.

Table 6: The data for Kaiser-Mead (secondary emissions only) were submitted by the company and were collected by EPA Methods 13/14.[9] The results of a test conducted for the MACT test program (labeled "Amtest") were also added to the data set.[10]

Table 7: The data for Intalco were submitted by the company[11] and were calculated from kg/day of total fluoride and monthly aluminum production. The results for both primary and secondary emissions are given for each run. A total of six fans are sampled each month, along with four runs for the primary system. A total of 3 scrubber tests out of 262 total were identified as outliers (2.7 to 3.2 lb/ton in January 1991).

Table 8: This analysis uses monthly averages for the wet roof scrubbers and adds a 12-month rolling average for the primary system to the monthly average of the scrubbers. (This is the way the rule is expected to be implemented.)

Table 9: This table presents the HSS POM data for secondary and primary emissions for Kaiser-Tacoma.[12] These data were collected as part of the MACT test program. Data for VSS1 are also included from tests conducted under the MACT program at Columbia-Goldendale and Northwest Aluminum.[13, 14, 15]

Table 10: The bake furnace data for Noranda were submitted by the company and were analyzed as the average of three runs.[16]

Table 11: Data for the bake furnace at Mt. Holly were submitted by the company.[17] Results shown for Kaiser-Mead and Noranda were collected under the MACT test program.[18, 19]

TABLE 1. ALUMAX MT. HOLLY -- TOTAL FLUORIDE

Line A		Line B	
MONTH	(lb/ton)	MONTH	(lb/ton)
3/89	0.77	1/89	0.81
7/89	0.77	5/89	0.74
11/89	1.02	9/89	0.96
1/90	0.67	2/90	0.68
4/90	0.63	6/90	0.75
8/90	1.17	10/90	0.78
9/90	0.74	3/91	0.72
12/90	0.84	7/91	0.89
1/91	0.77	11/91	0.87
5/91	0.76	4/92	0.74
9/91	0.87	8/92	0.81
2/92	0.56	12/92	0.63
6/92	1.04		
10/92	0.99		
Avg.	0.829		0.782
Std dev.	0.172		0.093
N	14		12

Summary of Lines A and B Combined

Avg.	0.807
Std dev.	0.141
N	26

TABLE 2. COLUMBIA-GOLDENDALE LINE 1 ROOF EMISSIONS

Date		lb/t TF
1	92	2.18
2	92	1.33
3	92	1.55
4	92	1.89
5	92	0.83
6	92	1.33
7	92	0.69
8	92	1.59
9	92	0.66
10	92	1.14
11	92	1.32
12	92	2.00
1	93	0.59
2	93	0.32
3	93	0.90
4	93	1.07
5	93	1.28
6	93	1.43
7	93	1.51
8	93	1.24
9	93	1.31
10	93	1.68
11	93	1.46
12	93	1.48
1	94	1.98
2	94	1.42
3	94	1.43
4	94	1.21
5	94	1.38
6	94	1.30

MACT test	1.05
Avg.	1.31
Std.dev.	0.42
N	31

Add 0.005 to 0.02 lb/t for primary emissions.

TABLE 3. NORANDA LINE 3 ROOF DATA (lb TF/ton)

Date	TF (lb/t)	
	Single run	Monthly average
11-Jan-89	1.07	1.22
12-Jan-89	1.40	
13-Jan-89	1.17	
14-Feb-89	0.89	0.85
15-Feb-89	0.81	
16-Feb-89	0.84	
07-Mar-89	1.22	0.96
08-Mar-89	0.99	
09-Mar-89	0.69	
11-Apr-89	1.02	0.80
12-Apr-89	0.59	
13-Apr-89	0.79	
09-May-89	1.28	1.02
10-May-89	0.79	
11-May-89	1.00	
06-Jun-89	0.92	1.01
07-Jun-89	1.03	
08-Jun-89	1.09	
11-Jul-89	0.74	0.82
12-Jul-89	0.70	
13-Jul-89	1.01	
08-Aug-89	0.80	1.02
09-Aug-89	1.11	
10-Aug-89	1.16	
18-Dec-89	0.61	0.66
19-Dec-89	0.71	
20-Dec-89	0.65	
09-Jan-90	0.59	0.92

