

Background Information for Cement Technical Team Discussion

March 13, 2007

California Air Resources Board (CARB): Climate Change Reporting

General Description of Greenhouse Gas Emission Sources

Greenhouse gas (GHG) emissions are released into the atmosphere during cement manufacturing. Carbon dioxide (CO₂) is emitted during the calcination process. This direct chemical process occurs when limestone¹ (CaCO₃ – calcium carbonate) and other raw materials including silica, aluminum, and iron oxides are exposed to high temperatures. The calcination process forms activated lime, which reacts with raw materials in the kiln to form clinker. CO₂ is emitted as a byproduct of this process. Cement is produced when clinker is ground with a small amount of gypsum.

Roughly half of the CO₂ emissions from cement manufacturing are produced during the calcination process. The other half are generated through on-site fossil fuel combustion and energy used to heat the kilns during manufacturing.ⁱ

Cement is one ingredient in the production of concrete, which includes a mixture of 10-15% cement, 60-70% aggregates (sand and gravel) and 15-20% water. Concrete is used in a variety of applications. Two important markets for concrete in California include construction of buildings and roads.ⁱⁱ

¹ Magnesium carbonate (MgCO₃) can also be used to produce clinker, which when exposed to high temperatures releases CO₂ into the atmosphere.

Key Contents of the Cement Reporting Protocol

The California Climate Action Registry (Registry) developed a voluntary protocol for cement manufacturers to report GHG emissions. The Cement Reporting Protocol provides guidance on calculating direct process-related emissions.

www.climateregistry.org/docs/PROTOCOLS/Cement_Reporting_Protocol_1205.pdf

Methodologies to Calculate Direct Process-Related CO₂ Emissions

The Cement Reporting Protocol acknowledges two methodologies (clinker-based and cement-based) to calculate direct process-related CO₂ emissions. The Registry recommends using the clinker-based approach.

1) **Clinker-Based Methodology:** Calculates CO₂ emissions based on the volume and composition of clinker produced as well as the amount of cement kiln dust (CKD) discarded during the manufacturing process.

$$\text{CO}_2 \text{ emissions} = [(\text{Cli}) (\text{EF}_{\text{cli}}) + (\text{CKD}) (\text{EF}_{\text{CKD}})]$$

Where:

Cli = Quantity of clinker produced
EF_{cli} = Clinker emission factor
CKD = Quantity CKD discarded
EF_{CKD} = CKD emission factor

Equation 1: Calculating process-related CO₂ emissions according to the clinker-based methodology.

2) **Cement-Based Methodology:** Calculates CO₂ based on the amount of raw materials and their carbonate content. This approach accounts for changes to the cement production process.

Origin and Consistency

The Clinker-Based Methodology is consistent with “The Cement CO₂ Protocol”

developed by the Cement Sustainability Initiative (CSI) of the World Business Council for Sustainable Development (WBCSD). It is also closely aligned with the World Resources Institute (WRI) protocol, European Union (EU) ETS Monitoring Guidance, and the U.S. EPA's Climate Leaders Program. The Intergovernmental Panel on Climate Change (IPCC) and Japan provide an approach based on the amount of clinker produced, which includes a CKD correction factor.

Efficiency Metric

The Registry's efficiency metric is similar to the performance indicator in WBCSD's Cement CO₂ Protocol. While the direct and indirect process related equations calculate overall GHG emissions, the efficiency metric calculates CO₂ emissions per ton of cementitious product.

Leaders in Protocol Development and Key Stakeholders

The Registry developed the Cement Protocol between June 2005 and November 2005 using a comprehensive stakeholder process. The protocol was prepared based on the WBCSD's cement CO₂ Protocol, the Registry's existing guidelines, and relevant state statutes. Registry staff and a workgroup of regulatory agencies, cement companies, non-governmental organizations, the Portland Cement Association and the U.S. EPA Climate Leaders program assisted the Registry with developing its Cement Reporting Protocol.

CARB Efforts to Develop Mandatory Reporting Program

California Global Warming Solutions Act of 2006 (AB 32; Statutes of 2006, chapter 488) requires CARB to develop a regulation for mandatory reporting of greenhouse gases. Building on the work already done, the Cement Technical Team was formed to get into the technical details of reporting GHG emissions from cement production and operations.

All interested parties are welcome and encouraged to participate in developing a mandatory reporting program for the cement industry.

Contact Information

Contact Dana Papke at dpapke@arb.ca.gov or (916) 323-2308 to participate on the Cement Technical Team. For information about CARB's Climate Change Reporting program, contact Doug Thompson at dthomps@arb.ca.gov or (916) 322-7062. Please visit the following website for more information regarding CARB's climate change program. www.arb.ca.gov/cc/cc.htm

ⁱ California Climate Action Team, "Climate Action Team Report to Governor Schwarzenegger and the California Legislature," Pg. 53, March 2006.

ⁱⁱ Lawrence Berkeley National Laboratory, "Optimization of Product Life Cycles to Reduce Greenhouse Gas Emissions in California," Prepared for California Energy Commission PIER Program, August 2005.