July 9, 1998

Mr. Michael A. Palazzolo
Environment, Health and Safety Services
ALCOA
425 Sixth Avenue
Pittsburgh, Pennsylvania 15219-1850

Dear Mr. Palazzolo:

This letter is in response to your June 18, 1997 letter to Mr. Bill Lamason requesting approval of optical scintillation anemometers as an alternative for determining aluminum smelter potroom roof monitor effluent velocity. Your request was subjected to the Environmental Protection Agency's (EPA) independent peer review process and additional information on scintillation anemometer technology was provided in your April 14, 1998 letter to Mr. Terry Harrison. This information was further clarified by Alcoa during a June 23 ,1998 meeting with EPA staff and in an additional June 26, 1998 submittal. As detailed below and in the attachments to this letter, EPA has approved your request of an alternative method to determine roof monitor effluent velocity from aluminum potrooms pursuant to 40 CFR 63 Subpart LL and 40 CFR 60 Subpart S.

<u>BACKGROUND</u>

Optical scintillation anemometers were originally developed by the National Oceanic and Atmospheric Administration (NOAA) to measure atmospheric turbulence and wind speed for military applications. The technology uses scintillation effects (the apparent position or brightness of an object when viewed through the atmosphere) to measure path-averaged cross winds and turbulence intensity. NOAA conducted a number of field studies to compare optical anemometers with more traditional velocity meters, such as propeller anemometers. These studies provide direct correlation between optical and propeller anemometers for specific instrument configurations and data analysis procedures. NOAA's optimal instrument design configuration, which is based on 15 cm transmitter/receiver mirrors and temporal cross-correlation data analysis, has recently become commercially available for non-military applications.

Compliance with the Primary Aluminum National Emission Standard for Hazardous Air Pollutants and the New Source Performance Standards requires the use of EPA Method 14 or 14A for determining secondary potroom emissions. To calculate total fluoride emissions, these methods require determination of roof monitor effluent gas flow rate using “propeller anemometers or equivalent”. Alcoa has requested EPA approval to use scintillation anemometers as an alternative to propeller anemometers.

Technical information and proposed Quality Assurance/Quality Control procedures submitted by Alcoa for application of the technology to potroom roof monitors were subjected to an independent peer review process. The review comments supported the proposed application of the technology, but identified several technical questions concerning effects of the potroom environment on instrument operation and the bell-shaped weighting function used to determine wind speed along the measurement path.

Questions concerning potroom environmental effects (corrosive environment, elevated temperature and turbulence levels) were addressed by Alcoa based on 12 months of operating experience at one facility. Specific technical questions related to instrument operation, calibration procedures and the weighting function were answered by the instrument supplier, Scientific Technology, Inc.

DISCUSSION AND CONCLUSIONS

The weighting function used by the proposed method to determine wind velocity is a bell-shaped curve with maximum sensitivity in the middle of the optical path and minimum sensitivity at each end. This weighting function is not ideal for a potroom application because higher or lower velocities in the middle of the potroom compared to the ends of the potroom may bias the average velocity reported for the entire roof monitor. However, the ability of the scintillation anemometer to detect and provide a path-integrated velocity over even three-quarters of the roof monitor is expected to provide as representative a measure of average velocity as the data collected by propeller anemometers currently used in compliance with EPA Methods 14 and 14A siting requirements.

Experience reported by Alcoa for one operating facility suggests that effects of potroom environment on instrument reliability can be minimized by proper instrument installation, which should include the use of an air-wipe and fluoride-resistant transmitter/receiver windows.

Ensuring representative data from the proposed alternate method will require 1) strict adherence to NOAA’s optical instrument standard design specifications; 2) proper instrument installation; 3) monitoring of data quality indicators; 4) periodic instrument calibration and 5) corrective action for instrument malfunction. Approval of the alternative method is therefore contingent upon adherence to both the optical instrument design specifications listed in Attachment 1 and the design, installation and operating procedures provided in Attachment 2.

