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Construction Continues on Federal GHG Regulation

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Trinity Consultants

EPA Proposes Revisions to GHG Mandatory Reporting Rule for Stationary Combustion Sources

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This summer, EPA proposed several updates and amendments to the GHG Mandatory Reporting Rule (40 CFR Part 98). This activity is consistent with EPA's stated intention to issue amendments and re-propose subparts (i.e., those subparts that were initially reserved upon finalization of the rule last October) by the end of 2010. EPA's published revisions in the Federal Register on June 15, 2010, and these revisions in general, do not change the overall requirements of the rule. Rather, these amendments were intended to improve clarity and ensure consistency across the calculation, monitoring, and data reporting requirements. EPA next issued updates on June 28, 2010 where additional subparts were finalized, including Subpart T – Magnesium Production, Subpart FF – Underground Coal Mine, Subpart II – Industrial Wastewater Treatment, and Subpart TT – Industrial Waste Landfills. EPA published additional amendments in the Federal Register on August 11, 2010, which consist of clarifications and technical changes to the final rule, including extensive updates to Subpart C for Stationary Combustion Sources. These recent amendments are meant to complement, not override, the first round of amendments published on June 15, 2010. A summary of all these amendments is available at *trinityconsultants.com/MRR*.

The Subpart C amendments for Stationary Combustion Sources affect most facilities that must comply with this rule. The following table summarizes the Subpart C amendments that were published in the Federal Register on August 11, 2010.

Summary of Subpart C Amendments

CHANGE TO SUBPART C	DESCRIPTION OF CHANGE
1) Definition of the source category.	• Clarifies that pilot lights need not be included (deemed not a stationary source)
2) GHGs to report. Amends §98.32.	• Clarifies that CO_2, CH_4, N_2O need not be reported under Subpart C if an exclusion is indicated elsewhere in Subpart C
3) Calculating GHG emissions. Amends §98.33a.	• Adds detail on who must use calculation methods o Points out certain sources can use 40 CFR Part 75 if already using Part 75 o Clarifies reporting of CO_2 when unit combusts both biomass and fossil fuels
4) Natural gas consumption expressed in therms. Amends §98.33(a)(1) and §98.36(e)(2)(i).	• Adds new calculation equation for Tier 1 methodology (Equation C-1a), allowing a reporting entity to easily calculate emissions from natural gas consumption, when consumption is provided in therms (rather than standard cubic feet) • New paragraph to reflect this in §98.33(b)(1)(v) • Allows fuel consumption to be reported in therms
5) Use of Equation C–2b to calculate weighted annual average HHV. Amends §98.33(a)(2)(ii).	• Requires weighted HHV calculation only for individual Tier 2 units with greater than 100 MMBtu/hr (or those units grouped as a single unit greater than 100 MMBtu/hr)
6) Categories of gaseous fuels. Amends §98.33(a)(2)(iii) and Table C-1.	• Replaces term "fossil fuel-derived gaseous fuels" with more inclusive term, i.e., "gaseous fuels other than natural gas"
7) Use of mass-based gas flow meters. Amends §98.33(a)(3)(iv).	• Conditionally allows flow meters that measure mass flow rates of gas fuels to be used for Tier 3
8) Site-specific stack gas moisture content values. Amends §98.33(a)(4)(iii).	• Allows use of site-specific moisture constants under Tier 4 o Default value must represent fuels used during normal, stable operation, accounting for different moisture content o Each site-specific default moisture percentage would require at least 9 runs using EPA Method 4, updated at least annually and whenever current value is believed to be non-representative
9) Determining emissions from an exhaust stream diverted from a CEMS monitored stack. Amends §98.33(a)(4).	• Addresses determination of CO_2 mass emissions from unit subject to Tier 4 when portion of flue gases generated by unit exhaust through a stack that is not equipped with a CEMS
10) Biomass combustion in units with CEMS. Amends 98.3(a)(5)(iii)(D) and redesignates as §98.33(a)(5)(iv).	• Corrects numbering error • Clarifies that the separate reporting of biogenic CO_2 is optional for units that are not subject to Acid Rain Program, but are using Part 75 to calculate CO_2 emisisons.
11) Use of Tier 3. Amends §98.33(b)(3)(iii).	• Clarifies that use of Tier 3 also applies to common pipe configurations where at least 1 unit served by the common pipe has heat input > 250 MMBtu/hr. • Requires Tier 3 to be used when specified in another subpart regardless of fuel type or unit size

CHANGE TO SUBPART C	DESCRIPTION OF CHANGE
12) Tier 4 requirements for units that combust greater than 250 tons of MSW per day. Amends §98.33(b)(4)(ii)(A).	• Changes 250 tons/day MSW to 600 tons/day MSW (approximately equivalent to 250 MMBtu/hr for other large stationary units)
13) Applicability of Tier 4 to common stack configurations. Amends §98.33(b)(4).	• Clarifies how Tier 4 criteria apply to common stack configurations, including paragraph on distinct common stack configurations to which Tier 4 might apply
14) Starting dates for the use of Tier 4. Amends §98.33(b)(5).	• Clarifies starting dates for the use of Tier 4 (essentially the start date will be the date the certification tests are passed)
15) CH_4 and N_2O calculations. Amends §98.33(c)(4)(i) and (ii).	• Allows use of site-specific or actual HHV data for N_2O and CH_4 calculations, rather than only default HHV values from Table C-1
16) CO_2 emissions from sorbent. Amends §98.33(d)	• Makes provision more generally applicable to different types of CO_2-producing sorbents
17) Biogenic CO_2 emissions from biomass combustion. Amends §98.33(e)	• Amends §98.33(e) for a number of technical corrections and clarifications
18) Fuel sampling for coal and fuel oil. Amends §98.34(a)(2)(ii).	• Clarifies that a fuel lot consists of all deliveries for a given calendar month; thus, required HHV sampling frequency is no greater than once per month • Adds similar language for Tier 3 fuel sampling provisions for fuel oil and coal • Allows manual oil samples to be taken after each addition to storage tank
19) Tier 3 sampling frequency for gaseous fuels. Amends §98.34(b)(3)(ii)(E).	• Clarifies daily sampling of gaseous fuels for carbon content and molecular weight only required where continuous, online equipment is in place; weekly sampling in all other cases
20) CO_2 emissions from blended fuel combustion.	• Provides Additional guidance on calculating emissions from blended fuels
21) Use of consensus standard methods.	• Removes specific methodologies for testing of HHV, carbon content, and molecular weight, to instead refer generically to use of appropriate methods published by consensus standards organizations (e.g., ASTM, ASME, etc)
22) CO_2 monitor span values. Amends §98.34(c).	• Adds new paragraph to allow CGAs of CO_2 monitor to be performed using calibration gas concentrations of 40-60% of span and 80-100% of span, when the CO_2 span is set higher than 20% CO_2
23) CEMS data validation.	• New paragraph §98.34(c)(7) to require hourly CEMs data validation to be consistent with sections of Part 60 or 75 or applicable State CEM program
24) Use of ASTM Methods D7459–08 and D6866–08.	• Removes restriction limiting use of these methods to units with CEMS. Any unit combusting fossil and biogenic fuels is allowed to use ASTM methods on quarterly basis.
25) Electronic data reporting and recordkeeping.	• Amends reporting provisions by: o Adding methodology start and end dates o Amending data element lists to be consistent with reporting of emissions by fuel type o Removes requirement to report customer meter number for natural gas o Reduces number of ID numbers to be reported in a group o Removes requirement to report combined annual emissions from fossil fuel (duplicative with Subpart A) o Requires reporting of fuel specific annual heat input estimates; requires reporting of annual average HHV when measured HHV data are used to calculate CH_4/N_2O for a Tier 3 unit in lieu of using default HHV from Table C-1 o Amends Tier 4 units reporting from annual CO_2 mass emissions to “non-biogenic” CO_2 mass emissions o Adds new alternative reporting option for situations where a common liquid or gaseous fuel supply is shared between large and small units o Simplifies recordkeeping requirements in cases where results of fuel analyses for HHV are provided by fuel supplier
26) Common stack reporting option. Amends §98.36(c)(2).	• Common stack reporting option would also apply when process and combustion gas streams from a single unit are combined
27) Common fuel supply pipe reporting option. Amends §98.36(c)(3).	• Corrects erroneous citation of §98.34(a) to read §98.34(b) • Calibrate fuel flow meter to accuracy required by §98.34(b), so that this is only required when Tier 3 is used