Date	TF (lb/t)	
	Single run	Monthly average
10-Jan-90	1.04	
11-Jan-90	1.13	
06-Feb-90	0.73	0.63
07-Feb-90	0.65	
08-Feb-90	0.51	
06-Mar-90	1.92	1.81
07-Mar-90	2.41	
08-Mar-90	1.09	
03-Apr-90	2.03	1.37
04-Apr-90	0.95	
05-Apr-90	1.12	
08-May-90	0.92	0.87
09-May-90	0.81	
10-May-90	0.87	
05-Jun-90	1.12	1.19
06-Jun-90	1.24	
07-Jun-90	1.20	
10-Jul-90	1.37	1.59
11-Jul-90	1.73	
12-Jul-90	1.68	
08-Aug-90	1.34	1.33
09-Aug-90	1.13	
10-Aug-90	1.53	
11-Sep-90	1.53	1.46
12-Sep-90	1.73	
13-Sep-90	1.12	
09-Oct-90	1.18	1.58
10-Oct-90	2.29	
11-Oct-90	3.26	

TABLE 3. NORANDA LINE 3 ROOF DATA (lb TF/ton)

23-Oct-90	0.65	
24-Oct-90	0.87	
25-Oct-90	1.22	
06-Nov-90	1.42	1.31
07-Nov-90	1.20	
11-Dec-90	1.37	1.75
12-Dec-90	1.53	
13-Dec-90	2.34	
08-Jan-91	0.59	0.99
09-Jan-91	1.31	
10-Jan-91	1.09	
05-Feb-91	0.75	0.92
06-Feb-91	0.90	
07-Feb-91	1.10	
05-Mar-91	1.70	1.54
06-Mar-91	1.20	
07-Mar-91	1.71	
09-Apr-91	0.78	1.16
10-Apr-91	1.35	
11-Apr-91	1.34	
08-May-91	1.70	1.82
09-May-91	2.15	
10-May-91	1.60	
10-Jun-91	1.47	1.56
11-Jun-91	1.57	
12-Jun-91	1.63	
09-Jul-91	1.08	1.15
10-Jul-91	1.39	
11-Jul-91	0.99	
12-Aug-91	0.74	0.72
12-Aug-91	0.76	
13-Aug-91	0.93	

TABLE 3. NORANDA LINE 3 ROOF DATA (lb TF/ton)

13-Aug-91	0.54	
14-Aug-91	0.74	
14-Aug-91	0.64	
09-Sep-91	0.86	0.69
09-Sep-91	0.54	
10-Sep-91	0.76	
11-Sep-91	0.70	
11-Sep-91	0.50	
12-Sep-91	0.92	
12-Sep-91	0.58	
07-Oct-91	0.89	0.95
07-Oct-91	0.62	
08-Oct-91	0.73	
08-Oct-91	0.98	
09-Oct-91	1.09	
09-Oct-91	1.40	
05-Nov-91	0.45	0.79
05-Nov-91	0.43	
06-Nov-91	0.79	
06-Nov-91	1.10	
07-Nov-91	0.99	
07-Nov-91	1.00	
09-Dec-91	0.89	0.80
09-Dec-91	1.07	
10-Dec-91	0.94	
10-Dec-91	0.76	
11-Dec-91	0.57	
12-Dec-91	0.61	
06-Jan-92	1.04	0.90
07-Jan-92	0.62	
07-Jan-92	0.85	
08-Jan-92	0.81	

TABLE 3. NORANDA LINE 3 ROOF DATA (lb TF/ton)

08-Jan-92	0.72	
09-Jan-92	1.36	
10-Feb-92	0.97	0.93
10-Feb-92	0.50	
11-Feb-92	0.71	
11-Feb-92	1.29	
12-Feb-92	1.24	
12-Feb-92	0.85	
09-Mar-92	1.25	1.34
09-Mar-92	1.56	
10-Mar-92	1.52	
10-Mar-92	1.04	
11-Mar-92	1.96	
11-Mar-92	0.73	
06-Apr-92	0.86	0.98
06-Apr-92	0.95	
07-Apr-92	1.11	
07-Apr-92	0.49	
08-Apr-92	1.34	
08-Apr-92	1.15	
04-May-92	0.95	1.20
05-May-92	1.91	
05-May-92	0.84	
06-May-92	1.18	
07-May-92	1.57	
07-May-92	0.76	
08-Jun-92	1.17	1.12
08-Jun-92	0.95	
09-Jun-92	1.55	
09-Jun-92	0.94	
10-Jun-92	1.33	
10-Jun-92	0.78	