Should you have any questions about this letter, please contact Terry Harrison at (919) 541-5233, Emission Measurement Center, MD-19, Research Triangle Park, North Carolina, 27711.

Sincerely,

/s/
William F. Hunt
Director
Emissions, Monitoring and
Analysis Division

Attachments

cc: Jane Engert, 2223A
Steve Fruh, MD 13
Bruce Jordan, MD 13
John Seitz, MD 10
Elaine Stanley, ORC
Robert Van Heuvelen, ORE
Linda Murphy, Region I
Kathleen Callahan, Region II
Judith Katz, Region III
Winston Smith, Region IV
David Kee, Region V
Robert Hanneschlager, Region VI
Art Spratlin, Region VII
Richard Long, Region VIII
David Howekamp, Region IX
Anita Frankel, Region X

ATTACHMENT 1

Optical Anemometer Standard Design Specifications

Technology

The system is to be based on NOAA standard optical scintillation technology. The technology is described in NOAA Technical Memorandum ERL WPL-52 dated October 1985, "Optical System Model IV for Space-Averaged Wind and Cn^2 Measurements." The sensor shall be capable of measuring the path-averaged cross wind. Key design criteria are listed below:

Optics

Transmitter:

Wavelength	940 nanometers (nm)
Optics	Circular, 150 millimeters (mm) diameter
Mean Output Power	40 milliwatts (mW)
Beam Divergence	5 - 10 milliradians (mrad)

Receiver:

Optics	Circular, tangent equal apertures, 150 mm diameter
Field of View	10 - 20 mrad

Performance

Velocity Range	0.1 to 40 meters/second (m/s)
Accuracy	0.1 m/s or +/- 5%, whichever is greater
Resolution	0.1 m/s
Long Term Stability	< 5% per six months
	Path Length 0.1 to 1 kilometers with Cn^2 in range of 10^{-16} to 10^{-10} m $^{-2/3}$
Wind Detection Method	Covariance technique
Automatic Gain Control	40 (decibel) dB minimum
Time Constant	10-second analog
Update Rate	1 minute block average

Diagnostics**:**

Built in self-test, updated once per minute, to monitor received signal strength from upper and lower channels (40 dB), turbulence, power supply condition, and microprocessor status.

Maintenance Frequency:

Every 6 months calibration check and optics cleaning

Calibration Technique

NOAA standard using two square waves in phase quadrature based on NOAA Technical Memorandum ERL WPL-88 dated November 1981 entitled “A Calibrator for Optical Instruments that Measure Cn2 and Crosswind.”

ATTACHMENT 2

Potroom Scintillometer Design, Installation and Operating Procedures

Instrument Design

Design specifications for potroom scintillometers shall include:

1) a threshold velocity not to exceed 6 m/min (20 fpm);
2) a measurement range to at least 600 m/min (2,000 fpm);
3) air pressurized housing to protect electronics from corrosive gases and maintain temperature below 70^{o}C;
4) Polycarbonate receiver window(s) to prevent acid etching by potroom fluoride;
5) installation of an air-wipe on the transmitter and receiver windows with adequate positive pressure air to prevent dust buildup and window corrosion;
6) a known relationship between the received optical signals and the anemometer output, at a minimum of three evenly spaced input frequencies equating to the anemometer outputs in the table below:

Dual optical Signal Input (90 degree phase shift)	Anemometer Output (ASCI, RS-232)	Equivalent Velocity
0.34 Hz	0.1 m/s	19.7 fpm
17.0 Hz	5.42 m/s	1067 fpm
34.0 Hz	10.84 m/s	2133 fpm

7) for a scintillometer using 0.15 m (6 inch) transmitting and receiving optical apertures over a 400 meter path, the operational range for turbulence intensity (C_n^2) from shall be between 10^{-16} $m^{-2/3}$ and 10^{-10} $m^{-2/3}$.

<u>Installation and Integration</u>

Scintillometers shall be installed in a manner that provides a determination of average roof monitor gas velocity for the entire length of the potroom (or potroom segment). If desired, the potroom (or potroom segment) may also be divided in half, with one scintillometer installed in each half of the room.

