Illinois Environmental Protection Agency
Bureau of Air, Permit Section

Project Summary for a Construction Permit Application from Cronus Chemicals, LLC, for a Fertilizer Manufacturing Facility near Tuscola, Illinois

Source Identification No.:	041804AAF
Application No.:	13060007
Date Received:	February 14, 2014

Schedule

Public Comment Period Begins:	May 12, 2014
Public Hearing:	June 26, 2014
Public Comment Period Closes:	July 25, 2014

Illinois EPA Contacts

Permit Analyst:	Bob Smet
Community Relations Coordinator:	Brad Frost

I. INTRODUCTION

Cronus Chemicals, LLC (Cronus), has submitted an application for an air pollution control construction permit for a fertilizer manufacturing facility that would be sited west of Tuscola. The principal product of the facility would be urea. It would also be allowed to make a limited amount of ammonia for sale, which would likely occur on a seasonal basis. Natural gas would be both feedstock and fuel for the facility.

The Illinois EPA has reviewed Cronus' application for a construction permit for the proposed facility and made a preliminary determination that it meets applicable requirements. In particular, the facility would be developed to use best available control technology, as applicable, to reduce its emissions. The air quality analyses that were conducted for the facility show that it will not cause violations of applicable ambient air quality standards.

The Illinois EPA has prepared a draft of the construction permit that it would propose to issue for the proposed facility. Prior to issuing any construction permit for the facility, the Illinois EPA is holding a public comment period that includes a public hearing to receive comments on the proposed issuance of a permit for the facility and the terms and conditions of the draft permit.

II. PROJECT DESCRIPTION

Cronus is proposing to construct a facility that would manufacture nitrogen based fertilizers (i.e., urea and ammonia) using natural gas as a feedstock. The facility would be developed to produce urea, which is a solid material that can be readily stored and handled. The facility would also be able to sell a fraction of its annual output as ammonia. This is expected to occur on a seasonal basis, consistent with agricultural demand for ammonia. The facility is being developed for a nominal daily production capacity of about 4880 tons of urea or 2789 tons of ammonia.

The principle emissions units at the facility would be an ammonia plant, a reformer furnace, a boiler and a urea plant. The ammonia plant would make the ammonia that would either be further processed in the urea plant or stored for direct sale. The gas-fired reformer furnace and the boiler would directly support the operation of the ammonia plant and, by way of the ammonia plant, provide steam for other operations at the facility.

Ammonia (NH_3) would be produced in the ammonia plant by combining hydrogen (H_2) and nitrogen (N_2). The hydrogen would be made in the reformer from the natural gas feedstock and water. The nitrogen would be obtained from the atmosphere. To produce urea ($(NH_2)_2CO$), the urea plant would combine ammonia with carbon dioxide (CO_2), which is also produced in the ammonia plant. For a further, more detailed description of the ammonia and urea production process, refer to Attachment A.

Other emission units at the proposed facility would include two flares to control releases of off-gas during startup and malfunction of the ammonia and urea plants, a startup heater for the ammonia plant, equipment for the storage and handling of urea product, a cooling tower, a safety flare for the ammonia storage tanks, components (i.e., valves, pumps and other equipment with potential for emissions from leaks), roadways and emergency engines.

III. EMISSIONS

The potential emissions of the proposed facility are listed below. Potential emissions are calculated based on continuous operation at the maximum design rates of the ammonia and urea plants and the maximum amount of ammonia that may be sold. Actual emissions will be less to the extent that the facility does not operate at its maximum capacity, does not operate at all hours of the year, and operates within a reasonable margin of compliance.[1]

Potential Emissions From the Facility (tons/year)

Pollutant	Emissions
Nitrogen Oxides (NOx)	120.8
Carbon Monoxide (CO)	253.4
Particulate Matter (PM)	157.3
Particulate Matter$_{10}$ (PM_{10})[2]	133.6
Particulate Matter$_{2.5}$ ($PM_{2.5}$)[2]	126.6
Greenhouse Gases (GHG), as carbon dioxide equivalents	1,302,165
Volatile Organic Material (VOM)	81.7
Sulfur Dioxide (SO_2)	5.0

IV. APPLICABLE EMISSION STANDARDS

The application shows that emissions units at the proposed facility will comply with applicable federal and state emission standards, including applicable federal emission standards adopted by the USEPA (40 CFR Parts 60) and the emission standards of the State of Illinois (35 Illinois Administrative Code: Subtitle B, Subchapter c).

The boiler would be subject to the federal New Source Performance Standards (NSPS) for Industrial-Commercial-Institutional Steam Generating Units, 40 CFR 60 Subpart Db. This NSPS sets emission limits

[1] The facility will not be a major source of emissions of hazardous air pollutants (HAPs) since its potential annual emissions of HAPs are less than 25 tons in aggregate and less than 10 tons for any single HAP. Accordingly, the facility will be an area source for purposes of the National Emissions Standards for Hazardous Air Pollutants, 40 CFR Part 63. Case-by-case determinations of Maximum Achievable Control Technology (MACT) are not required for emissions of HAPs from emission units at the proposed facility under Section 112(g) of the Clean Air Act.

[2] The potential emissions of PM_{10} and $PM_{2.5}$ are greater than the potential emissions of PM because, as now provided by 40 CFR 52.21(b)(50)(i)(*a*), both filterable and condensable particulate when determining emissions of PM_{10} and $PM_{2.5}$. Only filterable particulate is addressed when determining PM emissions.

for SO_2, NOx, particulate matter and opacity from the boiler. In addition, the NSPS for Equipment Components, 40 CFR 60 Subpart VVa, will apply to certain equipment components at the facility, setting VOM work practice requirements for applicable components. Emergency diesel engines at the facility will be subject to the NSPS for Stationary Compression Ignition Internal Combustion Engines, 40 CFR 60 Subpart IIII, which require engine manufacturers to meet emission limits for diesel emergency generators. In addition, the engines will be subject to 40 CFR 60 Subpart IIII compliance requirements specific to owners and operators of subject engines.

V. PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

a. Introduction

The proposed facility is a major new source subject to the federal rules for Prevention of Significant Deterioration of Air Quality (PSD), 40 CFR 52.21.[3] The proposed facility is major for emissions of NOx, CO, PM, PM_{10} and $PM_{2.5}$, with potential annual emissions of more than 100 tons for each of the pollutants. The proposed facility is also major for emissions of greenhouse gases (GHG), with potential annual emissions of more than 100,000 tons, as carbon dioxide equivalents (CO_2e). The facility will have significant VOM emissions. Because potential emissions of other regulated PSD pollutants, including SO_2 will be below their applicable significant emission rates, PSD will not apply for these other pollutants.[4]

b. Best Available Control Technology (BACT)

Under the PSD rules, a source or project that is subject to PSD must use BACT to control emissions of pollutants subject to PSD. Cronus has provided a BACT demonstration in its application addressing emissions of pollutants that are subject to PSD, i.e., NOx, VOM, CO, PM, PM_{10}, $PM_{2.5}$ and GHG.

BACT is defined by Section 1693. of the federal Clean Air Act as:

> An emission limitation based on the maximum degree of reduction of each pollutant subject to regulation under this Act emitted from or which results from any major emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental and other costs, determines is achievable for such facility through application of production processes and available methods,

[3] The proposed facility would also be considered a major source under Illinois' Clean Air Act Permit Program (CAAPP) pursuant to Title V of the Clean Air Act, because it is a major source for purposes of the PSD Rules. Cronus will have to apply for a CAAPP permit within 12 months of commencing operation.

[4] Under PSD, once a proposed new source is major for any PSD pollutant, all PSD pollutants whose potential emissions are above the specified significant emission rates in 40 CFR 52.21(b)(23) are also subject to PSD permitting.

systems and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each such pollutant.

BACT is generally set by a "Top-Down Process." In this process, the most effective control option that is available[5] and technically feasible[6] is assumed to constitute BACT for a particular unit, unless the energy, environmental and economic impacts associated with that control option are found to be excessive. An important resource for BACT determinations is USEPA's RACT/BACT/LAER Clearinghouse (Clearinghouse or RBLC), a national compendium of control technology determinations maintained by USEPA. Other documents that are consulted include general information in the technical literature and information on other similar or related projects that are proposed or have been recently permitted.

For the proposed project, another important resource for the BACT determinations was USEPA's recent rulemakings for New Source Performance Standards (NSPS) as they address emission units that would be present at the proposed facility, including boilers, engines and equipment components.