28) Table C–1 default HHV and CO_2 emission factors.	• Revises Table C-1: o Replaces "fossil fuel-derived fuels (solid) and (gaseous)" with "other fuels (solid) and (gaseous)" o Removes "pipeline" from natural gas description o Adds definitions of some fuels to §98.6 o Add waste oil with definition to list of petroleum products o Removes still gas from list of petroleum products o Revises footnote regarding MWC units o Removes qualifier of 100% for ethanol and biodiesel o Adds default CO_2 emission factor for petroleum-derived ethanol
29) Table C–2 default CH_4 and N_2O emission factors.	• Removes first (redundant) iteration of Table C-2 and makes minor corrections to the second one

Assuming these changes to the Mandatory GHG Reporting Rule are finalized in 2010 as expected, all of these amendments will apply to data reported to EPA in March 2011.

Understanding these changes may affect your monitoring and recordkeeping activities or emission calculation approaches immediately upon finalization of the proposed rules.

Therefore, it is prudent to evaluate whether these corrections affect any of your determinations or methods for complying with the rule, as soon as the proposed rules are finalized. ✥

EPA Establishes New 1-hour Standard for Sulfur Dioxide

On June 2, 2010, the U.S. EPA established a new 1-hour primary National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2). The new 1-hour standard was set at the level of 75 parts per billion (ppb) calculated as the three-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations. With the establishment of the new 1-hour SO_2 standard, EPA also revoked the two previous primary SO_2 standards of 140 ppb (24-hour standard), and 30 ppb (annual standard) because they will not provide additional public health protection beyond the 1-hour standard at 75 ppb.

EPA's evaluation of scientific information and the risks posed by exposure to SO_2 indicate that the new standard will protect public health by reducing exposure to high short-term (5-minutes to 24-hour) concentrations of SO_2, especially for children, the elderly, and people with asthma. EPA did not revise the secondary NAAQS for SO_2, which aims to protect public welfare, as part of this action and is assessing the need for changes to the secondary standard under a separate review.

Monitoring and Reporting Requirements

With the new 1-hour standard, EPA is also revising the ambient air quality monitoring requirements for SO_2. Under the new requirements, SO_2 monitors must be placed in Core Based Statistical Areas (CBSAs) based on a population weighted emissions index for the area, as follows:

- 3 monitors in CBSAs with index values of 1,000,000 or more
- 2 monitors in CBSAs with index values less than 1,000,000 but greater than 100,000
- 1 monitor in all CBSAs with index values greater than 5,000

At least 163 SO_2 monitoring sites nationwide are required by these criteria. EPA estimates that 41 new monitoring sites will need to be established, nationwide, to meet the new monitoring requirements. EPA regional administrators may also require additional monitoring sites for certain circumstances.

Under the new regulations, EPA also finalized changes to SO_2 data reporting requirements.

State and local agencies are now required to report two values for every monitored hour – (1) the 1-hour average SO_2 concentration; and (2) the maximum 5-minute block average SO_2 concentration for each hour. States must make adjustments to monitoring networks to meet the new SO_2 monitoring requirements by January 1, 2013.

Based on currently available 2007-2009 air quality monitoring data from existing SO_2 monitoring sites, 60 of the total 249 monitored counties violate the new 1-hour SO_2 standard. EPA expects to designate areas as attainment, nonattainment, or unclassifiable by June 2012 based on more recent air quality monitoring data, most likely from 2008-2010.

Dispersion Modeling Utilized

In an innovative approach, EPA also plans to utilize refined air dispersion modeling results, where available, as part of the attainment designation approach. EPA expects that, in areas without currently operating SO_2 monitors but with sources that might have the potential to cause or contribute to violations of the NAAQS, the identification of NAAQS violations and compliance with the 1-hour SO_2 NAAQS would primarily be accomplished through refined, source-oriented air quality dispersion modeling analyses, supplemented with the new, limited network of ambient air quality monitors. EPA justifies this approach, per the rule's preamble, saying that the revised approach would better address:

1) the unique source-specific impacts of SO_2 emissions
2) the special challenges SO_2 emissions present in terms of monitoring short-term SO_2 levels for comparison with the NAAQS in many situations
3) the superior utility that modeling offers for assessing SO_2 concentrations
4) the most appropriate method for ensuring that areas attain and maintain the new 1-hour SO_2 NAAQS in a manner that is as expeditious as practicable, taking into account the potential for substantial SO_2 emissions reductions from forthcoming national and regional rules that are currently underway

Of particular interest to specific sources of SO_2 emissions is EPA's recommendation, in the rule's preamble, to have states initially focus performance of attainment demonstration modeling on larger sources (e.g., those with > 100 tons per year (tpy) of SO_2), and that states would also identify and eventually conduct refined modeling of any other sources that may be anticipated to cause or contribute to a violation to determine compliance with the new SO_2 NAAQS.

This hybrid monitoring/modeling designation approach is planned as follows:

- Any area that has monitoring data or refined modeling results showing a violation would be designated "nonattainment"
- Any area that has both monitoring and refined modeling results showing no violations would be designated "attainment"
- All other areas would initially be designated "unclassifiable"
- The county boundary would be the presumptive nonattainment boundary unless state demonstrates otherwise in recommendations to EPA

States with counties classified as nonattainment areas must submit nonattainment State Implementation Plans (SIPs) by February 2014 and must demonstrate how those areas will be brought into attainment status by August 2017. For all other areas classified as attainment or unclassifiable, maintenance SIPs, as required by the Clean Air Act, are due by June 2013.