The scintillometer shall either be located in the center of the roof monitor throat or at a location determined by:

1) identifying potential locations in or near the roof monitor throat that have a clear line of sight along the entire potroom, unobstructed by building steel and supports;

2) making a velocity traverse of the width of the roof monitor; and

3) installing the scintillometer in an area of average velocity along the traverse.

The traverse may be made with any suitable low velocity measuring device, and shall be made during normal process operating conditions.

Effluent gas volumetric flow rate shall be calculated using the cross-sectional area of the roof monitor throat associated with the anemometer installation location. The anemometer shall be installed to measure the velocity vector component parallel to the roof monitor throat walls.

Mounting platforms should be located 24 to 30 inches below the velocity monitoring location selected from the velocity traverse. The platform should be stable, with zero deflection when loaded with 500 pounds.

Utility requirements include clean dry air (<80 psi) and 110/220 volts AC power or 12 volts DC power.

The instrument will be mounted and aligned per the manufacturer’s recommendations and interfaced to either an IBM PC or the plant process control computer for data storage. Data will be saved as one hour averages. Calibrations shall be performed in a manner that tests the scintillometer output, as well as the entire data acquisition system.

Calibration

Initial calibration requirements for the scintillation anemometer include:

1) development of a “reference” performance curve relating anemometer output velocity to a NIST-traceable input voltage/frequency generator for the applicable range of voltages/frequencies velocities between 0.1 m/s and 10 m/s (20 and 2000 fpm) (once to be provided by manufacturer);
2) a check of signal output for the anemometer at three voltage/frequency settings with at least $\pm$5% agreement between measured output and manufacturer’s value;
3) a low light intensity check to confirm that the data system properly records an error message for low light conditions;
4) a visual inspection of instrument and light sensor condition; and
5) a check for anemometer threshold velocity.

The periodic calibration requirements for the scintillation anemometer include:

1) repeat calibration checks above every 6 months of operation
2) increase frequency of checks to every 3 months if components fail 6 month checks

Data Quality Control/Reporting

In addition to the periodic calibrations, instrument data quality indicators shall be continuously recorded, at a minimum, during monthly roof monitor performance tests. Parameters to be recorded include instrument status indicators for low light level (both detectors) and turbulence. For normal instrument operation, detector light levels shall be between 0.03 and 3.0 volts and turbulence levels (Cn^2) shall be between 10^{-16} and 10^{-10} $m^{-2/3}$. Normal instrument operation is required for the performance tests to be considered valid. Records of the instrument data quality indicators and measured velocities shall reported along with other performance test results.

Corrective Action

Acceptance criteria and corrective action required for each of the instrument QC checks are summarized in Table 1.

Maintenance

Aside from the visual inspections and calibration checks noted above, the instrument will not require routine maintenance because the instrument has no moving parts. The light source has an expected life of greater than 10 years and will be replaced upon failure.

Table 1. Summary of QC Checks and Corrective Action for Scintillometer

Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
Three-point calibration check	Once every 6 months	Agreement of +/-5% between output velocity and manufacturer value	1. Repeat calibration check. 2. Repair or replace instrument as needed.
Check minimum threshold velocity	Once every 6 months	Threshold velocity less than or equal to 6 m/min (20 fpm)	1. Repeat threshold velocity check. 2. Repair or replace instrument as needed.
Check signal strength	Continuously once per minute during performance testing	Detector signal greater than 0.03 Volts and less than 3.0 volts	1. Flag data with signal strength out of range 2. Clean sensor optics. 3. Repeat signal strength check. 4. Check optical alignment. 5. Repeat signal strength check. 6. Replace or repair instrument as needed.
Check turbulence level	Continuously once per minute during performance testing	Turbulence (Cn2) between 10-16 and 10-10 m-2/3	1. Flag data outside acceptable turbulence level. 2. Repeat three-point calibration check. 3. Repair or replace instrument as needed.