A demonstration of BACT was provided for the facility in the permit application for emissions for the pollutants that are subject to PSD from the various emission units at the facility. The Illinois EPA's proposed determinations of BACT are discussed in Attachment B. The draft permit includes proposed BACT requirements and limits for emissions of the pollutants that are subject to PSD. These proposed limits have generally been determined based on the following:

- Emission data provided by the applicant;
- The demonstrated ability of similar equipment to meet the proposed emission limits or control requirements;
- Compliance periods associated with limits that are consistent with guidance issued by USEPA;
- Emission limits that account for normal operational

[5] As discussed by USEPA in its *PSD and Title V Permitting Guidance for Greenhouse Gases*, EPA-457/B-11-001, March 2011 (GHG Permitting Guidance), "Available control options are those air pollution control technologies or techniques (including lower-emitting processes and practices) that have the potential for practical application to the emissions unit and the regulated pollutant under evaluation." GHG Permitting Guidance, p. 24.

As previously discussed by USEPA in in its *New Source Review Workshop Manual*, Draft, October 1990 (NSR Workshop Manual, "Technologies which have not yet been applied to (or permitted for) full scale operations need not be considered available; an applicant should be able to purchase or construct a process or control device that has already been demonstrated in practice." NSR Manual, p. B.12.

[6] In its GHG Permitting Guidance, *USEPA* indicates that a technology should be considered "to be technically feasible if it 1) has been demonstrated and operated successfully on the same type of source under review, or 2) is available and applicable to the source under review." GHG Permitting Guidance, p. 33.

variability based on the equipment and control equipment design, when properly operated and maintained; and

- Review of emission limits and control efficiencies required of other new fertilizer production facilities as reported in the *Clearinghouse*.

VI. AIR QUALITY IMPACT ANALYSIS

a. Introduction

The previous discussions addressed emissions and emission standards. Emissions are the quantity of pollutants emitted by a source, as they are released to the atmosphere from various emission units. Standards are set limiting the amount of these emissions as a means to address the presence of contaminants in the air. The quality of air that people breathe is known as ambient air quality. Ambient air quality considers the emissions from a particular source after they have dispersed from the source following release from a stack or other emission point, in combination with pollutants emitted from other nearby sources and background pollutant levels. The level of pollutants in ambient air is typically expressed in terms of the concentration of the pollutant in the air. One form of this expression is parts per million. A more common scientific form for measuring air quality is “micrograms per cubic meter”, which are millionths of a gram by weight of a pollutant contained in a cubic meter of air.

The USEPA has standards for the level of various pollutants in the ambient air. These ambient air quality standards are based on a broad collection of scientific data to define levels of ambient air quality where adverse human health impacts and welfare impacts may occur. As part of the process of adopting air quality standards, the USEPA compiles scientific information on the potential impacts of the pollutant into a “criteria” document. Hence the pollutants for which air quality standards exist are known as criteria pollutants. Based upon the nature and effects of a pollutant, appropriate numerical standards(s) and associated averaging times are set to protect against adverse impacts. For some pollutants several standards are set, for others only a single standard has been established.

Areas can be designated as attainment or nonattainment for criteria pollutants, based on the existing air quality. In an attainment area, the goal is to generally preserve the existing clean air resource and prevent increases in emissions which would result in nonattainment. In a nonattainment area efforts must be taken to reduce emissions to come into attainment. An area can be attainment for one pollutant and nonattainment for another. The proposed Cronus facility, located in Douglas County, is classified as an attainment area for all criteria pollutants.

Compliance with air quality standards is determined by two techniques, monitoring and modeling. In monitoring one actually samples the levels of pollutants in the air on a routine basis. This is particularly valuable as monitoring provides data on actual air quality, considering actual weather and source operation. The Illinois EPA operates a network of ambient air monitoring stations across the state.

Monitoring is limited because one cannot operate monitors at all locations. One also cannot monitor to predict the effect of a future source, which has not yet been built, or to evaluate the effect of possible regulatory programs to reduce emissions. Modeling is used for these purposes. Modeling uses mathematical equations to predict ambient concentrations based on various factors, including the height of a stack, the velocity and temperature of exhaust gases, and weather data (speed, direction and atmospheric mixing). Modeling is performed by computer, allowing detailed estimates to be made of air quality impacts over a range of weather data. Modeling techniques are well developed for essentially stable pollutants like particulate matter, NOx and CO, and can readily address the impact of individual sources. Modeling techniques for reactive pollutants, e.g., ozone, are more complex and have generally been developed for analysis of entire urban areas. As such, these modeling techniques are not applied to a single source with small amounts of emissions.

Air quality analysis is the process of predicting ambient concentrations in an area as a result of a project, and comparing the concentration to the air quality standard or other reference level. Air quality analysis uses a combination of monitoring data and modeling as appropriate.

b. Air Quality Analysis for NO_2, PM_{10}, $PM_{2.5}$ and CO

An ambient air quality analysis was conducted by Cronus to assess the impact of the emissions of the proposed project, considering both normal operations and a startup scenario. These analyses determined that the proposed project will not cause or contribute to a violation of any applicable air quality standard.

Modeling Procedure

Significance Analysis (Step 1): The starting point for determining the extent of the modeling necessary for any proposed project is evaluating whether the project would have a “significant impact”. The PSD rules identify Significant Impact Levels (SIL), which represent thresholds triggering a need for more detailed modeling.[7] These thresholds are specified for all criteria pollutants, except ozone and lead.

Refined (Full Impact) Analysis (Step 2): For pollutants for which impacts are above the SIL, more detailed modeling is performed by incorporating proposed new emissions units at the facility, stationary sources in the surrounding area (from a regional inventory), and a background concentration.

Refined Culpability Analysis (Step 3): For pollutants for which the refined (full impact) modeling continues to indicate modeled exceedance(s) of a NAAQS, a more refined culpability (cause and contribute) analysis is performed incorporating additional specific procedures consistent with USEPA guidance.

The results of the significance analysis are provided in the following table.

---

[7] The significant impact levels do not correlate with health or welfare thresholds for humans, nor do they correspond to a threshold for effects on flora or fauna.

Results of the Significance Analysis (µg/m^3)			
Pollutant	Averaging Period	Maximum Predicted Impact	Significant Impact Level
NO_2	1-hour	18.0	7.52*
NO_2	Annual	0.7	1
PM_{10}	24-hour	5.8	5
PM_{10}	Annual	1.4	1
CO	1-hour	236.6	2,000
CO	8-hour	134.5	500
$PM_{2.5}$	24-hour	1.69	1.2**
$PM_{2.5}$	Annual	0.27	0.3**

*Interim Significant Impact Level

** While the SIL for $PM_{2.5}$ was vacated in early 2013, the vacatur of the SIL has not precluded its use.[8] In this case, the differences between the $PM_{2.5}$ NAAQS (24-hour, 35 µg/m^3, and annual, 12 µg/m^3) and the most recent monitored values at a nearby representative $PM_{2.5}$ monitor, the Bondville, Illinois monitor (24-hr $PM_{2.5}$, 21.8 µg/m^3, and annual $PM_{2.5}$, 9.9 µg/m^3, considering the period 2010-2012) are much greater than the SILs originally promulgated by USEPA.[9] Thus, consistent with USEPA guidance, use of the $PM_{2.5}$ SIL is justified in this specific air quality analysis.

The significance analysis[10] (Step 1) results demonstrate that all impacts over all averaging periods for CO are insignificant and no refined (full impact) analysis is required for this pollutant. Likewise, results indicate that impacts of the annual NO_2 and annual $PM_{2.5}$ averaging periods are insignificant,

[8] Circuit Court Decision on $PM_{2.5}$ Significant Impact Levels and Significant Monitoring Concentration, Questions and Answers, March 4, 2013. “The EPA does not interpret the Court’s decision to preclude the use of SILs for $PM_{2.5}$ entirely but additional care should be taken by permitting authorities in how they apply those SILs so that the permitting record supports a conclusion that the source will not cause or contribute to a violation of the $PM_{2.5}$ NAAQS.”

[9] Consistent with USEPA’s guidance (March 4, 2013 “Draft Guidance for $PM_{2.5}$ Permit Modeling”), “if the preconstruction monitoring data shows that the difference between the $PM_{2.5}$ NAAQS and the measured $PM_{2.5}$ background concentrations in the area is greater than the applicable vacated SIL value, then the EPA believes it would be sufficient in most cases for permitting authorities to conclude that a source with an impact below that SIL value will not cause or contribute to a violation of the NAAQS…”

[10] The significance analysis can also establish the need for pre-application air quality monitoring. In this instance, pre-application air quality monitoring has been fulfilled by representative nearby $PM_{2.5}$ monitoring data. $PM_{2.5}$ air quality data collected at the nearby Bondville monitoring station has been deemed representative of $PM_{2.5}$ air quality at the proposed Cronus location. Based on the proximity of the Bondville $PM_{2.5}$ monitoring station to the proposed Cronus location and the representativeness of the primary topographical feature between the two sites, flat agricultural land, it is appropriate to rely upon the Bondville monitoring station to fulfill PSD requirements for $PM_{2.5}$ preconstruction monitoring data for the proposed Cronus project (40 CFR 52.21(m)(1)(iv)). The significance analysis predicted maximum concentrations below monitoring de minimum concentrations established by USEPA for PM_{10}, CO, and NO_2 (Monitoring de minimis concentration for PM_{10} (10 µg/m^3,24-hour), CO (575 µg/m^3, 8-hour) and NO_2 (14 µg/m^3, annual).

and no refined (full impact) analysis is required for these pollutants over these averaging periods.