The final rule became effective August 23, 2010. As a result of the new rule, any new or modified major source is required to demonstrate compliance with the new 1-hour SO_2 NAAQS as part of federal permitting projects. States may also require a similar compliance demonstration for state-level permitting projects. The final rule does not include modeling significance levels or Class I / Class II Increment Standards associated with the SO_2 1-hour primary standard, nor does it establish a new significant emission rate for purposes of New Source Review (although EPA holds this option available, per discussion in the final rule preamble). EPA intends to issue separate guidance related to these implementation concerns of the new SO_2 standard and allow for public comment before issuing it in final form. For those areas designated as nonattainment under the new standard, additional nonattainment New Source Review permitting requirements will apply for new construction and source modification projects. States may also implement emissions control based regulations (e.g., RACT, Cap and Trade) to address attainment issues related to the new 1-hour SO_2 NAAQS. ⟐

Federal Transport Rule — the "New CAIR" Round 1

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On August 2, 2010, EPA proposed the long-awaited replacement for the Clean Air Interstate Rule (CAIR), which was rejected in 2008 by the D.C. Circuit Court of Appeals. Now called the Transport Rule (TR) by EPA, the new rule revises the CAIR approach to conform with the court ruling. In this first version (Round 1) of TR, overall emission budgets for NO_x are similar to the initial period in CAIR; overall SO_2 budgets are approximately 50% of the initial CAIR budget; and only utilities are regulated (see attached table). However, EPA has stated its intention in Round 2 to revise TR at minimum to consider additional NO_x reductions to assist at least two (likely three) metropolitan areas in meeting the 1997 ozone NAAQS of 0.08 ppm, for which an impact of 84 ppb was acceptable.

Unlike Round 1, Round 2 is expected to require many industrial NO_x emitters to reduce emissions. Further, EPA has clearly designed TR to be readily adaptable to future NAAQS revisions, and is defining the process for future TR versions in this initial rulemaking. As proposed, TR only seeks to remove upwind pollution that "significantly contributes to or interferes with maintenance of" the 1997 ozone NAAQS, the 1997 annual $PM_{2.5}$ NAAQS, and the 2006 24-hr $PM_{2.5}$ NAAQS, each of which is currently under review. A new ozone standard is expected in Fall 2010 and new $PM_{2.5}$ standards are expected in 2011, which may lead to TR Round 3. EPA expects to propose revised TR requirements approximately one year after new NAAQS designations, with a final rule one year later.

Why Address Transport?

Congress has long recognized the potential for transported emissions to impact air quality, and so called "good neighbor" provisions date to the 1970 Clean Air Act Amendments (CAAA). The original requirement was amended and is now contained in §110(a)(2)(D), which requires each state, in its state implementation plan (SIP), to prohibit:

… any source … within the state from emitting any air pollutant in amounts which will contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to any [NAAQS]….

Prior to CAIR, EPA regulated transport through the NO_x SIP Call, which addressed emissions contributing to ozone generally east of the Mississippi River. CAIR built upon the approach used in the NO_x SIP Call with both an expanded group of states and expanded NAAQS (both ozone and $PM_{2.5}$). Despite its grounding in the prior NO_x SIP Call, in a unexpected 2008 ruling, the court found CAIR so fundamentally flawed that it vacated the rule in its entirety. As a result of petitions regarding the lack of any requirement for additional emissions reductions while EPA developed a new rule, the court amended its vacatur to simply a remand, which the current TR seeks to address.

Development of Required Emission Reductions

For TR, EPA first determined via air dispersion modeling which states (considering all emissions statewide) had a significant impact on an out-of-state nonattainment area (or maintenance area), where EPA defined significant as 1% of the respective NAAQS. For example, Virginia was linked as follows for the annual $PM_{2.5}$ and ozone standards (listed by predominant cities in area). Comparatively more areas were linked for the $PM_{2.5}$ 24-hr standard (20 vs. 8).

Annual $PM_{2.5}$ - nonattainment

- Lancaster, PA
- York, PA
- Huntington, WV/Ashland, KY
- Charleston, WV

Annual $PM_{2.5}$ - maintenance

- New York, NY
- Reading, PA
- Hagerstown, MD/Martinsburg, WV
- Fairmont, WV

Ozone – nonattainment & maintenance

- New York, NY
- Philadelphia, PA

Once linkages were defined, EPA proceeded to determine the quantity of the "significant contribution," which is the amount to be eliminated via TR. For the NO_x SIP Call and CAIR, the determination was performed regionally; in TR, state-specific factors are used in response to the court ruling. For TR, EPA used a 4-step approach.

1. Identify reductions available at various costs
2. Use simplified air quality assessment tool to quantify impact of reductions at different $/ton levels
3. Identify "breakpoints" based on cost and air quality information
4. Quantify reductions available in each linked state at chosen cost threshold; verify using refined air model.

EPA's approach assumes the same cost per ton in upwind and downwind states, though EPA recognizes that unique local conditions can necessitate non-equal costs. EPA's proposed rule notes Liberty-Clairton PA as one area where there is a disproportionate local contribution due to coke ovens and other local sources.

In Step 1, EPA identified what controls were available and when. For instance, EPA believes that scrubbers and SCRs could not be installed until 2014; low NO_x burners (LNB) and fuel switching are deemed available in 2012. Of note, EPA does not include any considerations for air permitting in Its timeframe, although some units have previously triggered major New Source Review for LNB (and potentially other) projects. After determining available controls, EPA then models those impacts using a screening model in Step 2.

Step 3 comprises a review for each state of the appropriate cost breakpoint, and identifies a specific $/ton threshold for quantifying the amount of significant contribution. For $PM_{2.5}$

in 2014, after considering costs for SO_2 from $100/ton to $2,400/ton, EPA narrowed consideration to either $2,000/ton or $2,400/ton. Since the air quality model predicted no change in areas impacted by reducing from $2,000/ton to $2,4000/ton, the proposed rule is founded on $2,000/ton. However, changes costing $2,000/ton (scrubbers) could not be installed until 2014, and EPA considered what changes could be in place by 2012 (primarily operating scrubbers that are installed but not required to be operated under an existing regulatory program). EPA modeled this smaller set of emission reductions and found that these reductions (at less than $2,000/ton) eliminated the contribution from many states. Based on that finding, EPA separated the states into two groups for SO_2. Group 2 states are able to fully remove their significant contribution by 2012 at less than $2,000/ton and have only a single SO_2 budget. In contrast, Group 1 states have a 2-step approach, with one budget for 2012-13 and a more stringent budget for 2014 onward.

For NO_X (still with respect to $PM_{2.5}$ attainment) EPA determined $500/ton was appropriate since SO_2 contributes more to $PM_{2.5}$ than NO_X and to obtain additional reductions beyond those available at $500/ton required an increase to at least $2,400/ton.

Since the SO_2 budgets will require substantial SO_2 reductions, and the allocations are no longer linked to the Acid Rain program, SO_2 credits under Acid Rain will be greatly devalued, resulting in SO_2 "leakage" to non-covered states. EPA identified five states likely to see SO_2 increase by at least 5,000 tpy due to this leakage: Arkansas, Mississippi, North and South Dakota, and Texas. Additional modeling of these states' post-leakage budgets bumped Texas into a significant $PM_{2.5}$ contribution, and EPA seeks comment on whether Texas should be included in Group 2.

For ozone, EPA similarly considered available controls in 2012 and 2014 in Step 3. At $500/ton, EPA believes that utilities essentially are the only sector to be considered, while at higher costs other sectors should be considered. However, EPA did not have adequate time to consider higher thresholds for this rule-making, and plans a future rulemaking to consider whether reductions at a higher cost per ton are appropriate for utilities and other source categories. Based on $500/ton, all areas except Houston, TX and Baton Rouge, LA will be in attainment with the ozone NAAQS, while New York, NY flirts with nonattainment based on historical year-to-year ozone levels. For areas that contribute to Houston or Baton Rouge (and potentially areas that contribute to New York), EPA plans a review of additional reductions that could be achieved at more than $500/ton and at least up to $3,200/ton. At the highest cost thresholds, EPA expects to consider NO_X reductions from (1) industrial boilers, (2) reciprocating internal combustion engines (RICE), (3) portland cement manufacturing, (4) petroleum refining, (5) glass manufacturing, (6) pulp and paper production and, (7) iron and steel production.