TABLE 3. NORANDA LINE 3 ROOF DATA (lb TF/ton)

06-Jul-92	0.85	0.66
06-Jul-92	0.53	
07-Jul-92	0.75	
07-Jul-92	0.59	
08-Jul-92	0.75	
08-Jul-92	0.50	
12-Aug-92	0.69	1.00
12-Aug-92	0.94	
13-Aug-92	1.02	
13-Aug-92	1.00	
14-Aug-92	1.34	
14-Aug-92	0.99	
08-Sep-92	0.86	0.87
08-Sep-92	0.71	
09-Sep-92	1.04	
09-Sep-92	0.90	
10-Sep-92	1.00	
10-Sep-92	0.72	
05-Oct-92	1.03	1.15
05-Oct-92	1.41	
06-Oct-92	0.99	
06-Oct-92	1.03	
07-Oct-92	1.30	
07-Oct-92	1.12	
09-Nov-92	0.98	0.78
09-Nov-92	0.82	
10-Nov-92	0.62	
10-Nov-92	0.56	
11-Nov-92	0.76	
11-Nov-92	0.95	
07-Dec-92	0.74	0.77
07-Dec-92	0.58	

TABLE 3. NORANDA LINE 3 ROOF DATA (lb TF/ton)

08-Dec-92	0.72	
09-Dec-92	0.59	
09-Dec-92	1.03	
10-Dec-92	0.96	
AMTEST	1.01	0.91
	0.83	
	0.90	
Summary:		
Avg	1.05	1.08
Std	0.41	0.32
N	192	46
Add 0.06 lb/t for primary system		

TABLE 4. COLUMBIA FALLS ROOF DATA (TF in lb/ton)

Run	SINGLE RUN	3-RUN AVG.
1	2.75	2.40
2	0.86	
3	3.58	
4	2.69	2.16
5	1.88	
6	1.91	
7	2.04	1.93
8	1.87	
9	1.89	
10	1.00	1.60
11	2.24	
12	1.57	
13	1.29	1.63
14	1.09	
15	2.52	
16	1.93	2.74
17	2.77	
18	3.53	
19	2.33	2.34
20	2.34	
	Avg.	2.12
	Std. dev.	0.42
	N	7

Add 0.095 lb/ton for primary system emissions.

TABLE 5. KAISER-TACOMA LINE 2 ROOF DATA (lb/t TF)

Date	Single run	Monthly avg
Mar-93	2.13	2.12
	1.75	
	2.47	
Apr-93	2.83	2.28
	1.84	
	2.18	
May-93	1.23	1.56
	1.60	
	1.86	
Jun-93	2.09	2.01
	2.34	
	1.61	
Jul-93	2.12	1.97
	1.56	
	2.24	
Aug-93	1.82	1.90
	1.97	
	1.91	
Sep-93	2.03	2.30
	2.42	
	2.45	
Oct-93	1.37	1.37
	1.38	
	1.36	
Nov-93	1.76	2.11
	1.92	
	2.66	
Dec-93	2.13	2.32
	2.26	
	2.56	

Date	Single run	Monthly avg
Jan-94	0.97	1.39
	1.58	
	1.61	
Feb-94	1.43	1.54
	1.76	
	1.44	
Mar-94	2.06	1.83
	2.00	
	1.43	
Apr-94	2.30	2.13
	2.13	
	1.95	
May-94	2.13	2.20
	2.07	
	2.41	
Jun-94	2.23	2.02
	1.89	
	1.93	
Jul-94	1.61	1.65
	1.68	
Aug-94	2.06	2.01
	2.25	
	1.72	
Sep-94	2.27	2.64
	3.00	
Oct-94	2.04	2.45
	2.86	
Nov-94	1.74	2.21
	2.40	
	2.50	
Dec-94	2.09	2.46

	2.32	
	2.98	
Amtest	1.06	1.24
(Mar-94)	2.12	
	0.55	
Avg	1.98	1.97
Std dev.	0.47	0.36
N	66	23
Add 0.1 lb/t for the primary system		

TABLE 6. KAISER-MEAD LINE 1 ROOF DATA (lb/ton TF)