As modeling results demonstrate that impacts are significant for the PM_{10} 24-hour and annual, $PM_{2.5}$ 24-hour, and for the 1-hour NO_2 averaging periods, a refined (full impact) analysis (Step 2) was performed for these pollutants and averaging periods.

Full Impact Analysis for PM_{10} (Annual & 24-hour)

The refined (full impact) Step 2 analysis demonstrates that the project would not cause or contribute to a violation of the NAAQS[11] or applicable PSD increment(s) for PM_{10}.[12] No Refined Culpability Analysis (Step 3) was necessary.

Full Impact Analysis for NO_2 (1-hour)

The refined (full impact) Step 2 analysis demonstrates that the proposed new emissions units at the facility, stationary sources in the surrounding area (from a regional inventory), and a background concentration, would exceed the NO_2 1-hour NAAQS.[13,14] As modeling results demonstrated that impacts are significant for 1-hour NO_2 averaging period, a refined culpability analysis (Step 3) was performed for this pollutant and averaging period.

The Step 3 refined culpability analysis, performed consistent with USEPA guidance, indicated that the proposed facility's impacts were less than significant during the 1-hour periods of the NO_2 NAAQS modeled exceedances.

Full Impact Analysis for $PM_{2.5}$ (24-hour)

The refined (full impact) Step 2 analysis demonstrates that the proposed new emissions units at the facility, stationary sources in the surrounding area (from a regional inventory), and a background concentration, would exceed the $PM_{2.5}$ 24-hour NAAQS.[15] As modeling results demonstrated that impacts are

---

[11] For the full impact NAAQS evaluation, for normal operation, maximum modeled 24-hour PM_{10} impacts, plus a background concentration, resulted in a maximum concentration of 128.32 $\mu g/m^3$, compared to the NAAQS of 150 $\mu g/m^3$. The maximum modeled concentration was located immediately west of the Cronus facility fence line. The startup PM_{10} 24-hour scenario (representing Cronus operations during a startup event) showed modeled impacts plus background concentration of 80.47 $\mu g/m^3$.

[12] For the full impact PSD Increment evaluation, maximum modeled 24-hour PM_{10} impacts were 6.06 $\mu g/m^3$, compared to the PSD Increment of 30 $\mu g/m^3$; maximum modeled annual PM_{10} impacts were 1.55 $\mu g/m^3$, compared to the PSD Increment of 17 $\mu g/m^3$.

[13] For the full impact NAAQS evaluation, for normal operation, maximum modeled 1-hour NO_2 impacts, plus a background concentration, resulted in a maximum concentration of 2625.59 $\mu g/m^3$, compared to the NAAQS of 189 $\mu g/m^3$. The maximum modeled concentration was dominated by impacts from the regional inventory, and the maximum modeled concentration was located 500 meters south of the Cronus facility, near a natural gas compressor station. The startup NO_2 1-hour scenario (representing operation of the Cronus facility during a startup) showed modeled impacts plus background concentration of 127.78 $\mu g/m^3$.

[14] USEPA has not established PSD increments for 1-hour NO_2.

[15] For the full impact NAAQS evaluation, for normal operation, maximum modeled 24-hour $PM_{2.5}$ impacts, plus a background concentration, resulted in a maximum concentration of

significant for the 24-hour $PM_{2.5}$ averaging period, a refined culpability analysis (Step 3) was performed for this pollutant and averaging period.

The Step 3 refined culpability analysis, performed consistent with USEPA guidance, indicated that the proposed facility's impacts were less than significant during the 24-hour periods of the $PM_{2.5}$ NAAQS modeled exceedances.

The refined (full impact) Step 2 analysis demonstrates that the proposed project would not cause or contribute to a violation of the applicable PSD increment for 24-hour $PM_{2.5}$.[16]

$PM_{2.5}$ Secondary Formation

$PM_{2.5}$ can be emitted directly from sources or formed secondarily based on atmospheric reactions involving certain compounds emitted by sources. If the SO_2 or NOx emissions of a proposed major project are significant (i.e., 40 tons/year or more), USEPA has determined that the emissions of SO_2 or NOx, as applicable, warrant an assessment on both an annual and 24-hour basis for their role as a precursor to the formation of secondary $PM_{2.5}$ and ambient air quality for $PM_{2.5}$.[17]

As the proposed facility is not a significant emission source for SO_2 emissions, emitting less than 5 tons per year, no significant contribution to secondary $PM_{2.5}$ formation from SO_2 emissions is expected.

Given the proposed facility will be a significant emission source for NOx emissions, several factors were qualitatively assessed[18] to conclude that the proposed facility will not have a significant contribution to secondary $PM_{2.5}$ formation from NOx emissions, including:

205.04 μg/m^3, compared to the NAAQS of 35 μg/m^3. The maximum modeled concentration was dominated by impacts from the regional inventory, and the maximum modeled concentration was located 600 meters west of the Cronus facility, near another industrial source. The startup $PM_{2.5}$ 24-hour scenario (representing Cronus operations during a startup event) showed modeled impacts plus background concentration of 22.63 μg/m^3.

[16] For the full impact PSD Increment evaluation, maximum modeled 24-hour $PM_{2.5}$ impacts were 1.69 μg/m^3, compared to the PSD Increment of 9 μg/m^3.

[17] Table II-1, USEPA Suggested Assessment Cases that Define Needed Air Quality Analyses, "Draft Guidance for $PM_{2.5}$ Permit Modeling", March 4, 2013.

[18] Per USEPA's guidance (March 4, 2013 "Draft Guidance for $PM_{2.5}$ Permit Modeling") recommendations for a qualitative assessment include a review of the regional background $PM_{2.5}$ monitoring data and aspects of secondary $PM_{2.5}$ formation from existing sources; the relative ratio of the combined modeled primary $PM_{2.5}$ impacts and background $PM_{2.5}$ concentrations to the level of the NAAQS; the spatial and temporal correlation of the primary and secondary $PM_{2.5}$ impacts; meteorological characteristics of the region during periods of precursor pollutant emissions; the level of conservatism associated with the modeling of the primary $PM_{2.5}$ component and other elements of conservatism built into the overall NAAQS compliance demonstration; aspects of the precursor pollutant emissions in the context of limitations of other chemical species necessary for the photochemical reactions to form secondary $PM_{2.5}$; and an additional level of NAAQS protection through a post-construction monitoring requirement.

- The potential NOx emissions of the proposed facility are only about 121 tons/year. This represents a small (less than a 4%) increase to the existing Douglas County NOx emissions inventory.[19]

- The existing annual Douglas County NOx emissions would likely impact, if secondary formation of $PM_{2.5}$ occurs, the Bondville $PM_{2.5}$ monitor, given that the prevailing wind direction in this portion of Illinois is southerly (Douglas County is located directly south of Champaign County, where the Bondville $PM_{2.5}$ monitor in located).[20]

- $PM_{2.5}$ monitored concentrations at Bondville are consistently amongst the lowest of any $PM_{2.5}$ monitoring locations across Illinois, for both annual and 24-hour averaging periods, and have remained consistently lower than most other Illinois $PM_{2.5}$ monitoring locations.[21]

- The large majority of the NOx emissions from the proposed facility would occur from the Primary Reformer and Auxiliary Boiler, which would be designed for optimal combustion of natural gas fuel, which typically produces less oxides of nitrogen during combustion than other fuels.

- As noted in the NO_2 air quality analysis described above, the proposed facility's impacts were less than significant during the 1-hour periods of the NO_2 NAAQS modeled exceedances, indicating a low impact on ambient NO_2 concentrations from the proposed facility using proposed allowable emission rates.

- As noted in the $PM_{2.5}$ air quality analysis described above, the proposed facility's direct $PM_{2.5}$ emission impacts were less than significant during the 24-hour and annual periods of the $PM_{2.5}$ NAAQS modeled exceedances, indicating a low impact on ambient $PM_{2.5}$ concentrations from the proposed facility using the proposed allowable emission rates.

c. Air Quality Analysis for Ozone

For ozone, the applicant's analysis used the screening method formulated by USEPA for determining ozone air quality impacts for purposes of PSD permitting.[22] This methodology predicts increases in 1-hour ozone concentrations from the increases in emissions from a project, using conservative assumptions concerning baseline conditions for VOM and NOx

---

[19] State of Illinois, Illinois Environmental Protection Agency, 2012 Illinois Annual Air Quality Report, Table C6, 2011 Estimated County Stationary Point Source Emissions. This table shows that Douglas County emissions inventory are dominated by NOx and SO_2 emissions, and includes 1195.6 tons/year CO, 4611 tons/year NOx, 182.9 tons/year PM_{10}, 10,124 tons/year SO_2, and 462 tons/year VOM.

