The Aluminum Association Climate VISION Work Plan

ELEMENT 1: Emission measurement and reporting protocols to quantify industry achievements in meeting its Climate VISION goal.

The Aluminum Association and EPA will work together to ensure that the record of reductions is at a high level of quality. The Aluminum Association and EPA expect that companies that possess high quality emissions reduction records will be in a preferred position to participate in any future program that provides appropriate rewards and recognition for early voluntary action. Progress towards the sector commitment will be measured on a sector-wide basis using company-by-company monitoring data. Voluntary Aluminum Industrial Partnership (VAIP) companies will report annual direct CO_2 equivalent emissions data, by March 31 each year, to the Aluminum Association and EPA using the International Aluminium Institute "Aluminum Sector Greenhouse Gas Protocol" (Addendum to the WBCSC/WRI Greenhouse Gas Protocol; see http://www.world-aluminium.org/environment/climate/ghg_protocol.pdf). This Protocol supplements the World Business Council for Sustainable Development (WBCSD) and World Resource Institute (WRI) corporate accounting and reporting standard with aluminum industry specific examples. The WBCSD/WRI methodology references and is consistent with the IPCC Good Practice Guidance and VAIP perfluorocarbon (PFC) reporting. To the extent feasible, companies will use IPCC Tier 3 (smelter-specific) coefficients for PFCs, and will also report information into the DOE 1605(b) inventory protocol still under development.

ELEMENT 2: Near-term, cost-effective actions to reduce GHG emission intensity.

The Aluminum Sector Climate VISION commitment reflects opportunities for emission reduction from the adoption of currently available and/or near-term technology Participating companies plan to adopt the most cost-effective technology based on the unique situation at respective primary production facilities. Reduction opportunities will vary depending on the type of smelter technology used, plus technical and operational actions taken to date.

Anode effect performance differs considerably within specific smelter technology categories. Thus, smelter technology type plays a critical role in the amount of PFCs emitted. Since anode effects occur when there is too little alumina in the smelting pot, the way in which the alumina is fed in and the frequency at which it is fed in are important factors in determining how often anode effects occur. There are many technical parameters and operational procedures that impact anode effect frequency and duration. These include such things as: manual or automatic feed; type and quality of automatic feed system and feed strategy; variability in the physical properties of alumina feedstock; ability to maintain bath quality, quality and timeliness of measurement of reduction cell parameters; age of cell computer technology; and manual or automatic anode effect termination. Good operational practices will also reduce total emissions and improve overall smelter performance.

Incorporation of good practices for anode effect reduction and technology improvements are successfully lowering the frequency and duration of anode effects. Where cost-effective, point feeders are being installed on Søderberg cells and side work prebake cells, which result in considerable reductions in emissions. Improved computer algorithms to better control the alumina levels in cells and terminate anode effects more quickly, once initiated, are also being considered.

Options to reduce direct CO_2 emissions from the carbon anode Hall-Heroult process include improvements in chemical bath management and process controls to reposition the anodes. As a result, the anode-cathode gap can be optimized reducing electrical resistance and energy consumption as well as reducing anode carbon consumption rates. These improvements achieve efficiency gains in aluminum output per unit of carbon anode consumed, thereby reducing CO_2 emissions per unit of production and per unit of energy consumed.

As has been the practice for the Voluntary Aluminum Industry Partnership, the Aluminum Association and EPA will convene periodic meetings (generally one or two times/year) to share information, review program data, and identify annual work objectives. Meetings may be held in Washington, in conjunction with other industry-related events or by conference call. Emission reductions achieved as a result of Element 2 efforts will be incorporated into the reporting program included in Element 1.

The Aluminum Association, partner companies and EPA will work to together to develop and facilitate the adoption of practices and technologies to reduce direct carbon intensity reductions. In addition to the adoption of new technologies, efforts will include the development of education and training materials on emission reduction opportunities for facility managers and potroom operators, information sharing amongst partner companies on strategies to reduce emissions, and projects to facilitate data collection and to improve data quality.

ELEMENT 3: Identification of cross-sector projects through which the industry can help the country achieve the President's GHG intensity goal

The aluminum industry is pursuing several cross-sector projects with potential to favorably impact the GHG intensity goal. These include:

- Municipal curbside community recycling awareness pilot test program

The Aluminum Association has initiated a pilot test of a curbside community awareness program to increase local used beverage can (UBC) recycling rates. A pilot test program was conducted in 2004 for several cities to test curbside recycling public communications methods to achieve higher recycling rates of high value recyclables, including cans. The program is to be expanded in 2005 to 33 of the top 100 municipalities with existing curbside programs. The expansion will include public communications and best-practices partnerships with municipalities to improve recycling rates. Recycling aluminum saves 95 percent of the energy necessary for primary aluminum production. In recent years the UBC recycling rate in the U.S. has declined. However, approximately 45 percent of the U.S. population has curbside recycling services. Existing curbside recycling has been demonstrated in an Aluminum Association study to have the greatest and most cost-effective potential for improving aluminum can recycling rates. If successful, this program could help lead to programs that could improve the overall U.S. UBC recycling rate and substantially save energy used in can manufacturing. This effort will augment continuing efforts of the Association to increase aluminum recycling, including the "Habitat for Humanity" can program and the "Jimmy Neutron Recycles" TV ad campaigns.