Date	Single run	Monthly avg
Aug-93	2.62	2.37
	2.60	
	2.44	
	1.80	
Sep-93	2.98	2.90
	2.64	
	2.56	
	1.60	
	4.74	
Oct-93	2.14	1.69
	1.24	
	1.68	
	1.70	
Nov-93	1.10	1.38
	1.62	
	1.04	
	1.76	
Dec-93	0.80	1.55
	1.56	
	2.06	
	1.39	
	1.96	
Jan-94	2.14	2.02
	1.78	
	2.04	
	2.12	
Feb-94	1.70	2.62
	1.32	
	2.80	
	4.66	

Date	Single run	Monthly avg
Mar-94	2.73	2.17
	2.51	
	1.62	
	1.83	
Apr-94	1.84	2.04
	1.09	
	2.72	
	2.51	
May-94	2.23	1.78
	1.90	
	1.20	
Jun-94	1.91	1.79
	1.92	
	1.60	
	1.84	
	1.67	
Jul-94	2.05	2.71
	3.93	
	2.53	
	2.34	
Amtest	2.00	1.53
(Mar-94)	1.38	
	1.20	
Avg	2.06	2.04
Std dev.	0.78	0.49
N	53	13
Add 0.14 lb/ton to include primary system		

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/ton)

Wet roof scrubbers			Dry scrubbers		
Month/year		lb/ton	Month/year		lb/ton
1	1990	0.40	1	1990	0.18
1	1990	0.63	1	1990	0.48
1	1990	0.72	1	1990	0.05
1	1990	0.47	1	1990	0.09
1	1990	0.66	2	1990	0.26
1	1990	0.53	2	1990	0.09
3	1990	0.72	2	1990	0.13
3	1990	0.88	2	1990	0.19
3	1990	0.73	3	1990	0.28
3	1990	0.40	3	1990	0.29
3	1990	0.68	3	1990	0.40
3	1990	0.77	3	1990	0.73
4	1990	0.81	4	1990	0.26
4	1990	0.48	4	1990	0.25
4	1990	0.71	4	1990	0.06
4	1990	0.95	4	1990	0.14
4	1990	0.62	5	1990	0.24
4	1990	0.10	5	1990	0.05
5	1990	0.47	5	1990	0.06
5	1990	0.43	5	1990	0.14
5	1990	0.34	6	1990	0.85
5	1990	0.42	6	1990	0.10
5	1990	0.44	6	1990	0.10
5	1990	0.50	6	1990	0.03
6	1990	0.45	7	1990	0.08
6	1990	0.58	7	1990	0.18
6	1990	0.81	7	1990	0.14
6	1990	1.13	7	1990	0.10
6	1990	0.48	8	1990	0.10

Wet roof scrubbers			Dry scrubbers		
Month/year		lb/ton	Month/year		lb/ton
6	1990	0.54	8	1990	0.06
7	1990	0.86	8	1990	0.05
7	1990	0.78	8	1990	0.21
7	1990	0.75	9	1990	0.30
7	1990	0.50	9	1990	0.10
7	1990	0.49	9	1990	0.33
7	1990	0.64	9	1990	0.12
8	1990	1.10	10	1990	0.25
8	1990	0.61	10	1990	0.08
8	1990	0.82	10	1990	0.33
8	1990	1.05	10	1990	0.15
8	1990	0.65	11	1990	0.36
8	1990	0.77	11	1990	0.17
9	1990	0.55	11	1990	0.36
9	1990	0.66	11	1990	0.21
9	1990	0.54	12	1990	0.11
9	1990	0.81	12	1990	0.20
9	1990	0.72	12	1990	0.53
9	1990	1.11	12	1990	0.43
10	1990	1.10	1	1991	0.37
10	1990	0.65	1	1991	0.13
10	1990	0.71	1	1991	0.15
10	1990	0.66	1	1991	0.37
10	1990	0.44	2	1991	0.13
10	1990	0.49	2	1991	0.14
11	1990	0.42	2	1991	0.24
11	1990	0.45	2	1991	0.42
11	1990	0.49	3	1991	1.07
11	1990	0.63	3	1991	0.63
11	1990	0.42	3	1991	0.38