[20] Generated from website at http://www.wrcc.dri.edu/cgi-bin/wea_windrose2.pl

[21] State of Illinois, Illinois Environmental Protection Agency, 2012 Illinois Annual Air Quality Report, Table B8, 2012 $PM_{2.5}$ Annual Design Values. This table shows annual $PM_{2.5}$ concentrations of 9.9 µg/m^3, 10.4 µg/m^3, and 10.6 µg/m^3 (for the most recent three annual design periods), well below the 12 µg/m^3 NAAQS. Likewise, Table B7 shows $PM_{2.5}$ 24-hour design values of 21.8 µg/m^3, 22.0 µg/m^3, and 22.2 µg/m^3 (for the most recent three 24-hour design periods), well below the 35 µg/m^3 NAAQS.

[22] VOC/NOx Point Source Screening Tables, Scheffe, September, 1988.

emissions.[23]

Based on the analysis provided by Cronus, the 1-hour ozone concentration resulting from the proposed facility will be 0.013 ppm. Adding a background concentration of 0.09 ppm[24] yields a total 1-hour ozone concentration of 0.103 ppm. Since the total concentration of 0.103 ppm is below the former 1-hour ozone standard of 0.120 ppm, the proposed facility will not be expected to threaten the current 8-hour ozone NAAQS.

A direct evaluation of the impacts of the emissions of the proposed Cronus facility on ozone air quality, 8-hour average, can be made considering the potential emissions of ozone precursors from the proposed facility, the current levels of emissions in the region in which the facility is located and monitored ozone air quality for the region. The most recent data for existing emissions in the region that is available reflects data from the 2012 annual emission reports. Information on current ozone air quality in the region is available from the Illinois EPA's ambient monitoring station in Effingham.[25] The design value for the Effingham monitoring station for 2012, 0.070 ppm, 8-hour average, confirmed that ozone air quality in the region complied with the current ozone NAAQS.[26] The evaluation of the project's potential impact on ozone air quality then considered the increase in regional NOx and VOM emissions from the proposed Cronus facility. The total emissions in the region, a seven county area that includes Champaign, Coles, Douglas, Edgar, Moultrie, Piatt, and Vermilion Counties, were on the order of 10,558 and 4,155 tpy for NOx and VOM, respectively, with a VOM-to-NOx ratio of 0.39. Cronus' potential emissions are 120.8 and 81.7 tpy for NOx and VOM, respectively, with a similar VOM-to-NOx ratio, 0.68. Since these VOM-to-NOx ratios are similar, future ozone impacts to the region due to the emissions of the proposed Cronus facility can be very conservatively predicted by applying the increase in emissions to the monitored design value. The result is a predicted design value of 0.071 ppm, 8-hour average, which continues to be below the 8-hour ozone NAAQS, 0.075 ppm.[27] This assessment further confirms

---

[23] The 1-hour ozone impacts based on this methodology can also be used to address the 8-hour ozone NAAQS.

[24] The "background" ozone concentration is from an upwind urban monitor located in East St. Louis, Illinois for the period 2011 through 2013.

[25] While the ozone monitoring stations at Bondville and Thomasboro are slightly closer to Tuscola than the Effingham monitoring station, they cannot be used for the ozone air quality data for this evaluation, which is constrained by the timing of the data that is available for regional emissions. At the close of 2012, these other monitoring stations had only been operational for two calendar years. Three years of monitoring data are needed to properly determine a design value for 8-hour ozone air quality. A design value for 2012 is available from the Effingham monitor, which has been in operation for many years.

Incidentally, the 2013 design values for the Effingham and Thomasboro monitoring stations were 0.071 and 0.067 ppm, respectively, confirming continued attainment of the current ozone NAAQS.

[26] The design value is a metric that expresses the maximum level of ozone air quality over a three year period in terms that are consistent with the form of the current ozone NAAQS, which addresses the maximum levels of ozone over a three year period. A 2012 design value for ozone addresses the ozone air quality for the period of 2010 through 2012.

[27] The proposed Cronus facility will potentially increase the emissions of NOx and VOM in the region in which the facility is located by 1.0 percent. Assuming, very

that the proposed facility will not threaten ambient air quality for ozone.

d. Vegetation and Soils Analysis

Predominant land use in the vicinity of the Cronus facility is agricultural production (cultivated crops) followed by low to medium intensity development. The majority of the area surrounding the proposed site is used overwhelmingly for agriculture, followed by recreation and residential purposes.

Included in the vegetation analysis are potential impacts only to vegetation with significant commercial or recreational value. For the purpose of this analysis, only agricultural commodity crops (primarily corn and soybeans) were evaluated because the study area is predominately agricultural based. Forest products were not considered since essentially no commercial forestry occurs within the modeled pollutant impact area of the facility.

Cronus provided an analysis of the impacts of the proposed facility on vegetation and soils. The first stage of this analysis focused on the use of modeled air concentrations and published screening values for evaluating exposure to flora from selected criteria pollutants (NOx, CO, $PM_{10}/PM_{2.5}$). For NOx, the analysis showed that the maximum 1-hour NOx concentration from the proposed Cronus facility will be well less than the adverse health effect impact levels for typical row crop agriculture (corn, soybeans) which predominates in the vicinity of the proposed plant. Likewise, the maximum 1-hour and 8-hour CO concentrations from the proposed Cronus facility are far below any concentrations known to have a negative impact on plant species. Modeled maximum 24-hour and annual $PM_{10}/PM_{2.5}$ concentrations from the proposed facility will largely occur from the urea plant, in the form of urea particulate compounds. Predicted concentrations from the plant of $PM_{10}/PM_{2.5}$ are well below secondary NAAQS established to protect vegetative species. In addition, as only small amounts of SO_2 will be emitted from the proposed facility (less than significant amounts), no negative impacts to flora will occur.

Potential adverse impacts to soil and vegetation from deposition of NO_2, $PM_{10}/PM_{2.5}$, and hazardous air pollutants (HAPs) were also analyzed and reviewed. Douglas County is located within the Illinois and Iowa Deep Loess Drift, with the dominant soil compositions within the significant impact radius of the project area (3 km) consisting of Drummer-Milford silty clay loams and Flanagan silt loam. NO_2 deposition rates predicted by Cronus were well below nitrogen-based fertilizer application rates typical of row crop agriculture. As noted above, most of the $PM_{10}/PM_{2.5}$ from the proposed facility will be in the form of urea particulate compounds, and these deposition rates, even considering the additive impact of the NO_2 deposition rates, will also be only a small fraction of the nitrogen-based fertilizer application rates typical of row crop agriculture. Very minor levels of primarily organic HAP emissions (less than major source levels) will occur from the proposed facility, and thus deposition concentrations will be minimal.

---

conservatively, that the ozone air quality in this region is only caused by regional emissions of ozone precursors, the result is at most a 1 percent increase in ozone levels or a future design value of at most 0.071 ppm (0.070 x 1.01 = 0.0707, ≈ 0.071).

e. Construction and Growth Analysis

Cronus provided a discussion of the emissions impacts resulting from residential and commercial growth associated with construction of the proposed facility. Anticipated emissions resulting from residential, commercial, and industrial growth associated with construction and operation of the proposed facility are expected to be low. Despite the large number of workers required during the construction phase and a significant number of permanent employees for operation of the facility, emissions associated with new residential construction, commercial services, and supporting secondary industrial services are not expected to be significant. This is because the facility will draw from the large existing work force located within commuting distance of the facility that are already supported by the existing infrastructure. Thus, impacts would be minimal and distributed throughout the region.

f. Visibility Analysis

There are no national or state forests and no areas that can be described as scenic vistas in the immediate vicinity of the site.

The state park nearest to the site is Walnut Point State Park, which is located approximately 15 miles southeast of the project area. Based upon the maximum modeled concentrations being within the immediate vicinity of the proposed Cronus facility, and significant impacts of NO_2 and $PM_{10}/PM_{2.5}$ being measured out to less than two kilometers from the site, the project will not have a significant effect on visibility in the Walnut Point State Park. Likewise, the Upper Embarrass Woods Nature Preserve is the only Illinois Nature Preserve Commission site located in Douglas County (just southeast of the Walnut Point State Park). Visibility at the Nature Preserve is not anticipated to be impacted by the proposed Cronus facility.

VII. CHEMICAL ACCIDENT PREVENTION PROGRAM

Under the USEPA's rules for Chemical Accident Prevention, 40 CFR Part 68, Cronus is required to conduct Risk Management Planning for the facility for the storage and handling of ammonia. The elements of the Risk Management Planning required by these rules include preparation of hazard assessments that details the potential effects of accidental releases, and an evaluation of worst-case and alternative accidental releases; implementation of a prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and development of an emergency response program that spells out emergency health care, employee training measures and procedures for informing emergency response agencies and the public should an accident occur.