STAFF SPOTLIGHT

Environmental Professional Leverages Industry Experience to Benefit Clients

Christine Kurtz, a Managing Consultant in Trinity's Minneapolis office, provides clients in the Upper Midwest with the benefits of her 18 years of experience in both industry and consulting. Christine spent over 16 years in industry prior to joining Trinity. She started out in research and development, moved into process engineering, and then found her passion in environmental management where she spent 11 years managing environmental issues in roles such as Environmental and Safety Manager at a pulp and paper mill. As a result of her experiences, she provides expertise in multi-media environmental compliance, reporting, and permitting requirements encompassing air quality, wastewater treatment, solid waste management, chemical process safety management and land remediation. She also has valuable first-hand experience with the softer leadership skills of environmental management which include agency negotiations, community public relations, non-governmental organization communications, and employee relations.

As a consultant, Christine has used her experience and knowledge of industry issues to assist clients with complex air permitting and regulatory applicability issues, greenhouse gas emissions management, ISO 14001 environmental management system implementation, and process safety and process hazards analyses; she has also provided clients with onsite environmental management support. Christine is also a highly skilled project manager with experience leading multiple, complex projects with multi-discipline project teams.

Christine is a valuable resource to clients in a variety of industries. Upper Midwest Director Clay Raasch agrees: "With her broad-based background and experience as an environmental manager in a large industrial setting, Christine relates well to our clients, understanding the pressures they face and their need for straight answers. She's also demonstrated an excellent blend of strong work ethic and calm resolve in meeting a wide variety of client objectives".

Christine completed a BS degree in Chemical Engineering from Michigan Technological University and a MS in Project Management from City University of Seattle. She is also an avid outdoors person who enjoys road biking, mountain biking and hiking in the summer, and skiing and snowshoeing in the winter. ❖

State Emissions Budgets

Using the approach outlined previously, EPA ran its Integrated Planning Model with state-specific inputs to determine unit-by-unit expected emissions for Group 1 SO_2 states in 2014. For 2012 (Group 2 SO_2 and ozone), EPA used a mix of actual performance modified by pending controls. The details of EPA's approach are complex and unit-by-unit data should be closely reviewed by those subject to the rule; there are several exceptions to the general approach, both on a state and unit basis.

The unit-by-unit values were summed to determine state budgets. The state budgets represent the emissions that would remain after significant contributions and interference with maintenance have been addressed, in an average year. For example, in Virginia, IPM predicts that the following changes by 2014.

- Clinch River – three 230 MW units each add scrubbers/SCR
- Bremo Bluff No. 4 – 150 MW unit adds a scrubber
- Chesterfield No. 3 – 100 MW unit adds a scrubber

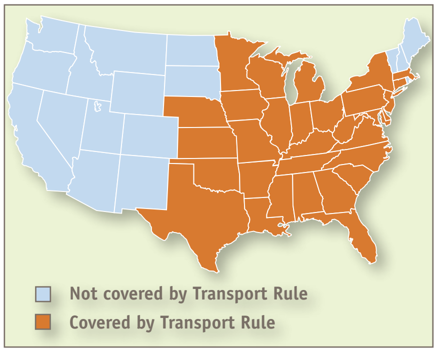
Compared to CAIR, TR budgets may be lower or higher. When comparing TR to the first-phase CAIR budgets (TR/CAIR), the ratio ranges from 30% to 190%. In the aggregate, NO_x emissions (ozone season and annual) are similar in TR Round 1 and CAIR Phase 1, while TR SO_2 emissions are approximately 50% of CAIR Phase 1. The low SO_2 budget, and dissociation from the Acid Rain Program (ARP) credits, results in essentially flooding the national ARP market, and projected increases in SO_2 emissions in states not covered by TR.

To address variability, EPA identified both 1-year and 3-year variability limits, which are values allowed above the state budgets, subject to conditions. The 1-year variability is either 10% of the annual budget or 5,000 tons (SO_2)/1,700 tons (NO_x), whichever is greater. The 3-year variability is based on dividing 1-year variability by the square root of three, while ozone season is the higher of 10% or 2,100 tons.

The variability limits would not apply until 2014 (1-year) and 2016 (3-year). Several alternatives are also considered in the proposal.

Emissions Trading

EPA proposed three approaches to implement the state budgets. The preferred approach allows unlimited intrastate trading and limited interstate trading. Alternative A allows solely intrastate trading, and Alternative B is a direct control option, likely with lb/MMBtu limits for individual sources.



The reason interstate trading is limited is due to what EPA terms "assurance provisions." If, in any 1-year or 3-year period, a state exceeds its variability limits, sources in that state are penalized by a requirement to submit "assurance" allowances. In essence, across a state, allowances submitted in excess of variability provisions are discounted by 50%, requiring submittal of additional allowances. EPA would calculate the quantities and apportion assurance allowances to individual units. The assurance allowances are above and beyond allowances already submitted by each unit for actual emissions. EPA believes the likelihood of triggering these provisions is low.

In concert with the proposed trading approach, EPA has proposed unit-specific emissions allocations based on the analysis used to develop the state emissions budgets. These allocations would be one-time and permanent (at least until EPA issues Round 2 TR). As with CAIR, EPA proposes a new unit set-aside, based on 3% of the state budget.

Under EPA's preferred option, most of the remaining trading requirements are similar to CAIR. For example, under TR, states have the option to develop their own SIPs to implement state-specific budgets.

Important Applicability

Applicability to TR is generally the same as for CAIR, namely limited to fossil fuel-fired units serving a generator greater than 25 MW producing electricity for sale. The exemptions for co-generation units and solid waste incinerators are generally the same as CAIR with minor technical corrections. Notably, EPA did not provide a broad exemption for trivial usage of fossil fuel, such as for startup only; any fossil fuel usage at any time makes a unit fossil fuel-fired forever. For example, biomass boilers that combust 100% biomass but use natural gas or diesel to startup would be classified as fossil fuel-fired.

EPA does propose to modify the definition of "fossil" solely for the solid waste incineration unit definition. The definition of solid waste incineration unit is tied to §129(g)(1) of the Clean Air Act, and thus is linked to the currently pending rulemaking to define solid waste (75 FR 31844, June 4, 2010). Further review of this exemption is warranted after finalization of the solid waste rule.

Next Steps

While EPA received multiple requests to extend the comment period on this complex rule, the comment period ends on October 1, 2010 for the core rule and on October 15, 2010 for additional IPM data made available on September 1. On September 17, in supporting its denial of requests for more review time, EPA announced that it believes sufficient time was provided to review the rule.

For industrials and those in states marked as "review pending" for ozone, expect to see additional proposed requirements to address NO_x emissions, at least for the summer ozone season, with a proposal likely in 2012. Lastly, both industrials and utilities should monitor future TR revisions (Round 3) that will follow pending NAAQS revisions.