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

11	1990	0.50	3	1991	0.37
12	1990	0.72	4	1991	0.29
12	1990	0.47	4	1991	0.31
12	1990	0.55	4	1991	0.07
12	1990	0.79	4	1991	0.56
12	1990	0.88	5	1991	0.29
1	1991	0.80	5	1991	0.11
			5	1991	0.14
			5	1991	0.20
			6	1991	0.24
1	1991	0.53	6	1991	0.10
1	1991	0.88	6	1991	0.26
2	1991	0.63	6	1991	0.08
2	1991	0.53	7	1991	0.32
2	1991	0.94	7	1991	0.13
2	1991	0.63	7	1991	0.32
2	1991	0.85	7	1991	0.09
2	1991	1.33	8	1991	0.16
3	1991	0.26	8	1991	0.45
3	1991	0.47	8	1991	0.54
3	1991	0.71	8	1991	0.33
3	1991	0.56	9	1991	0.76
3	1991	0.48	9	1991	0.29
3	1991	0.42	9	1991	0.40
4	1991	0.49	9	1991	0.29
4	1991	0.56	10	1991	0.56
4	1991	1.00	10	1991	0.23
4	1991	0.69	10	1991	0.50
4	1991	0.64	10	1991	0.12
4	1991	0.63	11	1991	0.14
5	1991	0.51	11	1991	0.21
5	1991	0.28	11	1991	0.43

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

5	1991	0.47	11	1991	0.16
5	1991	0.71	12	1991	0.20
5	1991	0.69	12	1991	0.32
5	1991	0.56	12	1991	0.36
6	1991	0.45	12	1991	0.65
6	1991	0.50	1	1992	0.87
6	1991	0.64	1	1992	0.20
6	1991	0.51	1	1992	0.31
6	1991	0.61	1	1992	0.23
6	1991	0.49	2	1992	0.16
7	1991	0.60	2	1992	0.46
7	1991	0.40	2	1992	0.37
7	1991	0.56	2	1992	0.12
7	1991	0.53	3	1992	0.13
7	1991	0.45	3	1992	0.23
7	1991	0.51	3	1992	0.05
8	1991	0.49	3	1992	0.16
8	1991	0.50	4	1992	0.48
8	1991	0.62	4	1992	0.05
8	1991	0.48	4	1992	0.26
8	1991	0.47	4	1992	0.23
8	1991	0.42	5	1992	0.13
9	1991	0.28	5	1992	0.05
9	1991	0.42	5	1992	0.10
9	1991	0.38	5	1992	0.07
9	1991	0.47	6	1992	0.08
9	1991	0.36	6	1992	0.19
9	1991	0.43	6	1992	0.32
10	1991	0.86	6	1992	0.03
10	1991	0.71	7	1992	0.20
10	1991	0.91	7	1992	0.07
10	1991	0.69	7	1992	0.20

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

10	1991	0.73	7	1992	0.29
10	1991	0.52	8	1992	0.18
11	1991	0.54	8	1992	0.33
11	1991	0.74	8	1992	0.07
11	1991	0.53	8	1992	0.35
11	1991	0.79	9	1992	0.23
11	1991	0.56	9	1992	0.17
11	1991	0.76	9	1992	0.06
12	1991	0.66	9	1992	0.14
12	1991	1.30	10	1992	0.09
12	1991	1.16	10	1992	0.04
12	1991	0.54	10	1992	0.02
12	1991	0.48	10	1992	0.64
12	1991	0.41	11	1992	0.03
1	1992	0.58	11	1992	0.25
1	1992	1.10	11	1992	0.13
1	1992	0.62	11	1992	0.27
1	1992	0.60	12	1992	0.28
1	1992	0.67	12	1992	0.44
1	1992	0.66	12	1992	0.12
2	1992	0.52	12	1992	0.16
2	1992	0.58	1	1993	0.74
2	1992	0.84	1	1993	0.13
2	1992	0.58	1	1993	0.31
2	1992	0.59	1	1993	0.34
2	1992	0.94	2	1993	0.02
3	1992	0.47	2	1993	0.30
3	1992	0.46	2	1993	0.21
3	1992	0.60	2	1993	0.18
3	1992	0.41	3	1993	0.29
3	1992	0.66	3	1993	0.47
3	1992	0.60	3	1993	0.36