VIII. CONSULTATIONS FOR THE PROJECT

a. Federal Endangered Species Act

As required under the federal Endangered Species Act, Cronus has initiated consultation with USEPA. As part of this consultation, USEPA will review the above conclusions with regard to the air quality impacts of the facility and will consider potential impacts on species of endangered plants and animals that are present in the area. USEPA will also consult with the United States Fish and Wildlife Service on its findings. The proposed construction permit will only be issued once it is determined that there will be no adverse effects on these species.

b. Illinois Endangered Species Act

Consultation between the Illinois EPA and the Illinois Department of Natural Resources (Illinois DNR), as required under Illinois' Endangered Species Protection Act, has been initiated by Cronus with regard to a review of the above conclusions with respect to species of vegetation and animals in the vicinity of the facility that are endangered. The proposed construction permit will only be issued once Illinois DNR has concluded that adverse effects on these species are unlikely.

c. National and State Historic Preservation Acts

USEPA considered the potential effects of this permit action on historic properties eligible for inclusion in the National Register of Historic Places consistent with the requirements of the National Historic Preservation Act. The USEPA found that there were no historic properties located within the Area of Potential Effects of the proposed project. The USEPA has provided a copy of its determination to the State Historic Preservation Officer for consultation and concurrence with its determination. The proposed construction permit will only be issued once the State Historic Preservation Officer provides concurrence on the determination that issuance of the permit will not affect historic properties eligible for inclusion in the National Register of Historic Places.

IX. DRAFT PERMIT

The Illinois EPA has prepared a draft of the construction permit that it would propose to issue for this facility. The conditions of the permit set forth the emission limits and the air pollution control requirements that the facility must meet. These requirements include the applicable emission standards that apply to the various units at the facility. They also include the measures that must be used and the emission limits that must be met for emissions of different regulated pollutants from the facility.

Limits are set for the emissions of various pollutants from the facility. In addition to annual limits on emissions, the permit includes short-term emission limits and operational limits, as needed to provide practical enforceability of the annual emission limits. As previously noted, actual emissions of the facility would be less than the permitted emissions to the extent that the facility operates at less than capacity and control equipment normally operates to achieve emission rates that are lower than the applicable standards and limits.

The permit would also establish appropriate compliance procedures for the facility, including requirements for emission testing, required work practices, operational and emissions monitoring, recordkeeping, and reporting. For the reformer furnace, continuous emissions monitoring would be required for NOx, CO and CO_2. For the boiler, continuous emissions monitoring would be required for NOx, CO and CO_2, and for the Ammonia Plant CO_2 Vent, continuous emissions monitoring would be required for CO_2. Testing of emissions or performance testing would be required for emissions of other pollutants from these units and for other units at the facility. These measures are imposed to assure that the operation and emissions of the facility are appropriately tracked to confirm compliance with the various limits and requirements established for individual units.

X. REQUEST FOR COMMENTS

It is the Illinois EPA's preliminary determination that the application for the proposed facility meets applicable state and federal air pollution control requirements.

The Illinois EPA is therefore proposing to issue a construction permit for the facility. Comments are requested on this proposed action by the Illinois EPA and the conditions of the draft permit.

ATTACHMENT A

Description of the Ammonia and Urea Production Process

Preparation of Natural Gas Feedstock for Hydrogen Production

The feedstock for the production of ammonia by the facility is natural gas, which is primarily methane. Before being used for ammonia production, the natural gas feedstock must be processed to remove sulfur compounds in the gas. While these compounds are present at very low concentrations, they would act to reduce the effectiveness and eventually poison the catalyst used in the process if they were not removed. After being desulfurized, feed gas is mixed with steam and routed to the reformer furnace.

Hydrogen Production

In hydrogen production, the steam/feed gas mixture is converted to hydrogen, carbon dioxide (CO_2), and carbon monoxide (CO) in the presence of a catalyst. Steam methane reforming is a two-step process involving both a primary and secondary reforming stage. In the primary reformer furnace, approximately 35 percent of the feed gas is reformed. The primary reformer furnace is equipped with natural gas burners to provide heat to drive the reforming process.

The reforming process is completed in the secondary reformer. The process gas stream from the primary reformer furnace is mixed with air and partially combusted to increase the temperature of the mixture to drive the reforming reaction. The air that is introduced in the secondary reformer also serves as the source of nitrogen required for synthesis of ammonia.

Shift Conversion

The process gas stream from reforming then undergoes shift conversion. Shift conversion is a two stage process where residual CO in the presence of water is converted into CO_2 and hydrogen. The first stage is a high temperature shift that converts the majority of the CO. The second stage is a low temperature shift, which converts the remaining CO with a catalyst that operates at a lower temperature.

CO_2 Removal/Recovery

The process gas from the low temperature shift converter is composed mainly of hydrogen, nitrogen, CO_2, and excess steam. This mixture is cooled to condense the excess steam prior to removal of CO_2. The process gas stream is then routed through an activated methyl diethanolamine (aMDEA) absorption system for the removal of CO_2. This absorption system is a regenerative system as it includes the following:

- A CO_2 absorber. Its overhead gas (now lean in CO_2) is heated by steam and heat exchanged with hot process gas and then sent to methanation.
- A Regenerator/Stripper to strip the CO_2 from the circulating aMDEA solution and recover the aMDEA for reuse.

When Urea is being produced, the CO_2 stream from the Regenerator is sent to the urea plant. Only a very small amount of CO_2 is vented to the atmosphere when needed to adjust pressure in the system.

Methanation and Purification

The process gas stream following CO_2 removal is further purified through a methanation step to remove residual CO and CO_2, which would negatively affect the catalyst used for synthesis of ammonia. In the methanator, the CO_2 and CO are reacted with hydrogen to form methane and water in a catalytic reactor. The water gas is then removed with molecular sieves. The methane, excess nitrogen and trace gases (CO, CO_2, and inert gases) in the gas are then removed by a cryogenic "cold box." The material that is removed is sent to the Reformer Furnace where it is used as fuel. The remaining process gas stream, which contains hydrogen and nitrogen in a stoichiometric ratio of three to one, is then sent to the ammonia synthesis process.

Ammonia Synthesis

The synthesis of ammonia takes place at elevated temperature and pressure in the presence of a catalyst. The process gases circulate in an ammonia synthesis loop (Converter, Heat Exchanger/Condenser, Separator). The produced ammonia is then sent to interim storage before being fed to the Urea Plant or being transferred for off-site ammonia sale.

Urea Synthesis

Urea is produced from ammonia and CO_2. The CO_2 produced during the manufacturing of ammonia is used in the synthesis of urea. The ammonia and CO_2 from the Ammonia Plant are reacted to form carbamate, an intermediate in the production of urea. This material then undergoes a further reaction to produce a solution of urea (also known as carbamide) and water. The resulting aqueous mixture, which now contains ammonia, carbamate and urea, is then stripped of unreacted ammonia. The stripped solution is passed through a series of reactors that operate at progressively lower pressures. Unconverted carbamate decomposes back to ammonia and CO_2, which is recycled back to the beginning of the urea synthesis process, leaving only the urea.

Production of Granulated Urea

Excess water is removed from the urea process solution to produce a concentrated urea solution. This solution is then processed in a fluidized bed granulator where dry urea granules are formed and cooled. The solid urea granules are then sent to bulk storage prior to load out to truck or rail. The exhaust air from the granulator and the cooler is scrubbed by a high efficiency Venturi scrubber to remove urea dust and ammonia traces before venting to the atmosphere.

The finished granulated urea product will be loaded by truck or rail. Emissions of particulate from handling, storage and load-out of finished urea product will be controlled by a central filter system.

Attachment B

Discussion of Best Available Control Technology (BACT)

Table of Contents

Introduction

This attachment discusses the Illinois EPA's analysis of Best Available Control Technology (BACT) and proposed determinations of BACT for the various subject emission units at the facility.

The emission units at the facility for which BACT is required and the pollutants that these units would emit, i.e., NOx, CO, VOM, particulate (PM, PM_{10} and $PM_{2.5}$) or greenhouses gases (GHG), are summarized below.

Emission Unit(s)	NOx	CO	VOM	Particulate	GHG
Ammonia Plant – CO_2 Vents		x	x		x[a]
Ammonia Plant – Flares	x	x	x	x	x
Reformer Furnace	x	x	x	x	x[a]
Boiler	x	x	x	x	x[a]
Startup Heater	x	x	x	x	x
Ammonia Storage Flare	x	x	x	x	x
Urea Granulator			x	x	x
Cooling Tower				x	
Equipment Components			x		x
Handling of Finished Urea				x	
Roadways				x	
Emergency Engines	x	x	x	x	x
Storage Tanks			x		

Note:
a. BACT for emissions of GHG from the principal emissions units involved in production of ammonia and urea is generally addressed together. These units operate in an integrated manner and BACT for their GHG emissions is better addressed overall. BACT for emissions of GHG from other emission units, which are not integral to ammonia or urea production, such as the startup heater, are addressed individually.

