Caprolactam, Glyoxal, and Glyoxylic Acid Production

Subpart YY, Greenhouse Gas Reporting Program

OVERVIEW

Subpart YY of the Greenhouse Gas Reporting Program (GHGRP) (40 CFR 98.510 – 98.518) applies to any facility that produces caprolactam ($C_6H_{11}NO$), glyoxal ($C_2H_2O_2$), or glyoxylic acid ($C_2H_2O_3$) and meets the Subpart YY source category definition. Some subparts have thresholds that determine applicability for reporting, and some do not. To decide whether your facility must report under this subpart, please refer to 40 CFR § 98.511 and the GHGRP Applicability Tool.

This Information Sheet is intended to help facilities reporting under Subpart YY understand how the source category is defined, what greenhouse gases (GHGs) must be reported, how GHG emissions must be calculated and shared with EPA, and where to find more information.

How is This Source Category Defined?

The Subpart YY source category applies to any facility that produces caprolactam ($C_6H_{11}NO$), glyoxal ($C_2H_2O_2$), or glyoxylic acid ($C_2H_2O_3$), but excludes the production of $C_2H_2O_2$ through the LaPorte process (i.e., the gas-phase catalytic oxidation of ethylene glycol ($C_2H_6O_2$) with air in the presence of a silver (Ag) or copper (Cu) catalyst).

What GHGs Must Be Reported?

Under Subpart YY, facilities must report nitrous oxide (N_2O) process emissions from the production of $C_6H_{11}NO$, $C_2H_2O_2$, and $C_2H_2O_3$.

If multiple Greenhouse Gas Reporting Program (GHGRP) source categories are co-located at a facility, the facility may need to report greenhouse gas (GHG) emissions under a different subpart. Please refer to the relevant information sheet for a summary of the rule requirements for any other source categories located at the facility. For example, facilities that produce $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$, must report carbon dioxide (CO_2), methane (CH_4), and N_2O emissions from each stationary combustion unit under Subpart C (General Stationary Fuel Combustion Sources), found at 40 CFR 98.30 – 98.38.

How Must GHG Emissions Be Calculated?

Under Subpart YY, facilities that produce $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$, must report:

- Annual N_2O process emissions from each $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ process line using the appropriate default N_2O generation factor(s) from Table YY-1,
- Site-specific N_2O destruction factor(s) for each N_2O abatement device, and
- Site-specific production data (as applicable):

- Determine the annual amount of $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ produced (product *i*) on each process line *t* (metric tons product) by summing the respective monthly quantities. To determine total monthly amounts produced, use one of the two following methods:
  - Direct measurement of production (such as using flow meters, weigh scales, etc.); or
  - Existing plant procedures used for accounting purposes (i.e., dedicated tank-level and acid concentration measurements).
- If process line *t* exhausts to any N_2O abatement technology *j*, determine the destruction efficiency (DE) for each N_2O abatement technology as follows:
  - Use the control device manufacturer's specified DE; and
  - Estimate the DE through process knowledge. Examples of information that could constitute process knowledge include calculations based on material balances, process stoichiometry, or previous test results provided the results are still relevant to the current vent stream conditions. Explain and document how process knowledge (if applicable) was used to determine the DE.
- If process line *t* exhausts to any N_2O abatement technology *j*, determine the abatement utilization factor for each N_2O abatement technology as follows:
  - If the abatement technology *j* has no downtime during the year, use 1.
  - If the abatement technology *j* was not operational while product *i* was being produced on process line *t*, calculate the abatement utilization factor according to Equation 1 of YY.

Equation 1 of YY: $AF_j = \frac{T_{i,j}}{T_i}$

AF_j = Monthly abatement utilization factor of N_2O abatement technology *j* from process line *t* (fraction of time that abatement technology is operating).

$T_{i,j}$ = Total number of hours during month that product *i* ($C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$), was produced from process line *t* during which N_2O abatement technology *j* was operational (hours).

T_i = Total number of hours during month that product *i* ($C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$), was produced from process line *t* (hours).

- Calculate N_2O emissions for each product *i* from each process line *t* and each N_2O control technology *j* according to Equation 2 of YY.

Equation 2 of YY: $E_{N2Ot} = \sum_{i,j}\left[EF_i * P_i * \left(1 - \left(DE_j * AF_j\right)\right)\right] * 0.001$

E_{N2Ot} = Monthly process emissions of N_2O, metric tons from process line *t*.

EF_i = N_2O generation factor for product *i* ($C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$), kilograms (kg) of N_2O/ metric tons of product produced, as shown in Table YY-1.

P_i = Monthly production of product *i*, ($C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$), metric tons.

DE_j = DE of N_2O abatement technology type *j*, fraction (decimal fraction of N_2O removed from vent stream).

AF_j = Monthly abatement utilization factor for N_2O abatement technology type *j*, fraction, calculated using Equation 1 of this subpart.

0.001 = Conversion factor from kg to metric tons.

- Determine the annual emissions combined from each process line at your facility using Equation 3 of YY.