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

4	1992	0.86	3	1993	0.78
4	1992	0.34	4	1993	0.07
4	1992	0.65	4	1993	0.17
4	1992	0.49	4	1993	0.17
4	1992	0.84	4	1993	0.12
4	1992	0.62	5	1993	0.21
5	1992	0.51	5	1993	0.31
5	1992	0.84	5	1993	0.09
5	1992	1.05	5	1993	0.20
5	1992	0.56	6	1993	0.16
5	1992	0.69	6	1993	0.66
5	1992	0.14	6	1993	0.67
6	1992	0.39	6	1993	0.78
6	1992	0.46	7	1993	0.36
6	1992	0.67	7	1993	0.15
6	1992	0.38	7	1993	0.15
6	1992	0.37	7	1993	0.15
6	1992	0.47	8	1993	0.18
7	1992	0.57	8	1993	0.32
7	1992	0.46	8	1993	0.20
7	1992	0.76	8	1993	1.24
7	1992	0.62	9	1993	0.16
7	1992	0.49	9	1993	3.44
7	1992	0.77	9	1993	0.40
8	1992	0.64	9	1993	0.31
8	1992	1.84	9	1993	0.31
8	1992	0.98	10	1993	0.14
8	1992	0.43	10	1993	0.11
8	1992	0.42	10	1993	0.66
8	1992	0.74	10	1993	0.13
9	1992	0.44	11	1993	0.12
9	1992	0.42	11	1993	0.25

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

9	1992	0.80	11	1993	0.33
9	1992	0.55	11	1993	0.35
9	1992	0.46	12	1993	0.10
9	1992	0.63	12	1993	0.05
10	1992	0.88	12	1993	0.13
10	1992	0.46	12	1993	0.07
10	1992	0.65			
10	1992	0.68		Avg.	0.275
10	1992	0.45		Std dev.	0.304
10	1992	0.43		N	193
12	1992	0.50			
12	1992	0.57			
12	1992	0.67			
1	1993	0.41			
1	1993	0.51			
1	1993	0.67			
1	1993	1.02			
1	1993	0.89			
3	1993	1.09			
3	1993	0.86			
3	1993	1.09			
3	1993	1.28			
3	1993	0.69			
4	1993	1.35			
4	1993	0.46			
4	1993	0.38			
4	1993	0.72			
4	1993	0.77			
4	1993	0.69			
5	1993	1.31			
5	1993	0.07			
5	1993	1.57			

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

5	1993	1.55
5	1993	0.94
5	1993	0.90
6	1993	0.97
6	1993	0.75
6	1993	0.15
6	1993	1.37
6	1993	0.55
6	1993	0.54
7	1993	0.94
7	1993	0.62
7	1993	1.05
7	1993	0.82
7	1993	0.51
7	1993	0.03
8	1993	0.57
8	1993	0.50
8	1993	0.39
8	1993	0.51
8	1993	0.55
8	1993	0.43
9	1993	1.17
9	1993	0.69
9	1993	0.87
9	1993	0.72
9	1993	0.75
9	1993	0.06
10	1993	0.91
10	1993	0.55
10	1993	0.20
10	1993	0.56
10	1993	0.91

TABLE 7. INDIVIDUAL RUN DATA FOR INTALCO LINE C (TF in lb/to

10	1993	0.71
11	1993	0.95
11	1993	0.52
11	1993	2.17
11	1993	0.51
12	1993	0.90
12	1993	0.95
12	1993	1.17
12	1993	0.70
12	1993	1.50
12	1993	0.37
Avg.		0.69
Std dev.		0.37
N		259

TABLE 8. INTALCO LINE C MONTHLY AVERAGES
(Monthly average for wet roof scrubbers
plus 12-month average for primary system)

Month/year		TF lb/ton
1	1990	0.79
3	1990	0.92
4	1990	0.83
5	1990	0.65
6	1990	0.88
7	1990	0.89
8	1990	1.05
9	1990	0.95
10	1990	0.90
11	1990	0.70
12	1990	0.90
1	1991	0.74
2	1991	1.13
3	1991	0.79
4	1991	0.98
5	1991	0.85
6	1991	0.84
7	1991	0.82
8	1991	0.81
9	1991	0.70
10	1991	1.05
11	1991	0.96
12	1991	1.07
1	1992	0.92
2	1992	0.89
3	1992	0.74
4	1992	0.84
5	1992	0.84
6	1992	0.67

Month/year		TF lb/ton
7	1992	0.82
8	1992	1.05
9	1992	0.76
10	1992	0.80
12	1992	0.79
1	1993	1.13
3	1993	1.36
4	1993	1.09
5	1993	1.42
6	1993	1.08
7	1993	1.02
8	1993	0.85
9	1993	1.07
10	1993	1.00
11	1993	1.40
12	1993	1.29
	Avg.	0.97
	Std dev.	0.26
	N	45