- Spent Potliner (SPL) test demonstration for resource recovery in cement kilns

SPL is a waste byproduct from primary aluminum production comprised of disposed solid carbonaceous material when aluminum production cells are relined. A test demonstration project was initiated by the Aluminum Association in 2003, with the Phase I feasibility project completed in 2004. A Phase II effort began in early 2005 and is expected to be completed by the 2nd quarter. Phase I demonstrated that SPL can be successfully processed in cement kilns including direct SPL BTU input (averaging 4500 BTU per pound), and SPL mineralization benefits lowering the temperature (and energy) requirements for clinker formation. The Phase II effort includes development of advanced SPL handling systems at the cement facility, and air emission stack testing and testing of the fate of SPL waste constituents. Other benefits from SPL use in cement kilns to be addressed in Phase II include: complete kiln destruction of all SPL waste constituents of concern eliminating landfill disposal, reduction of cement kiln nitrogen oxide emissions, improved clinker quality from SPL mineralization benefits and fluoride utilization (also reducing the need for fluorspar in cement kiln operations), and reduced feedstock needs of alumina and silica for cement production. If testing is successful and SPL can be incorporated into commercial cement plants, the energy benefits for each ton of SPL used in a cement kiln would replace the equivalent of at least 1/3 of a ton of coal and result in a greater output of cement production. SPL use in cement production could then commence as soon as Resource Conservation and Recovery Act (RCRA) regulatory barriers are addressed.

- Energy efficiency, transportation sector – light-weight vehicles, recycling

Together with the North American automotive industry, the Aluminum Association has conducted a comprehensive Life Cycle Assessment (LCA) of aluminum use in the automobile and light truck transportation segment. The peer reviewed study demonstrated that one pound of aluminum used in automobiles and light trucks saves over the lifetime of the vehicle an average of at least 20 pounds of carbon dioxide equivalent emissions. This is a result of the high recycling rates of aluminum in automobiles and light trucks and the replacement of heavier materials by aluminum leading to improved fuel economy. Aluminum use in the automobile and light truck market of the U.S. has grown from an average of 183 pounds per vehicle in 1991, to 274 pounds in 2002. Current projections forecast that this trend will continue with aluminum use expected at levels over 315 pounds per vehicle on average in 2010. At those projected aluminum use levels, at least 820 pounds of carbon dioxide equivalent emissions will be saved per vehicle produced over their operating lifetime for 2010 models compared to 2002 models. Several member companies are pursuing these efforts with the automotive industry including applications in aluminum body sheet, safety parts, die-cast engine components and structural elements, and suspension parts.

ELEMENT 4: Development and commercialization of new technology through a collaborative R&D/technology commercialization program focused on technologies that can reduce greenhouse gas emission intensity by 2010.

The Aluminum Association is participating in a technology R&D program though DOE Industrial Technologies Program, Aluminum Industries of the Future (IOF) subprogram. This program encompasses a series of projects which are described as R&D needs in the Aluminum Industry Technology Roadmap with mid- and long-term goals, all of which seek to improve energy efficiency. These projects are enumerated on the Aluminum IOF website (http://www.oit.doe.gov/aluminum/) and the Aluminum Industry Technology Roadmap can be viewed at (http://www.oit.doe.gov/cfm/fullarticle.cfm/id=742). Aluminum IOF projects with strong energy saving and emission reduction potential and midterm (approximately seven year) goals are:

- Development of Wetted Drained Cathode Technology – seeks to design a primary aluminum cell with titanium diboride or other cathode materials for longer life and lower electrical resistance to save substantial energy and associate emissions in aluminum production of perhaps up to 15 percent. The Aluminum IOF has funded multiple projects related to the development of wetted cathodes. A 2006 to 2013 goal has been established for the project to address technical difficulties of cell design and material engineering.

Wetted drained cathodes contribute to energy savings by allowing designs in which the aluminum pad can be continuously drained out of the anode-cathode spacing. A modern Hall Heroult cell operates at about 4.6 V(dc) and has an anode cathode distance (ACD) of 4.5 cm. This distance is required to prevent shorting between the anode and hydrodynamically deformed molten aluminum pad that acts as the cathode surface. Approximately 1.75 V(dc) of the voltage is associated with the resistance across the ACD. Lowering the ACD to 2.5 cm would directly change the voltage associated with the bath to 1 V(dc), a 16% reduction in the total voltage requirement. This not only provides a 16% reduction in energy use but an equivalent reduction in CO_2 emissions. Patents have been issued for drained sloped wetted cathodes which would allow the ACD to be reduced to 1.5 to 2.0 cm. Sloping ensures good feed of alumina to the electrolytic system by taking advantage of the buoyancy of the gas generated at the anode. Lower in the ACD to 2.0 cm would provide a 20% reduction in energy and emissions.