Transport Rule State Budget Summary and Comparison to CAIR Phase I

Basis	Ozone		$PM_{2.5}$				Comparison - TR/CAIR		
Pollutant	NO_x		SO_2			NO_x			
Years	2012+		SO_2	2012-13 (G1)	2014+		Ozone	$PM_{2.5}$	
	May - Sept	Review Pending[D]	Group	2012+ (G2)	(G1 only)		NO_x	SO_2	NO_x
Alabama	29,738	LA/TX	2	161,871	--	69,169	92%	103%	100%
Arkansas	16,660	LA/TX	--	--	--	--	145%	--	--
Connecticut	1,315	NY	2[A]	3,059	--	2,775	51%	Added	Added
Delaware	2,450	NY	2	7,784	--	6,206	110%	35%	149%
DC	105		2	337	--	170	94%	48%	118%
Florida	56,939	LA/TX	2[B]	161,739	--	120,001	119%	64%	121%
Georgia	32,144	LA/TX	1	233,260	85,717	73,801	Added	40%	111%
Illinois	23,570	LA/TX	1	208,957	151,530	56,040	77%	79%	74%
Indiana	49,987	NY	1	400,378	201,412	115,687	109%	79%	106%
Iowa	--		1	94,052	86,088	46,068	Removed	134%	141%
Kansas	21,433		2[A]	57,275	--	51,321	Added	Added	Added
Kentucky	30,908	LA/TX/NY	1	219,549	113,844	74,117	86%	60%	89%
Louisiana	21,220	LA/TX	2	90,477	--	43,946	124%	151%	124%
Maryland	7,232	NY	2[A]	39,665	--	17,044	56%	56%	61%
Massachusetts	--		2[A]	7,902	--	5,960	Removed	Added	Added
Michigan	28,253		1	251,337	155,675	64,932	98%	87%	99%
Minnesota	--		2[A]	47,101	--	41,322	--	94%	131%
Mississippi	16,530	LA/TX	--	--	--	--	190%	Removed	Removed
Missouri	--		1	203,689	158,764	57,681	Removed	116%	96%
Nebraska	--		2[A]	71,598	--	43,228	--	Added	Added
New Jersey	5,269	NY	2[A]	11,291	--	11,826	79%	35%	93%
New York	11,090		1	66,542	42,041	23,341	54%	31%	51%
North Carolina	23,539	NY	1	111,485	81,859	51,800	83%	60%	83%
Ohio	40,661	NY	1	464,964	178,307	97,313	89%	53%	90%
Oklahoma	37,087		--	--	--	--	Added	--	--
Pennsylvania	48,271	NY	1	388,612	141,693	113,903	114%	51%	115%
South Carolina	15,222		2	116,483	--	33,882	100%	203%	104%
Tennessee	11,575	LA/TX	1	100,007	100,007	28,362	51%	73%	56%
Texas	75,574	LA/TX	[C]	--	--	--	Added	Removed	Removed
Virginia	12,608	NY	1	72,595	40,785	29,581	79%	64%	82%
West Virginia	22,234	NY	1	205,422	119,016	51,990	83%	55%	70%
Wisconsin	--		1	96,439	66,683	44,846	Removed	76%	110%
						Total	113%	47%	90%

[A] EPA has requested comment on bumping these states to Group 1 SO_2 due to their contribution to several $PM_{2.5}$ nonattainment areas.
[B] EPA has requested comment on bumping FL to Group 1 SO_2 due to its contribution to the Birmingham $PM_{2.5}$ nonattainment area.
[C] EPA has requested comment on adding TX to Group 2 SO_2 due to "leakage" emissions increasing impacts to above significance thresholds.
[D] EPA currently plans additional review for states contributing to ozone impacts in Houston (TX) and Baton Rouge (LA), and is taking comment on whether to do the same for states impacting New York City (NY).

Cementing the PC MACT

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On September 9, 2010, the U.S. EPA promulgated the final amendments to the National Emissions Standard for Hazardous Air Pollutants from Portland Cement Manufacturing Industry (40 CFR 63 Subpart LLL), also known as the PC MACT. EPA's self-proclaimed "historic" rulemaking includes some important implications for cement manufacturers and other sources that may be subject to revised MACT rulemaking in the future. Among the landmark issues that EPA promulgated were: 1) finalizing a more rigorous methodology for setting MACT floor levels that will require significant investment in control technology by industry; 2) incorporating unprecedented levels of continuous emissions monitoring for compliance assurance; and 3) a new regulatory schema for regulating Startup, Shutdown, and Malfunction (SSM) emissions. Simultaneously, EPA finalized aggressive new limits for PM, NO_x, and SO_2 in a revision of the New Source Performance Standard for Portland Cement Plants under 40 CFR 60 Subpart F which is not addressed in this article.

MACT Floor Values

In calculating these emission limits, EPA considered numerous court cases that have fundamentally changed the methodology for calculating MACT floors. EPA has generally expressed that the approach closely adheres to the tenets ascribed by the courts in various rulings and a plain reading of the Clean Air Act. However, regulated sources may consider this approach as an impractical or unachievable application of the law and the related court rulings. Many of EPA's assumptions are based on the Brick MACT case [*Sierra Club v. EPA*, D.C. Cir. 2007] which concluded:

- Sources with low HAP emissions, due to low levels of HAP in their raw materials, can be considered best performers in establishing the MACT floor
- Floors for existing sources must reflect the average emission limitation achieved by the best performing 12 percent of existing sources, not levels EPA considers to be achievable by all sources
- EPA cannot set floors of "no control"; EPA must set floors for all HAP, including those not controlled by at-the-stack control devices
- EPA cannot ignore non-technology factors that reduce HAP emissions
- EPA can consider the variability in the dataset; however, EPA can only use the variability of the "best performers" in calculating the floor. Limiting the dataset will result in a smaller standard deviation and will lower the MACT floors.

This calculation methodology can also affect the floor values for other industries to be regulated in the future such as the proposed Boiler MACT. (For a discussion on the potential effect of this methodology on other industries, see *Portland Cement MACT Proposal Potentially Affects Other Industries,* published in *Environmental Quarterly,* July 2009.) In the final rule, the outcome has effectively codified the approach that some have dubbed the "Franken MACT" approach – where the final limits are the best of best on a pollutant-specific basis and not on a best source achieved basis. The result, in effect, provides final emission limits that no single U.S. cement kiln in existence can meet without additional controls.

Table 1 summarizes the final MACT limits for existing and new cement kilns, and compares them with the limits in the proposed rule. Table 1 shows that the mercury standards for new and existing sources are higher than the standards in the proposed rule due to the additional data that EPA received after proposing the rule and EPA's reconsideration of how to account for variability. The PM and THC emissions limits were revised downward and upward, respectively from the proposed rule. A key reason for this reduction in emission limits is EPA's correction of its variability equation rather than a change in the dataset. Additionally, EPA has required CEMS for PM in the final rule and has therefore added a 30-day averaging period to the limit that resulted in a change of the standard.

In spite of receiving numerous comments from industry and other interested stakeholders requesting a separate category for raw materials with high mercury content, EPA has not included a separate category for such materials in the final rule. EPA reasoned that there are only two quarries at cement plants in the U.S. where the mercury content of the limestone is well above the general population of cement kilns in the U.S. EPA has also noted that the two kilns that use the limestone from these quarries emit more than 25 percent of the mercury emissions from this source category. As such, EPA has not defined a separate subcategory for the two facilities. EPA stated in the preamble, however, that if these two kilns achieve significant near-term reductions by the compliance date, EPA could extend the compliance deadline for them. However, they also acknowledge that given the current state of mercury control that these kilns are not expected to achieve the final MACT limitations.