GHG, principally CO_2, would be emitted from the facility by three classes of emission units: 1) The CO_2 vents, which emit concentrated streams of CO_2; 2) The fuel combustion units, notably the reformer furnace and boiler, with flue gas streams that contain large amounts of CO_2 at much lower concentrations; and 3) The small emitters, such as the engines and the heater. The Top-Down BACT Process for GHG proceeds differently for these classes of units. In particular, for the CO_2 vents, cost consideration is relevant in Step 4. For other units, technology to capture CO_2 from the flue gas stream has not been developed. Capture of CO_2 from those other units is not feasible and the BACT analysis need not reach Step 4, but end at Step 2.

As required by the PSD rules and USEPA guidance, BACT for individual emission units must be appropriately addressed using the Top-Down BACT process. This necessitates application of the Top-Down BACT process to individual emission units and operations at the facility. This generally leads to the establishment of emission limits for each individual unit or operation that reflect use of BACT. However, a BACT limit for GHG can be established for a group of emission units at a source where it is reasonable to establish such a limit.[28] Since the overall efficiency of the ammonia manufacturing process at the proposed facility determines the GHG emissions of this process, it is appropriate to establish an overall BACT limit for GHG that addresses the efficiency of this process. The GHG emission units that will be part of the ammonia manufacturing process are the CO_2 vents, the reformer furnace and the boiler at the facility. Accordingly, an overall BACT limit for GHG emissions is proposed that addresses the combined GHG emissions from the CO_2 vents, the reformer furnace and the boiler.

[28] USEPA guidance allows for this practice. USEPA's *PSD and Title V Permitting Guidance for Greenhouse Gases*, EPA-457/B-11-001, March 2011 (GHG Permitting Guidance) notes that "EPA has generally recommended that permit applicants and permitting authorities conduct a separate BACT analysis for each emissions unit at a facility and has also encouraged applicants and permitting authorities to consider logical groupings of emissions units as appropriate on a case-by-case basis." GHG Permitting Guidance, p. 22.

The NSR Manual also observes that "Each new or modified emission unit (or logical grouping of new or modified emission units) subject to PSD is required to undergo BACT review." NSR Manual, p. B.10.

Section B.1 – BACT for the Ammonia Plant

Subsection B.1a – Ammonia Manufacturing Process – BACT for GHG (Addresses GHG from the Main CO_2 Vent, the Reformer Furnace, the Boiler and the Pressure Relief CO_2 Vent in the Urea Plant)

In the ammonia manufacturing process, carbon dioxide (CO_2) is removed from the process gas stream that is eventually used for the synthesis of ammonia. The majority of the CO_2 in the process gas stream is removed by scrubbing with an absorbent solution containing amine compounds. This solution is then processed in a regenerator that drives the CO_2 out of the solution. When the facility is producing urea, almost all of this CO_2 from the regenerator is fed to the Urea Plant where it is used in making urea and is not emitted. The full CO_2 stream from the regenerator is only emitted to the atmosphere when the facility produces ammonia for direct sale. This is limited to at most 25 percent of the ammonia production capacity of the facility.[29] These emissions of CO_2 will occur through the CO_2 Vent at the Ammonia Plant, also referred to as the Main CO_2 Vent.

The BACT determination for GHG from the ammonia manufacturing process considered the control methods for GHG emissions from the individual units that are integral to the production of ammonia, namely, the CO_2 vents, the reformer furnace and the boiler. However, when considering a BACT limit for GHG from the ammonia manufacturing process, the reformer and boiler are not stand-alone units but are integral to the ammonia manufacturing process. The only function of the boiler is to supply medium pressure steam to the reforming process in the ammonia plant. The reformer furnace supplies the process gas stream that is eventually used to make ammonia.[30] Given the relationships between these units, it was determined that it would be

[29] Ammonia production for direct sale will likely occur seasonally, in the fall and spring, either after harvesting or before planting.

[30] The boiler, which supplies medium pressure steam to the reforming process in the ammonia plant, is not the only unit at the facility that makes steam. Before steam from the boiler is combined with natural gas in the first step of the steam reforming process, the steam is further heated in the reformer furnace to a higher pressure. In the second step of the reforming process, in which air is added to the process gas stream and combustion occurs, additional steam is produced in a waste heat boiler from the hot process gas stream before it undergoes further processing. Heat is also generated from other steps of the ammonia manufacturing process that involve exothermic reactions. Various heat exchangers are generally used to productively recover this heat for process purposes. However, the hot process stream from the high temperature CO shift process is used to pre-heat the feedwater for the boiler.

The operation of the reformer furnace is also directly linked to the ammonia manufacturing process because this furnace fires a combination of natural gas and process off-gases from the ammonia plant. These process off-gases, which are derived from natural gas, are an inherent aspect of the methanation and purification of the process gas stream in the ammonia plant in preparation for ammonia synthesis.

In addition, the ammonia plant itself will be designed to produce CO_2 and ammonia at a ratio of slightly more than two to one, the stoichiometric ratio for synthesis of urea. This has implications for the fuel inputs to the manufacturing process. The three points at which natural gas is fed into the process, i.e., the boiler, the reformer furnace and the steam reforming process, must be coordinated so that the CO_2 stream from the regeneration of the CO_2 sorbent and the amount of ammonia are in the correct ratio for the production of urea.

appropriate to set a BACT limit for GHG for the entire process, rather than setting BACT limits for GHG for each individual emission unit within the process.[31]

In summary, each individual unit within the ammonia manufacturing process, i.e., the CO_2 vents, the reformer furnace and the boiler, is examined by the Top-Down BACT Process to identify appropriate BACT technology for GHG for these units. At the same time, a BACT limit for GHG is proposed for the ammonia manufacturing process as a whole, which addresses the combined GHG emissions of these units.[32] BACT for pollutants other than GHG will be addressed in later sections of this attachment for the individual emission units involved in the ammonia manufacturing process (CO_2 Vents: Section B.1b, Reformer Furnace: Section B.2, and Boiler: Section B.3). The only exception to this approach involves the BACT for methane for the CO_2 vents, which will be further addressed as part of the discussion of BACT for CO and VOM.[33]

The proposed BACT limit for GHG emissions from the ammonia manufacturing process is found in Condition 2.1.2-3 of the draft permit. The limit would apply on an annual average, rolled monthly. This is appropriate to account for normal variability in the operation of the ammonia manufacturing process, which will affect the energy efficiency and GHG emissions of the process. The BACT Limit would address all GHG, including methane (CH_4) and nitrous oxide (N_2O), as well as CO_2. The limit is set by a formula because the limit must account for the actual production of ammonia by the facility and the disposition of the ammonia, i.e., the amount of ammonia sent to the Urea Plant to make urea and the amount of ammonia sent to storage for direct sale. The formula uses different values for the GHG emission rates depending upon the disposition of the ammonia.[34]

---

[31] USEPA guidance accommodates this practice. In particular, the GHG Permitting Guidance observes that that "EPA has generally recommended that permit applicants and permitting authorities conduct a separate BACT analysis for each emissions unit at a facility and has also encouraged applicants and permitting authorities to consider logical groupings of emissions units as appropriate on a case-by-case basis." GHG Permitting Guidance, p. 22.

[32] During plant startup, shutdown and upsets or malfunctions, CO_2 is also vented through the Main CO_2 Vent at the Ammonia Plant. Since the CO_2 emissions from the Urea Plant only involve release of the CO_2 stream from the ammonia manufacturing process through a another CO_2 vent, the Pressure Control Vent, which is located at the Urea Plant, these CO_2 emissions are also considered in the overall BACT limit for GHG emissions. Only very small amounts of CO_2, relative to the total amount of CO_2 produced at the ammonia plant, will be emitted through the Pressure Control CO_2 Vent at the Urea Plant, also referred to as the CO_2 Compressor Vent.

[33] BACT for methane is further addressed with BACT for CO and VOM for the CO_2 vents because the emissions of methane, CO and VOM are all directly related to the "process efficiency" of the ammonia manufacturing plant, as well as having a role in the energy efficiency of this plant. That is, the levels of CO, VOM and methane in the exhaust streams from the CO_2 vents are related to the effectiveness of this plant in removing these materials from the process gas stream that is used for synthesis of ammonia and also producing a stream of high-purity CO_2 that is suitable for making urea. In addition, as this CO_2 stream would not undergo combustion and BACT must be established for this stream as it would contain some CO and VOM, it is appropriate that the methane content of this stream also be addressed. (If combustion were present, the BACT limits for CO and/or VOM would serve as surrogates to address emissions of methane as would be a production of incomplete combustion.)

