# Mandatory Greenhouse Gas Reporting Rule

## Pulp and Paper Manufacturing Subpart AA

05/08/12

# Who Is Subject to Subpart AA?

- Facilities that emit 25,000 metric tons $CO_2e$ emissions (excluding biogenic $CO_2$) from:
  - Chemical recovery furnaces and lime kilns at kraft and soda mills.
  - Chemical recovery combustion units at sulfite and stand-alone semichemical facilities.
  - The addition of makeup chemicals ($CaCO_3$, $Na_2CO_3$) in the chemical recovery area.
  - Other stationary fuel combustion units.

# What GHGs Must Be Reported?

| Source | Report Emissions Under This Subpart . . . | | | | | |
|---|---|---|---|---|---|---|
| | $CO_2$ | Biogenic $CO_2$ | $CH_4$ (fuel combustion) | $N_2O$ (fuel combustion) | $CH_4$ (biomass combustion) | $N_2O$ (biomass combustion) |
| Chemical recovery furnaces at kraft and soda mills | AA[1] | AA | AA[1] | AA[1] | AA | AA |
| Chemical recovery combustion units at sulfite and stand-alone semichemical mills | AA[1] | AA | AA[1] | AA[1] | AA | AA |
| Lime kilns at kraft and soda mills | AA[1] | AA | AA[1] | AA[1] | Not applicable | Not applicable |
| Makeup chemicals used in chemical pulp mills | AA | Not applicable | | | | |
| Other stationary combustion units | C | C | C | C | C | C |

[1] The calculation methodology is found in Subpart C but emissions are reported under subpart AA. Lime kiln emission factors are for CH4 and N2O are obtained from Subpart AA (Table AA-2).

# How Are GHG Emissions Estimated for Kraft and Soda Mills?

- Chemical recovery furnaces:
  - Use Eq. AA-1 to calculate biogenic $CO_2$ emissions and $CH_4$ and $N_2O$ emissions from combustion of spent liquor solids.
  - Use Eq. C-1, C-1a or C-1b to calculate $CO_2$ emissions from fossil fuel combustion. A higher Tier may be used if the respective monitoring and QA/QC requirements in 98.34 are met.
  - Use Eq. C-8, C-8a or C-8b to calculate $CH_4$, and $N_2O$ emissions from fossil fuel combustion.
- Lime kilns:
  - Use Eq. C-1, C-1a or C-1b to calculate $CO_2$ emissions from fossil fuel combustion (biogenic $CO_2$ emissions from conversion of $CaCO_3$ to CaO are included in the biogenic $CO_2$ estimate for the recovery furnace). A higher Tier may be used if the respective monitoring and QA/QC requirements in 98.34 are met.
  - Use Eq. C-8, C-8a or C-8b to calculate $CH_4$ and $N_2O$ emissions from fossil fuel combustion.
- Makeup chemical additions:
  - Use Eq. AA-3 to calculate $CO_2$ emissions.

# How Are GHG Emissions Estimated for Sulfite and Stand-alone Sulfite Mills?

- Chemical recovery combustion units:
  - Use Eq. AA-2 to calculate biogenic $CO_2$ emissions from combustion of spent liquor solids
  - Use Eq. AA-1 to calculate $CH_4$ and $N_2O$ emissions from combustion of spent liquor solids
  - Use Eq. C-1, C-1a or C-1b to calculate $CO_2$ emissions from fossil fuel combustion. A higher Tier may be used if the respective monitoring and QA/QC requirements in 98.34 are met.
  - Use Eq. C-8, C8a or C-8b to calculate $CH_4$ and $N_2O$ emissions from fossil fuel combustion
- Makeup chemical additions:
  - Use Eq. AA-3 to calculate $CO_2$ emissions

# Monitoring Requirements Kraft and Soda Mills

| Parameter | Frequency | Method |
|---|---|---|
| Mass of spent liquor solids fired in chemical recovery furnaces (tons/yr) | At least annually | TAPPI method T684 om-05 (Solids Content of Black Liquor), or<br><br>Records from online measurement system that determines mass of spent liquor solids. |
| Site-specific high heat value of spent liquor solids (mmBtu/kg) | At least annually | TAPPI method T684 om-06 (Gross Heating Value of Black Liquor) |
| Amount of fossil fuels fired in chemical recovery furnaces, lime kilns, and fossil fuel combustion units (tons/yr, scf/yr, gal/yr) | Annually | Company records (e.g., direct measurement) |
| Amount of make-up chemicals used (Mg/yr) | Annually | Direct or indirect measurement |