Another significant issue that has been disregarded by EPA is the option of utilizing a risk-based standard for HCl. EPA has agreed that a risk-based standard for HCl would have been much higher than the proposed standard. However, EPA noted that emissions of other non-HAP pollutants will also be reduced if a lower HCl standard is implemented and, on this basis, it rejects a higher standard for HCl. That is, EPA relied significantly on collateral benefits of non-HAP pollutant reductions to support the final HCl limits. Although EPA criticized the cement industry's HCl risk assessment, it supported the use of a risk based HCl limit for other MACT categories.

Monitoring Requirements

Undoubtedly, complying with the numerical emission limits in the final PC MACT will be challenging for the cement industry. However, the emission limits themselves may not be

Table 1: PC MACT Kiln Limits

Pollutant	PC MACT Version	Emission Limit	Ongoing Compliance Demonstration	Averaging Period	Notes
Existing Kiln or In-line Kiln Raw Mill					
PM (filterable)	2009 (Proposed)	0.085 lb/ton clinker	BLDS, ESP Model		Does not include condensables
	2010 (Final)	0.04 lb/ton clinker	CEMS	30-day	
Dioxin/Furan	2009 (Proposed)	0.2 ng/dscm	Temperature Monitoring	3-hour	0.4 ng/dscm if the temperature is less than 400^0 F at the inlet of PMCD.
	2010 (Final)	0.2 ng/dscm			
THC (or OHAP)	2009 (Proposed)	7 ppmvd ,or 2 ppmvd OHAP	CEMS	30-day	
	2010 (Final)	24 ppmvd, or 9 ppmvd OHAP	CEMS	30-day	
Hg	2009 (Proposed)	43 lbs/MMton of clinker	Hg CEMS	30-day	
	2010 (Final)	55 lbs/Mmton of clinker	Hg CEMS	30-day	
HCl	2009 (Proposed)	2 ppmvd	CEMS	30-day	Only applies to major sources; CEMS not required for limestone wet scrubber
	2010 (Final)	3 ppmvd	CEMS	30-day	
New Kiln or In-line Kiln Raw Mill					
PM (filterable)	2009 (Proposed)	0.080 lb/ton clinker	BLDS, ESP Model		Does not include condensables
	2010 (Final)	0.01 lb/ton clinker	CEMS	30-day	
Dioxin/Furan	2009 (Proposed)	0.2 ng/dscm	Temperature Monitoring	3-hour	0.4 ng/dscm if the temperature is less than 400^0 F at the inlet of PMCD.
	2010 (Final)	0.2 ng/dscm			
THC (or OHAP)	2009 (Proposed)	6 ppmv, or 1 ppmvd organic HAP	CEMS	30-day	
	2010 (Final)	24 ppmvd, or 9 ppmvd OHAP	CEMS	30-day	
Hg	2009 (Proposed)	14 lbs/MMton of clinker	Hg CEMS	30-day	or 2 ppmv Organic HAP
	2010 (Final)	21 lbs/MMton of clinker	Hg CEMS	30-day	
HCl	2009 (Proposed)	0.1 ppmvd	CEMS	30-day	Only applies to major sources; CEMS not required for limestone wet scrubber
	2010 (Final)	3 ppmvd	CEMS	30-day	

Abbreviations:
THC - total hydrocarbon
OHAP - organic hazardous air pollutant
COMS - continuous opacity monitoring system
CEMS - continuous emission monitoring system
BLDS - bag leak detection system
ESP - electrostatic precipitator

the most challenging part of the rule when compared with the monitoring requirements. While the 30-day averaging period that is utilized by EPA offsets the stringency of the numerical limits to some extent, a plethora of monitoring devices is required by the rule; some of which have not been demonstrated in continuous use on cement kilns in the U.S. For instance, EPA requires mercury CEMS on kilns while virtually all of the mercury CEMS in the U.S. that are used for compliance demonstration purposes are installed at power plants. A summary of monitoring requirements is provided below.

Kilns and clinker coolers subject to PM emission limits must measure the concentration of PM, the flow rate to convert the PM concentration to mass, and the clinker production or the kiln feed rate to normalize the pollutant mass for comparison to the standard. As such, EPA requires facilities that are subject to this limit to install PM CEMS with the ability to collect data at least every 15 minutes. The 15-minute measurements will then be rolled into daily and 30-day averages. In addition to the CEMS, EPA requires installation of a flow meter to measure the exhaust flow rate and hourly recording of the feed or clinker production rate with +/- five percent accuracy. The monitoring requirements for facilities subject to mercury limits are similar to PM, in that the rule requires Hg CEMS or a sorbent trap-based integrated monitoring system as well as continuous measurement of the exhaust gas flow rate.

Other pollutants that must be monitored with CEMS include THC and HCl. All sources that are subject to the THC emission limit must use a THC CEMS to monitor the concentration of the pollutant. However, sources that are equipped with an alkali bypass stack can use the results of the initial or following performance tests to demonstrate compliance. All sources that utilize the Organic HAP (OHAP) emission limit alternative to total THC must also monitor THC. Sources subject to HCl limits are required to install HCl CEMS unless they install a wet scrubber. However, in that case, they must also install an additional continuous parameter monitoring system (CPMS) to measure the parameters of the wet scrubbers.

With the exception of THC monitoring, a facility can petition EPA to perform alternate monitoring for the pollutants subject to emission limits. The alternative cannot have different averaging periods than the rule unless the facility can justify that the alternate monitoring method is at least as accurate or stringent. Should the facility prefer alternate monitoring, the application must be submitted and approved before the notification of performance test. However, until the administrator approves the application, the facility must comply with the monitoring requirements of the rule. Facilities must also prepare a site-specific monitoring plan that addresses operation and maintenance procedures, accuracy tests, and data quality assurance procedures for the monitoring device. The monitoring plan must be kept on site and will only be submitted to the EPA upon request.

Startup, Shutdown, and Malfunction Limits

Another unique aspect of the final PC MACT rule is EPA's approach to startup, shutdown, and malfunction (SSM) emissions. The D.C. Circuit Court ruled in 2008 that EPA cannot exempt periods of startup, shutdown, and malfunction from MACT requirements and EPA is now requiring sources to be in compliance with emissions limits at all times. In this rulemaking, EPA has recognized that applying the same MACT floor limits for normal operation to SSM periods is impractical. EPA noted the following reasons to explain why the same limits cannot be applied to SSM periods:

- The rate of production during the periods of startup and shutdown is zero or virtually zero which rules out the possibility of normalization by feed or production rates. Even when this rate is non-zero, EPA finds it difficult to directly correlate the HAP concentration with the feed rate or clinker production rate.
- Accurate flow rate measurement, necessary to convert concentration to mass, is impossible during SSM periods. All parameters affecting the flow rate are constantly changing during these periods since the kiln is not operating in a steady state, by definition.
- Averaging out the concentration spikes over time by using a 30-day averaging period is challenging. A rotary kiln can operate continuously for an extended period of time with no need for maintenance and a 30-day startup/shutdown dataset could take a few years to develop.

To address the above-mentioned items, EPA established standards on a concentration basis. An averaging period of seven days was established to facilitate data collection. EPA recognizes the fact that startup and shutdown events do not take seven days and as a result, compliance with the standard cannot be determined based on one startup or shutdown event. However, EPA believes that this shorter averaging period will allow the facility to collect the data, calculate the average, and determine compliance in "certainly less than a year." EPA's approach to shutdown is exactly the same as startup as EPA considers shutdown operation to be "in many ways a mirror image of startup." The limits for startup/shutdown have been summarized in Table 2.