Equation 3 of YY: $N_2O = \sum_1^{12} E_{N2Ot}$

N_2O = Annual process N_2O emissions from each process line for product *I* ($C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$) (metric tons).

E_{N2Ot} = Monthly process emissions of N_2O from each process line for product *i* ($C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$) (metric tons).

Table YY-1. N_2O Generation Factors

Product	N_2O Generation Factor *
Caprolactam	9.0
Glyoxal	520
Glyoxylic acid	100

* *Generation factors in units of kg of N_2O emitted per metric tons of product produced.*

A checklist for data that must be monitored is available here: Subpart YY Monitoring Checklist.

What Information Must Be Reported?

In addition to the information required by the General Provisions in Subpart A, found at 40 CFR 98.3(c), facilities that produce $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ must report the following:

- Process line identification number.
- Annual process N_2O emissions from each process line as follows:
  - N_2O from $C_6H_{11}NO$ production (metric tons);
  - N_2O from $C_2H_2O_2$ production (metric tons);
  - N_2O from $C_2H_2O_3$ production (metric tons).
- Annual production quantities from all process lines at the $C_6H_{11}NO$, $C_2H_2O_2$, or C_2H_2O production facility as follows:
  - $C_6H_{11}NO$ production (metric tons);
  - $C_2H_2O_2$ production (metric tons);
  - $C_2H_2O_3$ production (metric tons).
- Annual production capacity from all process lines at the $C_6H_{11}NO$, $C_2H_2O_2$, or C_2H_2O production facility, as applicable, as follows:
  - $C_6H_{11}NO$ production capacity (metric tons);
  - $C_2H_2O_2$ production capacity (metric tons);
  - $C_2H_2O_3$ production capacity (metric tons).
- Number of process lines at the $C_6H_{11}NO$, $C_2H_2O_2$, or C_2H_2O production facility, by product, as follows:
  - Total number of process lines producing $C_6H_{11}NO$;
  - Total number of process lines producing $C_2H_2O_2$;
  - Total number of process lines producing $C_2H_2O_3$.
- Number of operating hours in the calendar year for each process line at the $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ production facility (hours).

- N_2O abatement technologies used (if applicable) and date of installation of abatement technology at the $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ production facility.
- Monthly abatement utilization factor for each N_2O abatement technology for each process line at the $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ production facility.
- Number of times in the reporting year that missing data procedures were followed to measure production quantities of $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ (months).
- Annual percent N_2O emission reduction per chemical produced at the $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ production facility, as applicable, as follows:
    - Annual percent N_2O emission reduction for all $C_6H_{11}NO$ production process lines;
    - Annual percent N_2O emission reduction for all $C_2H_2O_2$ production process lines;
    - Annual percent N_2O emission reduction for all $C_2H_2O_3$ production process lines.

A complete record of all measured parameters used in GHG emissions calculations is required. Whenever a quality-assured value of a required parameter is unavailable, a substitute data value for the missing parameter must be used in the calculations as specified below:

- For each missing value of $C_6H_{11}NO$, $C_2H_2O_2$, or $C_2H_2O_3$ production, the substitute data must be the best available estimate based on all available process data or data used for accounting purposes (such as sales records).
- For missing values related to the N_2O abatement device, assuming that the operation is generally constant from year to year, the substitute data value should be the most recent quality-assured value.

What Records Must Be Maintained?

Reporters are required to retain records that pertain to their annual GHGRP report for at least three years after the date the report is submitted. Please see the Subpart A Information Sheet and 40 CFR 98.3(g) for general recordkeeping requirements. Specific recordkeeping requirements for Subpart YY are listed at 40 CFR 98.517.

When and How Must Reports Be Submitted?

Reporters must submit their annual GHGRP reports for the previous calendar year to the EPA by March 31st, unless the 31st falls on a Saturday, Sunday, or federal holiday, in which case reports are due on the next business day. Annual reports must be submitted electronically using the electronic Greenhouse Gas Reporting Tool (e-GGRT), the GHGRP's online reporting system.

Additional information on setting up user accounts, registering a facility, and submitting annual reports is available on the GHGRP Help webpage.

When Can a Facility Stop Reporting?

A facility may discontinue reporting under several scenarios, which are summarized in Subpart A (found at 40 CFR 98.2(j)) and the Subpart A Information Sheet.

For More Information

For additional information on Subpart YY, please visit the Subpart YY webpage. For additional information on the GHGRP, please visit the GHGRP website, which includes additional information sheets, data previously reported to the GHGRP, training materials, and links to Frequently Asked Questions (FAQs). For questions that cannot be answered through the GHGRP website, please contact us at: GHGreporting@epa.gov.

This Information Sheet is provided solely for informational purposes. It does not replace the need to read and comply with the regulatory text contained in the rule. Rather, it is intended to help reporting facilities and suppliers understand key provisions of the GHGRP. It does not provide legal advice; have a legally binding effect; or expressly or implicitly create, expand, or limit any legal rights, obligations, responsibilities, expectations, or benefits with regard to any person or entity.