# Monitoring Requirements for Sulfite and Stand-alone Semichemical Mills

| Parameter | Frequency | Method |
|---|---|---|
| Mass of spent liquor solids fired in chemical recovery furnaces (tons/yr) | At least annually | TAPPI method T684 om-05 (Solids Content of Black Liquor), or<br><br>Records from online measurement system that determines mass of spent liquor solids. |
| Site-specific high heat value of spent liquor solids (mmBtu/kg) | At least annually | TAPPI method T684 om-06 (Gross Heating Value of Black Liquor) |
| Carbon content of spent liquor solids (wt %) | At least annually | ASTM D5373-08 (Instrumental Determination of Carbon, Hydrogen, and Nitrogen) |
| Amount of fossil fuels fired in chemical recovery furnaces, lime kilns, and fossil fuel combustion units (tons/yr, scf/yr, gal/yr) | Annually | Company records (e.g., direct measurement) |
| Amount of make-up chemicals used (Mg/yr) | Annually | Direct or indirect measurement |

# What Information Must Be Included in the Annual Report?

- In addition to the information specified in Subpart A (98.3(c)), each annual report must include the following information specific to Subpart AA:
  - Speciated GHG emission estimates (metric tons/yr).
  - Quantity of fossil fuels (by type) fired in the chemical recovery combustion units, furnaces, and lime kilns (short tons/yr, gal/yr, scf/yr).
  - Mass of spent liquor solids fired (short tons/yr) used in Eq. AA-1 (short tons/yr) and the basis for determination (i.e., TAPPI method or online system).
  - High heat value of spent liquor used in Eq. AA-1 (mmBtu/kg).

# What Information Must Be Included in the Annual Report? (cont'd)

- In addition to the information specified in Subpart A (98.3(c)), each annual report must include the following information specific to Subpart AA:
  - Emission factor values used in Eq. AA-1 (kg GHG/mmBtu).
  - Carbon content of spent liquor solids used in Eq. AA-2 (wt. % expressed as a decimal fraction).
  - Quantity of make-up chemicals used in Eq. AA-3 (metric tons/yr).
  - Steam purchases (lbs steam/yr).
  - Quantity of pulp and/or paper products manufactured (metric tons)[1].

[1] Pulp production should be reported in air dried metric tons of unbleached virgin chemical pulp. The reported paper production should be the paper product exiting all of the paper machine(s) at the mill. See FAQ 626 and 653 for more information.

# What Records Must be Kept?

- In addition to the information specified in Subpart A (98.3(g)), the following records specific to Subpart AA must be kept:
  - GHG emission estimates for each source (biogenic $CO_2$ estimates must be kept separately).
  - Annual analysis results of spent liquor.
  - Annual mass of spent liquor solids fired (by source) and the basis for determination.
  - Annual quantities of make-up chemicals added.
  - Annual steam purchases.
  - Annual production of pulp and/or paper products manufactured.

# For further information

- www.epa.gov/climatechange/emissions/ghgrulemaking.html
  - Applicability tool
  - Pulp and Paper information sheet
  - Pulp and Paper checklist
  - Technical Support document
  - Preamble and rule (2009), rule amendments (2010, 2011)
  - Subpart AA comment response document
  - FAQs

- Email: GHGReporting@epa.gov

# Subpart AA (Pulp and Paper Manufacturing) – Emission Calculation Equations

# Appendix

Equations for Calculating GHG Emissions from Pulp and Paper Manufacturing

# Equation AA-1: Biogenic $CO_2$ Emissions and Emissions of $CH_4$ and $N_2O$ From Chemical Recovery Furnaces at Kraft and Soda Mills

$$CO_2,\ CH_4,\ \text{or}\ N_2O\ \text{from biomass} = (0.90718) * \text{Solids} * \text{HHV} * \text{EF}$$

Where:

$CO_2$, $CH_4$, or $N_2O$ from Biomass = Biogenic $CO_2$ emissions or emissions of $CH_4$ or $N_2O$ from spent liquor solids combustion (metric tons per year).

Solids = Mass of spent liquor solids combusted (short tons per year) determined according to §98.274(b).

HHV = Annual high heat value of the spent liquor solids (mmBtu per kilogram) determined according to 98.274(b).

EF = Default or site-specific emission factor for CO2, CH4, or N2O, from Table AA-1 of this subpart (kg CO2, CH4, or N2O per mmBtu).

0.90718 = Conversion factor from short tons to metric tons.

# Equation AA-2: Biogenic $CO_2$ Emissions From Chemical Recovery Combustion Units at Sulfite and Stand-alone Semichemical Mills

$$Biogenic\ CO_2 = \frac{44}{12} * Solids * CC * (0.90718)$$

Where:

Biogenic CO2 = Annual CO2 mass emissions for spent liquor solids combustion (metric tons per year).

Solids = Mass of the spent liquor solids combusted (short tons per year) determined according to §98.274(b).

CC = Annual carbon content of the spent liquor solids, determined according to §98.274(b) (percent by weight, expressed as a decimal fraction, e.g., 95% = 0.95).

44/12 = Ratio of molecular weights, CO2 to carbon.

0.90718 = Conversion from short tons to metric tons.