Due to the issues above, concentrations of PM and Hg can be directly compared to the standard, as measured with CEMS, during startup. The THC standard during normal operation is already concentration-based and needs no conversion. Since the oxygen content often fluctuates notably in the stack gas during startup and shutdown periods, the THC standard during these periods does not include oxygen correction (as required under normal operations). The standard for HCl during startup/shutdown periods is the same as normal operation for the sources equipped with CEMS, with the removal of the oxygen correction factor and the different averaging period of seven days. However, sources that control emissions with wet scrubbers may use stack testing and parametric monitoring. EPA set the HCl standard of zero in such cases stating that there are no parameters to be monitored because emissions of HCl are not expected from the cleaner fuels that are utilized during startup.

EPA took a different approach to setting the standards for dioxin/furan. For dioxin/furan, the standards are either based on concentration or a combination of concentration and inlet temperature to the PM control device (See the notes in Table 1). The temperature measurements at the inlet of the particulate matter control device (PMCD) can be increased by 10 percent during startup/shutdown.

The MACT rule does not include specific malfunction limits as EPA found setting limits for these unplanned events impossible. EPA recognized in the preamble that malfunction events are not actual operating modes and therefore, EPA cannot set limits for them due to their sudden and unexpected nature. As such, EPA added an "affirmative defense" to the MACT that requires the facil-

Table 2: PC MACT Startup/Shutdown Kiln Limits

Pollutant	PC MACT Version	Emission Limit	Ongoing Compliance Demonstration	Averaging Period
Existing Kiln or In-line Kiln Raw Mill				
PM (filterable)	2010 (Final)	0.004 gr/dscf	CEMS	7-day
Dioxin/Furan[1]	2010 (Final)	0.2 ng/dscm		
THC (or OHAP)	2010 (Final)	24 ppmvd, or 9 ppmv OHAP	CEMS	7-day
Hg	2010 (Final)	10 µg/dscm	Hg CEMS	7-day
HCl[2]	2010 (Final)	3 ppmvd	CEMS	7-day
New Kiln or In-line Kiln Raw Mill				
PM (filterable)	2010 (Final)	0.0008 gr/dscf	CEMS	7-day
Dioxin/Furan[1]	2010 (Final)	0.2 ng/dscm		
THC (or OHAP)	2010 (Final)	24 ppmvd, or 9 ppmv OHAP	CEMS	7-day
Hg	2010 (Final)	4 µg/dscm	Hg CEMS	7-day
HCl[2]	2010 (Final)	3 ppmvd	CEMS	7-day

[1] *The emissions limit is 0.4 ng/dscm if the inlet temperature at the PMCD is less than 400°F. Temperature requirement is increased by 10% during startup/shutdown.*

[2] *HCl limit only applies to major sources. CEMS is not required if a scrubber is installed.*

ity to demonstrate the event actually meets the definition of malfunction as described in 40 CFR 63.2[1]. Penalties will apply if the facility cannot prove that the malfunction was not caused by poor maintenance or careless operation.

The definitions for startup and shutdown have not been well described in the rule, potentially creating confusion. Nevertheless, EPA offered the following definition of startup in the preamble of the final rule, "Startup is the period of time between when fuel is first introduced into a cement kiln that is not firing fuel, and when the kiln temperatures are within normal operating limits, the kiln is using its normal operating fuel, and the kiln is producing clinker." This definition raises a few questions. First, the terms "normal operating fuel" and "normal operating limits" are undefined. Second, EPA states in the preamble that kilns will probably be in compliance during startup/shutdown periods because cleaner fuels are burned and feed rates are lower during periods. However, based on the definition, the kiln can burn its normal operating fuel and still be in startup since it has not met the temperature or production requirements. Shutdown is defined as "the period of time between when kiln raw material feed is shutoff and gas flow through the kiln ceases." Therefore, until the material feed is completely stopped and the kiln ID fan is turned off, the kiln is not considered to have completed a shutdown period.

Determining initial compliance with the SSM requirements of the new PC MACT may be difficult. Most facilities do not have any test data on startup or shutdown because of the previous exemptions, nor do they have the ability to control emissions very well in these phases of operation. Collecting such data to calculate the 7-day average concentration for all subject pollutants could take longer than a year. This leaves a short time to review and implement all steps necessary for compliance before the compliance date, which is only three years from the date of publication. It is also important to note that while it was EPA's intent that the same limits apply during SSM, the 7-day averaging period that is applied to startup/shutdowns is more stringent than the 30-day averaging period applied to other pollutants during normal operation. This small discrepancy could make the startup/shutdown limits subject to scrutiny and future public commenting. Lastly, add the complications of applying and managing CEMS to meet two sets of emissions limits (normal and startup/shutdown) provides for a very complicated regime for a cement kiln operator to continuously comply.

Conclusion

Indeed, it is understandable that EPA would describe the final PC MACT rule as "historic." Given the scope of the final rule, litigation of its lawfulness is a near certainty. For those source categories in the process of or expected to go through a MACT revision, understanding EPA's approaches to the PC MACT rule is a must to prepare for these new realities. Given the nature of cement kilns and their emissions, each compliance assurance approach will be unique to a kiln. Although the final chapter on the PC MACT rule has not yet been written, the compliance date is known. As a result, sources affected by the PC MACT rule should begin efforts to comply with the rule. In addition to efforts to comply with aspects of the final rule (not addressed in this article) that are slated to become effective on or about November 8, 2010, these efforts may include collecting kiln specific emissions data (especially on startup/shutdown operations) while also assessing variability of emissions, developing plans to install continuous monitoring, and beginning to assess various control strategies. ❖

[1] *40 CFR 63.2 defines Malfunction as any sudden, infrequent, and not reasonably preventable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner which causes, or has the potential to cause, the emission limitations in an applicable standard to be exceeded. Failures that are caused in part by poor maintenance or careless operation are not malfunctions.*

Should Your Company Be Conducting Life Cycle Analyses?

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Many companies have already answered yes to that question – for a combination of reasons typically related to stakeholder interest, key customer demands, public perception, and competitive positioning. In fact, life cycle analysis (LCA) has increasingly become an important tool in mature corporate sustainability programs, providing organizations with a consistent methodology for implementing key program components such as:

- Product Carbon Footprinting
- Design for the Environment
- Environmental Product Declarations
- Environmentally Preferable Purchasing
- Environmental Supply Chain Management

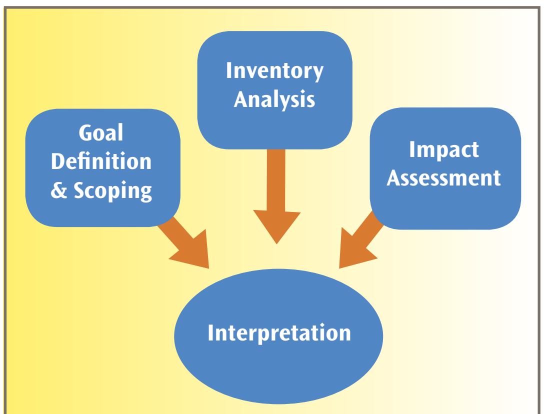
What Constitutes an LCA?