TABLE 9. SODERBERG POM DATA

TACOMA POM DATA lb/ton				
	Line 2 Roof		Dry scrubber	
	Single runs lb/ton	Avg 3 runs lb/ton	Single runs lb/ton	Avg 3 runs lb/ton
March 94	1.76	1.71	2.52	1.60
	1.78		1.21	
	1.58		1.06	
Oct 94	1.59	1.63	0.164	0.11
	1.51		0.058	
	1.78		0.093	
	1.52	1.38	1.72	0.64
	1.25		0.105	
	1.38		0.097	
	1.42	1.64		
	1.62			
	1.88			
	2.36	2.72		
	3.72			
	2.09			
Average	1.816	1.816	0.781	0.781
Standard deviation	0.598	0.522	0.899	0.756
N	15	5	9	3

TABLE 9. SODERBERG POM DATA (cont'd)

POM in lb/ton for roof scrubbers

Plant	Fan	Inlet POM	Avg of 3	Outlet POM	Avg of 3
Columbia	9	1.610	0.90	0.365	0.18
Aluminum		0.365		0.029	
		0.730		0.146	
	12	2.260	2.07	0.292	0.44
		1.460		0.438	
		2.480		0.584	
Northwest	2	3.16	3.68	1.6430	1.42
Aluminum		3.15		1.5730	
		4.74		1.0420	
	3	3.13	3.21	1.8800	2.19
		3.13		2.0650	
		3.35		2.6160	
	2	4.76	3.45	3.0000	2.40
		3.48		2.4000	
		2.12		1.8000	
	3	3.53	2.47	2.6800	1.88
		2.54		1.8800	
		1.33		1.0800	
	Avg.	2.63	2.63	1.42	1.42
	Std dev.	1.22	1.04	0.95	0.92
	N	18	6	18	6
	Maximum	4.76	3.68	3.00	2.40

Tests of the primary control system at Northwest Aluminum from 3 runs showed POM emissions averaged only 0.0097 lb/ton (range of 0.009 to 0.011 lb/ton).

TABLE 10. NORANDA BAKE FURNACE DATA

	Total fluoride lb/ton Alum.	Anode	Ln	lb/ton anode Avg of 3 runs lb/ton	Ln
Sep 1983	0.018	0.036	-3.324	0.035	-3.362
	0.017	0.034	-3.381		
Nov 1983	0.017	0.034	-3.381		
	0.011	0.022	-3.817	0.018	-4.017
	0.011	0.022	-3.817		
Mar 1984	0.005	0.010	-4.605		
	0.004	0.008	-4.828	0.009	-4.748
	0.004	0.008	-4.828		
Apr 1984	0.005	0.010	-4.605		
	0.005	0.010	-4.605	0.010	-4.605
	0.005	0.010	-4.605		
May 1984	0.005	0.010	-4.605		
	0.026	0.052	-2.957	0.065	-2.728
	0.067	0.134	-2.010		
Jun 1984	0.005	0.010	-4.605		
	0.011	0.022	-3.817	0.014	-4.269
	0.004	0.008	-4.828		
Jul 1984	0.006	0.012	-4.423		
	0.026	0.052	-2.957	0.031	-3.463
	0.018	0.036	-3.324		
Aug 1984	0.003	0.006	-5.116		
	0.003	0.006	-5.116	0.010	-4.605
	0.003	0.006	-5.116		
Sep 1984	0.009	0.018	-4.017		
	0.005	0.010	-4.605	0.011	-4.480
	0.007	0.014	-4.269		
Oct 1984	0.005	0.010	-4.605		