- Development of Continuous or Semi-continuous Sensors to Measure Alumina, Superheat, Temperature and Bath Chemistry – seeks to develop robust sensors for primary aluminum cells to provide for more refined control of cell operation to optimize alumina feed, bath chemistry and temperature for improved efficiency. A 2010 goal has been established to complete development and testing.

Control of batch chemistry is critical to energy performance and avoidance of perfluorocarbon (PFC) emissions. PFC gases have 6,000 to 9,000 times the global warming potential of carbon dioxide. Currently alumina concentration can not be measured directly or in real time. This value is inferred from the cell operating condition. Alumina saturation is reached at about 7% alumina dissolved in a typical 960°C cryolite bath. The normal operating level is about 3% alumina. If the level goes above 4%, some of the added alumina may not dissolve rapidly in the shallow bath and can settle to form a sludge on the cell bottom reducing cell conductivity. If it falls below 1% alumina the cell is starved of the reactant and an "anode effect" ensues. When this occurs, the production of metal is interrupted and PFC gases are discharged instead of carbon dioxide.

- Development of Inert Anode Technology - inert anode technology eliminates nearly all perfluorocarbon (PFC) and direct CO_2 emissions from the cells used in primary production of aluminum. The Aluminum IOF has contributed to the funding of seven projects that emphasize the development of an inert anode. The materials developed to date have not been truly inert and success has been limited due to unacceptable rates of dissolution of the anode. However, progress is being made with work on new materials and lower temperature cells.

All aluminum today is produced in Hall-Héroult cells with carbon anodes ($2Al_2O_3 + 3C \rightarrow 4\ Al + 3\ CO_2$). Inert anodes produce aluminum directly from alumina ($2Al_2O_3 \rightarrow 4\ Al + 3\ O_2$), eliminating all carbon dioxide from the Hall-Héroult reaction. The inert anode reaction requires additional energy (~1 V(dc)) however it enables more efficient alumina feeding and gas release providing greater control of the anode-cathode-distance (ACD), which represents the largest voltage drop in the cell. The greater ACD control offsets the additional voltage requirement and when inert anodes are used in conjunction with a drained cathode, they are estimated to save up to 22% of the energy required for producing aluminum. Inert anodes and wetted cathodes are technologies that could be retrofit to existing cells with minor changes in potline infrastructure.

Projects that have been funded by the Aluminum IOF that are now commercially available or emerging as available technologies are listed below. The results of these projects offer potential users the opportunity to save energy and reduce emission today.

- Development of Molten Aluminum Probe and Filter - commercialization has begun on a new probe and filter technology to detect and selectively removes salts from molten aluminum. These salts contribute to defects in ingots and casting which then require remelting. The technology provides a significant potential for energy savings and a reduction in chlorine use (unit based efficiency improvements to be added).

Removing trace salts from molten aluminum by filtration during transfer from primary cells to holding furnaces saves furnace holding time (fuel) and reduces the need for chlorine fluxing normally used to remove the salts. It is estimated that this technology would reduce holding times by 15% and chlorine use by 33%. These reductions would annually save about 1.2 trillion Btu annual in natural gas for furnaces and remove 0.015 million metric tons of CO_2 from the furnace emissions. In addition, significant energy use and environmental emissions are saved by avoiding the production of 6 million cubic feet of chlorine.

- Development of Software - capable of monitoring and analyzing cell data on a continuous real-time basis. This software "Intelligent Potroom Operation" applies advanced computational techniques to anticipate cells about to slip into degraded operation and dispatch operators to intervene. This technology is estimated to 0.5 billion kWh per year in the U.S. (reduced average cell voltage by 0.03 volts) and decreased perfluorocarbon (PFC) emissions with an increase in the overall efficiency of the Hall-Héroult refining process by an estimated 0.3 percent.

Projects To Enhance Recycling

- Development and Demonstration of a Vertical Floatation Melter - pilot scale unit furnace which decoats, preheats and melts aluminum scrap in one operation. This unit provides an efficiency 2.5 times that of a conventional furnace. The design also provides a higher metal yield (dross reduction) because of lower gas temperature, lower residence time, lower oxygen content and no direct flame impingement on the metal.

- Development of an Advanced Scrap Sorting Process - provides additional incentives to aluminum recycle operations. Mixed alloy scrap traveling on conveyers can be separated in real-time into cast, wrought, and alloy families utilizing tint etching color sorting and laser induced breakdown spectroscopy. This technology can potentially enhance recycling and as a result save energy.

Project That Could Help Efficiency Of Any Gas Fired Thermal Process

- Development of Advanced Oxygen-Air-Fuel Burners - coupled with improved insulation, refractories, and sensors and control systems have the potential to reduce fuel demands to save energy, improving production rates, and reducing emissions.