Simply put, it is an advanced environmental impact analysis that covers more than just interactions caused by an organization's manufacturing and/or service operations. An LCA examines environmental interactions along the entire organizational value chain - incorporating a full-spectrum analysis of the acquisition of raw materials, manufacturing activity, product use and/or delivery of a service, maintenance of the product or service, and ultimate disposal. The overarching goals of an LCA are to:

1. Develop a comprehensive inventory of material inputs, energy consumption, water usage, and environmental releases
2. Evaluate the potential impacts of environmental releases and resource consumption at each stage of the value chain
3. Clarify and interpret the impact analysis results
4. Use the information to make more informed decisions concerning resource inputs, product and/or service design, supplier selection, and marketing

The approach for conducting an LCA is addressed under the ISO 14040 standard (see *International Organization for Standards. 1997. Environmental Management. Life Cycle Assessment – Principles and Framework*). ISO 14040 identifies that a typical LCA consists of four main phases, as noted in the diagram below.

Goal Definition and Scoping – In this phase, the organization identifies the primary reason(s) for conducting its study, main audience for receiving the results, types of information needed by decision-makers, and the level of specificity required.



Main Life cycle Analysis Phases

Inventory Analysis – The inventory phase involves characterizing the boundaries of your system (typically via constructing a flow diagram illustrating the processes being evaluated), types of data needed, data collection methodology, and procedure for verifying data. At each stage along the defined value chain, the organization examines key inputs (e.g., electricity, fossil fuels, water, specific process raw materials) and outputs (e.g., air emissions, water discharges, solid wastes, resource use).

Impact Assessment – The assessment phase involves converting the outputs of the inventory into an indicator for defined impact categories. Impact categories typically cover a broad range of environmental concerns - including climate change, water consumption, acid rain and eco-toxicity.

Interpretation – In the last phase, an organization analyzes the results and develops conclusions relative to its original goals. Ideally, the organization should recognize and explain the limitations of its study after developing conclusions. The interpretation phase commonly includes LCA documentation and reporting activity.

Why Conduct an LCA?

There are numerous reasons why companies, trade associations, and even governmental entities have made the decision to conduct an LCA. These motivating factors can generally be categorized into four main groups:

Environmental Supply Chain Management – Companies respond to the demands of key customers for information that the customer may need for its own sustainability program. For example, large retailers have been very active in requiring their suppliers to examine at least the carbon, energy and water footprints associated with its products. Furthermore, food and beverage companies have similarly been working with key customers to obtain LCA data that can be used in their sustainability efforts.

Process Improvement – While there are often external forces prompting a company to conduct an LCA, many have decided to employ the LCA methodology for process improvement. For example, an LCA can assist a company in comparing the relative benefits of one process versus another, different raw materials within a given process, and where the environmental "hot spots" exist along its value chain.

Product Marketing Opportunities – LCA has long been used to compare rival products in the marketplace. Often this is done via broad-based LCAs conducted by trade associations.

More recently, the LCA approach has been used to support environmental product declarations and other eco-labeling initiatives.

Environmental Performance Measurement – An LCA program can allow an organization to examine its impacts in a disciplined manner and provide a platform for determining the effectiveness of environmental mitigation and/or sustainability actions.

Companies across a broad spectrum of industries are using LCA methodologies for corporate decision-making. Some examples of corporations with active LCA programs include Procter and Gamble, Coca-Cola, Pepsi Co, Dow Chemical, Volvo, Ford Motor Company, Levi Strauss, 3M, Hewlett-Packard, Kodak and McDonalds. Active trade associations include the Glass Packaging Institute, National Council for Air and Stream Improvement, Portland Cement Association, and Association of Plastics Manufacturers in Europe.

Available Tools for Conducting an LCA

Software and databases have emerged in recent years to facilitate the process for conducting an LCA. Presently, two software products dominate the market among LCA tool providers. According to a 2006 study conducted by Columbia University, about 90% of LCA practitioners use either Gabi Version 4 [*http://www.gabi-software.com*] or Simapro Version 7.1[*http://www.pre.nl/simapro/default.htm*] as part of the overall analysis. Both are process-based models that quantify physical flows of energy, resources, and environmental impacts related to the production of a specific product. Other notable LCA tools in the marketplace include Umberto, Jamai Pro, and the US Life Cycle Inventory database (sponsored by the National Renewable Energy Laboratory). For moderately to highly complex industry operations, it can be very challenging to conduct an LCA without the use of software tools – particularly where multiple products or process options need to be examined. Thus, most LCA practitioners tend to use one of these available tools to minimize the time required and improve the accuracy of the analysis.

As the LCA field continues to mature, development of more readily available data may improve the ability of companies to conduct an LCA efficiently and cost-effectively. The recent uptick in LCA activity has led to the establishment of Earthster [http://www.earthster.org] – an open source platform for collecting and sharing environmental data in supply chains. The goal of this open platform is to increase transparency in using this supply chain information for conducting LCAs and/or carbon footprints. Time will tell whether this web portal achieves its lofty goals.

Getting Started

For most organizations initiating the LCA process, development of a Scoping Framework document is critical – regardless of whether software tools or manual approaches will be used to conduct the analysis. The Framework document can be used to establish important factors that will guide the process and resources needed for the overall initiative. Below is a recommended outline for the Scoping Framework document.

- ***Goal statement –*** Brief statement on the primary and ancillary goals of the analysis
- ***Intended applications –*** Identification of processes and/or material input options considered
- ***Intended audience –*** Clarification on the main audience and target decision-makers who will be recipients on the results
- ***Intended use of results –*** Discussion on whether data will be used by key customers in their own sustainability programs as well as whether the organization may also use results in its own internal evaluations for sustainability and process improvement
- ***Function, functional unit, reference flow –*** Key point for the analysis serving as the point of comparison (should be developed in terms of delivery of a defined amount of product or level of service)
- ***System boundaries –*** General diagram of the system to be evaluated, including clarification on whether the analysis involves cradle to gate, cradle to grave, or cradle to cradle
- ***Criteria for including inputs/outputs –*** Explanation of how data will be selected and whether the analysis will establish *de minimis* flow values for certain raw material inputs
- ***Data quality requirements –*** Explanation of how data will be analyzed and verified
- ***Allocation approach –*** Discussion of how results will be allocated to multiple products or by-products (if applicable)

After the Framework document has been completed, the organization needs to prepare for data collection. That step begins with developing a detailed flow diagram of the processes to be considered. A flow diagram is a tool to map the inputs and outputs to a process or system. For example, calculations of energy flow should take into account the different fuels and electricity sources used, the efficiency of conversion and distribution of energy flow as well as the inputs and outputs associated with the generation and use of that energy flow. The goal is to have a detailed and accurate list of all the inputs and outputs of the process studied. However, this analysis is iterative and as data is collected and more is learned about the system, new data requirements or limitations may be identified that require a change in the data collection procedures so that the goals of the study will be met.

Once the LCA scope has been established and the process boundaries clearly delineated, the organization is ready to proceed with the data intensive LCA phases: Inventory Analysis, Impact Assessment, and Interpretation. Future EQ articles will provide more detailed guidance on these phases.

For further information on Product Carbon Footprinting and Life Cycle Analysis, please contact Rich Pandullo (Director, Sustainability and Environmental Management) at *rpandullo@trinityconsultants.com* or 919-462-9693 or Maren Seibold (Managing Consultant) at *mseibold@trinityconsultant.com*.

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