# Equation AA-3: $CO_2$ Emissions From Makeup Chemical Usage

$$CO_2 = \left[ M_{(CaCO_3)} * \frac{44}{100} + M_{(Na_2CO_3)} \frac{44}{105.99} \right] * 1000\, kg / metric\, ton$$

Where:

$CO_2$ = $CO_2$ mass emissions from makeup chemicals (kilograms/yr).

M ($CaCO_3$) = Make-up quantity of $CaCO_3$ used for the reporting year (metric tons per year).

M ($NaCO_3$) = Make-up quantity of $Na_2CO_3$ used for the reporting year (metric tons per year).

44 = Molecular weight of $CO_2$.

100 = Molecular weight of $CaCO_3$.

105.99 = Molecular weight of $Na_2CO_3$.

# Equation C-1: $CO_2$ Emissions From Fossil Fuel Combustion

$$CO_2 = 1x10^{-3} * Fuel * HHV * EF$$

Where:

$CO_2$ = Annual $CO_2$ mass emissions for the specific fuel type (metric tons).

Fuel = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel).

HHV = Default high heat value of the fuel, from Table C-1 of this subpart (mmBtu per mass or mmBtu per volume, as applicable).

EF = Fuel-specific default $CO_2$ emission factor, from Table C-1 of this subpart (kg $CO_2$ / mmBtu).

$1 \times 10^{-3}$ = Conversion factor from kilograms to metric tons.

# Equation C-1a: $CO_2$ Emissions From Natural Gas Combustion (therms)

$$CO_2 = 1x10^{-3} * [0.1 * Gas * EF]$$

Where:

$CO_2$ = Annual $CO_2$ mass emissions for natural gas combustion (metric tons).

Gas = Annual natural gas usage, from billing records (therms).

EF = Fuel-specific default $CO_2$ emission factor for natural gas, from Table C-1 of this subpart (kg $CO_2$ / mmBtu).

0.1 = Conversion factor from therms to mmBtu.

1 x $10^{-3}$ = Conversion factor from kilograms to metric tons.

# Equation C-1b: $CO_2$ Emissions From Natural Gas Combustion (mmBtu)

$$CO_2 = 1x10^{-3} * Gas * EF$$

Where:

$CO_2$ = Annual $CO_2$ mass emissions for natural gas combusion (metric tons).

Gas = Annual natural gas usage, from billing records (mmBtu).

EF = Fuel-specific default $CO_2$ emission factor for natural gas, from Table C-1 of this subpart (kg $CO_2$ / mmBtu).

$1 \times 10^{-3}$ = Conversion factor from kilograms to metric tons.

# Equation C-8: Emissions of $CH_4$ and $N_2O$ From Fossil Fuel Combustion

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * Fuel * HHV * EF$$

Where:

$CH_4$ or $N_2O$ = Annual $CH_4$ or $N_2O$ emissions from the combustion of a particular type of fuel (metric tons).

Fuel = Mass or volume of the fuel combusted, either from company records or directly measured by a fuel flow meter, as applicable (mass or volume per year).

HHV = Default high heat value of the fuel from Table C-1 of this subpart (mmBtu per mass or volume).

EF = Fuel-specific default emission factor for $CH_4$ or $N_2O$, from Table C-2 of this subpart (kg $CH_4$ or $N_2O$ per mmBtu).

$1 \times 10^{-3}$ = Conversion factor from kilograms to metric tons.

# Equation C-8a: Emissions of $CH_4$ and $N_2O$ From Natural Gas Combustion (therms)

$$CH_4 \text{ or } N_2O = 1 x 10^{-3} * Fuel * 0.1 * EF$$

Where:

$CH_4$ or $N_2O$ = Annual $CH_4$ or $N_2O$ emissions from the combustion of natural gas (metric tons).

Fuel = Annual natural gas usage, from gas billing records (therms).

EF = Fuel-specific default emission factor for $CH_4$ or $N_2O$, from Table C-2 of this subpart (kg $CH_4$ or $N_2O$ per mmBtu).

0.1 = Conversion factor from therms to mmBtu.

$1 x 10^{-3}$ = Conversion factor from kilograms to metric tons.

# Equation C-8b: Emissions of $CH_4$ and $N_2O$ From Natural Gas Combustion (mmBtu)

$$CH_4 \text{ or } N_2O = 1 x 10^{-3} * Fuel * EF$$

Where:

$CH_4$ or $N_2O$ = Annual $CH_4$ or $N_2O$ emissions from the combustion of natural gas (metric tons).

Fuel = Annual natural gas usage, from gas billing records (mmBtu).

EF = Fuel-specific default emission factor for $CH_4$ or $N_2O$, from Table C-2 of this subpart (kg $CH_4$ or $N_2O$ per mmBtu).

$1 \times 10^{-3}$ = Conversion factor from kilograms to metric tons.