[34]

Basis for the GHG Emission Rates for the Ammonia Manufacturing Process

The proposed BACT limit for GHG for the ammonia manufacturing process would also provide for higher emissions during the shakedown of the facility before commissioning of the facility is complete.[35] In this context, “commissioning” means the point at which the responsibility for operation of the facility is formally transferred from the firm that designed and/or constructed the facility to Cronus. Higher GHG emission rates must be expected during shakedown because the initial operation of the ammonia manufacturing process cannot be expected to be as efficient as it will be once shakedown and commissioning is complete. Factors that will affect the initial efficiency of the ammonia manufacturing process during the shakedown of the facility include the rate at which the process is able to be run and the length of time between shutdowns. This is because the manufacturing process will be less efficient when it is operating below the rate at which it is designed to normally operate. The efficiency of the process will also be lower if there are more frequent interruptions in operation than contemplated in the design. It should be expected that this will be the case during shakedown as the ammonia plant must be removed from service to make adjustments or repairs to equipment so that they operate in accordance with their physical or process design.[36] Because of these considerations, the draft permit would accommodate a somewhat higher GHG BACT emission rate during the shakedown of the facility before commissioning of the facility is complete.[37] In this regard, the draft permit also contemplates and would accommodate more flaring and more use of the startup heater, accompanied by more emissions, during the shakedown of the ammonia plant.[38] When commissioning of the facility is complete and the

Disposition of Ammonia	Contribution to Overall Emission Rate				Emission Rate (Total)
	Boiler	Reformer Furnace	Pressure Control CO_2 Vent	Main CO_2 Vent	
Urea Production	0.44	0.48	0.0029	–	0.92
Storage for Sale				1.3	2.22

[35] For this purpose, the alternative GHG emission rate for production of ammonia during shakedown would be approximately 10 percent higher than the base rate after commissioning is completed. The alternative GHG emission rate for production of urea would be 20 percent higher. These alternative rates both accommodate about 0.25 tons more GHG emissions per ton of ammonia produced during the shakedown period.
[36] The preconstruction/Part 70 permit issued by the Louisiana Department of Environmental Quality, Activity No. PER20120001, for an ammonia production facility proposed by Dyno Nobel Louisiana Ammonia, LLC, provides an example of alternative requirements during the initial operation of an ammonia production facility before commissioning of the facility is complete. This permit would provide for two natural gas-fired “commissioning boilers,” each with a nominal capacity of 220 mmBtu/hour. These boilers would be limited to operation as “temporary boilers,” as defined by 40 CFR 60.41b. This would limit the operation of each of these boilers to less than one year, effectively restricting their operation to the initial shakedown of that facility, before commissioning of that facility is complete.
[37] The draft permit would include other limits for the ammonia manufacturing process that would address the mass or overall tonnage of GHG emissions on an annual basis. These limits would not provide for greater tonnage of GHG emissions from the ammonia plant during the shakedown period. Moreover, it is expected that the tonnage of GHG emissions of the ammonia manufacturing facility would be lower during the shakedown period. This is because the process would be operated at lower rates with more frequent interruptions during shakedown than after this period is completed.
[38] To address additional flaring during shakedown of the ammonia plant, the draft permit would require that the GHG emissions of the flares and the CO_2 vents, together, not exceed the total of the permitted GHG emissions of these units, rather than being

ammonia manufacturing process has demonstrated that it meets the contractual specifications that were established for this process, the BACT GHG rates for routine operation of this process would begin to apply.[39] Likewise, the provisions for more flaring and more use of the startup heater would end.

In addition to providing for higher rates of GHG emissions during shakedown, the draft permit would also provide for tightening of the GHG BACT limit for the ammonia manufacturing process if actual operation demonstrates that a higher energy efficiency with lower GHG emissions can be reliably achieved by this process.[40] This provision is included in the permit because of the conservative nature of engineering design. It is reasonable to expect that GHG emissions lower than the design rates will be demonstrated in practice by the proposed ammonia plant. Given the lack of data for GHG emission rates of ammonia plants and facilities that are similar to the facility that is proposed, it is uncertain whether the design is actually conservative or, if it is conservative, exactly how conservative the design is. However, it would be unrealistic to expect that the actual performance considering the units that combust fuel, i.e., the reformer furnace and boiler, will be 20 percent better than the design performance. Accordingly, the draft permit would provide that a BACT limit that reflects as much as a 20 percent improvement in the energy efficiency of the ammonia plant can be set after a "demonstration period." The duration of the demonstration period would be four years from the date of initial startup of the facility, with provision, subject to approval by the Illinois EPA for up to an additional two years if needed to effectively set a revised BACT limit for GHG. This amount of time is appropriate because a BACT limit is proposed for GHG that would apply as an annual average. The actual demonstration phase for GHG also should not begin until shakedown of the ammonia plant is complete. It should also go well beyond the initial period of operation of the plant. Based on that initial period of operation, Cronus may take actions to improve the energy efficiency. There also may be phenomena that negatively impact energy efficiency of the ammonia plant that only develop gradually over time but are inherent to the performance of the plant.

Incidentally, Cronus also proposed an overall limit for the facility for GHG emissions. Its proposed limit was 0.73 tons of GHG per ton of urea, annual

---

subject to separate limits. This is based on the premise that any "extra" flaring during shakedown would be compensated for by reduced operation of the ammonia plant and lower GHG emissions from the CO_2 vents. For pollutants other than GHG, for which such compensation cannot be assumed as a result of reduced emissions from the CO_2 vents, the draft permit would directly provide for additional emissions from flaring during the shakedown period. This would be done by applying the annual emission limits on a bi-monthly basis.

To address additional use of the startup heater during shakedown of the ammonia plant, the draft permit would also provide for additional emissions of this unit during the shakedown period. This would also be done by applying the annual emission limits on a bi-monthly basis.

[39] If the shakedown of the facility is prolonged and the commissioning of the facility is delayed, the draft permit would also provide that the BACT emission rates for routine operation of the ammonia manufacturing process would then automatically take effect one year after the initial startup of the ammonia plant.

[40] The alterative GHG emission rates based on the demonstrated performance of the facility would be based on achieving as much as a 20 percent improvement in the energy efficiency of the boiler and reformer furnace, or achievement of GHG emission rates that are 0.20 tons lower per ton of ammonia produced.

average, rolled monthly, and would have addressed GHG emissions from all GHG emission units at the facility. As Cronus' proposed limit was developed from and expressed in terms of urea production, it would not properly have accounted for the two modes of operation of the facility, with ammonia either being produced for storage and sale or for use in making urea.[41] In particular, Cronus' limit would not have properly accounted for the actual production of ammonia for sale. To the extent that this is less than 25 percent of the ammonia output of the facility, the GHG emission rate of the facility, in tons per ton of product, will also be lower. Cronus only proposed a single number as the BACT limit for GHG emissions of the facility, independent of the actual disposition of the ammonia from the ammonia manufacturing plant.[42] The overall BACT limit for GHG that the Illinois EPA is proposing for the ammonia manufacturing process, including the CO vents, reformer furnace and the boiler, would properly and appropriately address the two different modes of operation of the facility.

CO_2 Vents[43]

Introduction

The GHG that is present in the emission stream from the CO_2 Vents is primarily CO_2. It also contains very small amounts of CO, VOM and methane, which are carried over into this stream by the CO_2 sorbent, along with the CO_2.

Proposal

[41] Cronus' limit was developed from GHG emission data based on its design for the facility, with 25 percent of the ammonia from the ammonia plant going for direct sale and 75 percent being used for making urea. At the same time, the limit was based on facility's production of urea as if the facility would only make urea and never sell any ammonia. Because of this inconsistency, Cronus' proposed limit would not have addressed GHG emissions in terms of the real production of the facility. In addition, the limit did not account for the actual disposition of ammonia, the limit was also potentially inflated. To the extent that the ammonia production of the facility for direct sale is less than 25 percent, the GHG emission rate of the facility should be lower. For example, if none of the output of the ammonia plant is sold as ammonia and all ammonia is used for making urea, the GHG emission rate of the facility per ton of urea produced should be no more than 0.54 tons/ton of urea produced. (GHG emissions of only about 960,000 tpy ÷ 1,781,200 tpy urea = 0.539, ≈ 0.54 ton GHG/ton urea)

[42] Cronus' proposed limit was also inappropriate because it extended to units whose GHG emissions are not directly related to the energy efficiency of the ammonia manufacturing process. The operation and GHG emissions of the flares and startup heater are related to the availability of the ammonia plant, as they involve startup, shutdown and malfunction. They should have a minor role in the efficiency of the ammonia manufacturing process. The GHG emissions of the emergency engines are completely unrelated to the ammonia manufacturing process. They involve units at the facility that would be present to address power outages and provide fire protection.

Cronus' proposed BACT limit also would be unnecessarily complicated in practice, reducing the practical enforceability of the limit. This is because it extended to all GHG emission units at the facility, rather than the principal emission units that comprise the ammonia manufacturing process. While the GHG emissions of these other units are small, they would necessarily have to be included in the compliance determination for the facility if the overall GHG limit included these units.