	Total fluoride			lb/ton anode	
				Avg of 3 runs	
	lb/ton				
	Alum.	Anode	Ln	lb/ton	Ln
	0.002	0.004	-5.521	0.004	-5.521
	0.002	0.004	-5.521		
Nov 1984	0.002	0.004	-5.521		
	0.001	0.002	-6.215	0.006	-5.116
	0.004	0.008	-4.828		
Dec 1984	0.004	0.008	-4.828		
	0.015	0.030	-3.507	0.019	-3.981
Jan 1985	0.002	0.004	-5.521		
	0.011	0.022	-3.817		
Apr 1985	0.010	0.020	-3.912	0.011	-4.541
Jun 1985	0.002	0.004	-5.521		
	0.004	0.008	-4.828		
	0.006	0.012	-4.423	0.024	-3.730
Jan 1986	0.020	0.040	-3.219		
Feb 1986	0.010	0.020	-3.912		
Mar 1986	0.007	0.014	-4.269	0.019	-3.981
	0.006	0.012	-4.423		
	0.015	0.030	-3.507		
Apr 1987	0.057	0.114	-2.172	0.059	-2.836
May 1987	0.018	0.036	-3.324		
Jun 1987	0.013	0.026	-3.650		
	0.013	0.026	-3.650	0.061	-2.802
	0.008	0.016	-4.135		
Jun 1988	0.070	0.140	-1.966		
Aug 1988	0.026	0.052	-2.957	0.497	-0.698
Sep 1988	0.031	0.062	-2.781		
Oct 1988	0.689	1.378	0.321		
Nov 1988	0.032	0.064	-2.749	0.160	-1.833

TABLE 10. NORANDA BAKE FUR

	0.041	0.082	-2.501		
	0.167	0.334	-1.097		
	0.526	1.052	0.051	0.362	-1.016
	0.010	0.020	-3.912		
	0.007	0.014	-4.269		
Dec 1988	0.003	0.006	-5.116	0.035	-3.343
Feb 1989	0.031	0.062	-2.781		
	0.019	0.038	-3.270		
Mar 1989	0.022	0.044	-3.124	0.120	-2.120
	0.021	0.042	-3.170		
	0.137	0.274	-1.295		
Jul 1989	0.024	0.048	-3.037	0.078	-2.551
Aug 1989	0.005	0.010	-4.605		
Jan 1990	0.088	0.176	-1.737		
Feb 1990	0.244	0.488	-0.717	0.417	-0.874
	0.370	0.740	-0.301		
Apr 1990	0.012	0.024	-3.730		
	0.007	0.014	-4.269	0.013	-4.317
May 1990	0.008	0.016	-4.135		
	0.005	0.010	-4.605		
	0.005	0.010	-4.605	0.022	-3.817
Jan 1991	0.013	0.026	-3.650		
Aug 1991	0.015	0.030	-3.507		
	0.018	0.036	-3.324	0.024	-3.730
Sep 1991	0.006	0.012	-4.423		
	0.012	0.024	-3.730		
	0.012	0.024	-3.730	0.038	-3.270
Jan 1992	0.007	0.014	-4.269		
Feb 1992	0.038	0.076	-2.577		
Mar 1992	0.037	0.074	-2.604	0.034	-3.381
Jul 1992	0.005	0.010	-4.605		
	0.009	0.018	-4.017		

Aug 1992	0.005	0.010	-4.605	0.014	-4.269
	0.007	0.014	-4.269		
	0.009	0.018	-4.017		
May 1993	0.011	0.022	-3.817	0.023	-3.758
Jun 1993	0.011	0.022	-3.817		
	0.013	0.026	-3.650		
Jul 1993	0.031	0.062	-2.781	0.048	-3.037
	0.036	0.072	-2.631		
	0.005	0.010	-4.605		
AMTEST		0.054	-2.919	0.027	-3.612
		0.016	-4.135		
		0.024	-3.730		
		0.014	-4.269		
	Avg.	0.070	-3.744	0.070	-3.467
	Std dev.	0.191	1.199	0.118	1.154
	N	100	100	33	33

TABLE 11. BAKE FURNACE DATA

		ALUMAX BAKE FURNACE--TOTAL FLUORIDE	
		Single runs	Avg of 3 runs
		lb/ton	lb/ton
1992		0.0036	0.0038
		0.0042	
		0.0036	
1993		0.0232	0.0136
		0.0114	
		0.0062	
1994		0.0040	0.0039
		0.0042	
		0.0036	
	Avg	0.0071	0.0071
	Std dev	0.0065	0.0056

	KAISER-MEAD BAKE FURNACE (lb/ton anode)	
	POM	TF
	lb/ton	lb/ton
	0.168	0.006
	0.166	0.019
	0.148	0.015
Avg.	0.161	0.013
Std dev	0.011	0.007

	NORANDA BAKE FURNACE
	lb/t POM
	0.038
	0.020
	0.016
Avg.	0.025
Std dev	0.012

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