[43] The CO_2 Vents include both the CO_2 vent in the ammonia plant and the CO_2 Compression Vent located in the urea plant.

In its application, Cronus proposed that BACT for GHG for the CO_2 Vents is use of CO_2 from the Ammonia Plant to make urea when the Urea Plant is operating, rather than emitting the CO_2 through the CO_2 Vent. This aspect of the design[44] of the proposed facility acts to reduce its emissions of CO_2. This is because essentially all of the CO_2 stream from the regenerator in the Ammonia Plant will be productively used and will not be emitted whenever urea is being produced. Consistent with Cronus' design for the facility, as presented in the application, this will act to lower the CO_2 emissions from the Main CO_2 Vent. These emissions will be at most 25 percent of the amount that would theoretically be emitted if CO_2 were not used to make urea, since the production of ammonia by the facility for direct sale is limited to 25 percent of the ammonia production capacity of the facility.[45]

The production of urea by the proposed facility is certainly an aspect of Cronus' design for the proposed facility that will act to lower its emissions of CO_2 compared to a facility that would not produce urea. As discussed, this aspect of the design of the proposed facility results in lower CO_2 emissions since the CO_2 stream from the regenerator will only go to the atmosphere, by means of the Main CO_2 Vent, for part of the year. However, this aspect of Cronus' design for the facility was not considered a control technique for purposes of the BACT analysis for the CO_2 Vents or the ammonia manufacturing process. This is because it is a fundamental aspect of Cronus' design or objectives for the proposed facility.

Accordingly, the Illinois EPA is proposing that the BACT technology for GHG specifically for the CO_2 Vents be process design and good operating practices. This is because the CO_2 emission rate of the CO_2 Vents is dictated by the use of this stream to make urea. To accomplish this, the ammonia plant must be engineered to produce CO_2 and ammonia at a ratio of slightly more than two to one, the stoichiometric ratio for synthesis of urea. This yields a CO_2 emission rate for the Main CO_2 Vent that is slightly more than 1.292 tons per ton of ammonia that is produced by the ammonia plant.

The ammonia plant will also be designed for low carryover of methane, as well as CO and VOM into the CO_2 stream. These materials need not be present in the CO_2 stream for the synthesis of urea. However, these materials have value as fuel for the reformer furnace. Accordingly, the ammonia manufacturing process is designed to reduce carryover of these materials into the CO_2 stream and instead collect these materials in the process off-gas streams that serve as some of the fuel for the reformer furnace. To directly address carryover of methane, a BACT limit will also be set for the methane content of the CO_2 stream from the CO_2 vents. This is further addressed in the discussion of BACT for CO and VOM for the CO_2 Vents, since the technologies specifically for control of emissions of methane and emissions of CO and VOM in this stream

[44] For purposes of this discussion, consistent with relevant USEPA guidance in its GHG Permitting Guidance and the NSR Manual, the term "design" is used to describe Cronus' basic business purpose or goal, objectives and basic design for the proposed facility. The term "design" is not used to refer to Cronus' technical or engineering plans or specifications for the facility.

[45] Cronus has proposed a facility that, in addition to producing urea, would have the capability to produce some ammonia to be able to supply current markets for ammonia. For this purpose, Cronus has proposed a facility whose production of ammonia for sale would be restricted to 25 percent of its annual ammonia production capacity.

are the same.

Step 1: Identify Available Control Technologies

The following GHG control technologies were identified for the CO_2 Vents:

1. Carbon Capture and Sequestration (CCS); and

2. Design and Good Operational Practices.

Step 2: Eliminate Technically Infeasible Options

Neither of the available technologies for the CO_2 Vents has been considered to be technically infeasible. While there are significant technical and logistical hurdles that would have to be overcome for CCS to be used for the CO_2 Vents, CCS technology has been carried over into Steps 3 and 4 of the BACT analysis for the CO_2 Vents. This is because the CO_2 Vents will emit an essentially pure stream of CO_2.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

For purposes of the ranking of control technologies, it was conservatively assumed that CCS would provide 100 percent control of CO_2, from the CO_2 vents, compared to baseline emissions. In practice, the control efficiency would easily be as much as 5 percent lower because of outages of the equipment and facilities for compression and sequestration of CO_2. This is because the operation of the facility would have to continue during such periods to maintain stable operation.

Step 4: Evaluate the Most Effective Controls

1. Carbon Capture and Sequestration (CCS)

CCS would entail capture of CO_2 from the CO_2 Vents, then compressing and transporting it via pipeline to either a storage location or a location for use in Enhanced Oil Recovery (EOR). CCS involves four basic steps, as follows:

- The capture of CO_2 from a unit;
- The cleanup of emission stream(s) to remove impurities to meet pipeline specifications and to compress the CO_2 to pipeline conditions;
- The transport of compressed CO_2 to a sequestration site and compressing it to a high pressure prior to injection; and
- Sequestration of the CO_2.

The primary source of purified CO_2 at the facility is the CO_2 Vents. Assuming 100 percent capture efficiency, a maximum of 340,199 tons per 12-month period of GHG, as CO_2e, are potentially available for CCS. However, this CO_2 would only be available on an intermittent basis, since CO_2 from the Ammonia Plant would supply the urea plant when that plant is in operation, rather than being available at the CO_2 vents. Due to the high purity of the CO_2 stream, only minor treatment or cleanup would be necessary to bring the CO_2 stream to pipeline specifications. Additional compression would be necessary.[46]

At this time, pipeline infrastructure to support the transfer of purified CO_2 does not exist in Illinois. Therefore, transportation of the CO_2 stream would require the construction of a pipeline to a sequestration site.[47]

Sequestration can either be geologic (i.e., injecting CO_2 into geological formations) or for use in enhanced oil recovery (EOR) (i.e. injection of CO_2 into oil wells to recover additional crude oil). Technology for geological sequestration is still under development. While there are sequestration demonstration projects underway in Central Illinois, these projects are not available for commercial use, i.e., they are not unavailable for the purposes of BACT. The use of CO_2 for EOR has been demonstrated and is currently in use in certain oil fields in North America. However, there are no demonstrated applications of EOR near the facility. The nearest CO_2 pipeline for existing applications of EOR is Denbury's Green Pipeline. The nearest tie in point for this pipeline is in Jackson Dome, Mississippi, which is about 580 miles away. Infrastructure for sequestration does not exist in the vicinity of the proposed site. Therefore, for the CO_2 that would otherwise be emitted from the CO_2 Vent to be used for EOR, the facility would have to be able to temporarily store CO_2 and find a long-term demand or market for use of its stored CO_2 for EOR.[48]

For the CO_2 vents, the cost-effectiveness of using CCS would be approximately \$100/ton CO_2 produced.[49] These cost impacts for control of CO_2 are appropriately deemed excessive. A comparison of the annualized cost of CCS to the annualized capital cost of the proposed facility was also made. The annualized cost of CCS for the CO_2 vents would represent about a 30 percent increase in the annualized capital cost for the facility compared to a facility without CCS.[50] This

[46] Cronus used cost information for CCS from the President's Interagency Task Force on Carbon Capture and Storage, *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010. This report provides a cost for capture and compression of CO_2 of \$104/ton CO_2. Given the purity of the CO_2 stream from the ammonia manufacturing CO_2 Vents at the proposed facility, the costs of capture of CO_2 at the facility would be significantly lower than estimated in that report. It was assumed that the costs would be 20% of this total based on the need for only additional compression, or \$20.80/ton CO_2. <u>However</u>, this cost reflects the partial year cost, given that production at the Ammonia Plant for ammonia for sale (when CO_2 will be emitted from the CO_2 vent) is limited to 25% of the total annual ammonia production. Compression costs for the CO_2 Vents thus become \$83.20/ton CO_2 (\$20.80 x 100/25 = \$83.20). This cost does not include the significant increase in purchased electricity needed to compress the CO_2.

[47] These costs were predicted to be \$1.10/ton CO_2, for a 62 mile pipeline.

[48] These costs were predicted to be \$6.60/ton CO_2.

[49] Compression cost (\$83.2/ton CO_2) + transportation cost (\$1.10/ton CO_2 [for 62 miles] x 580 miles to closest pipeline/62 miles = \$10.29/ton CO_2) + storage costs (\$6.60/ton CO_2) = \$100.10/ton, ≈ \$100/ton.

[50] Annualized cost of CCS for the CO_2 vents, \$34.31 million/year (343,105 tpy of CO_2 x CCS cost of \$100/ton CO_2) ÷ Annual capital recovery cost for the facility, \$112.8 million/year (capital cost of facility, \$1,200 million x capital recovery factor of 0.094) = 30.42%.

comparison also shows that the cost-impact of using CCS for the GHG emissions from the CO_2 vents would be excessive.[51]

2. Design and Good Operational Practices.

Good design and operational practices of the ammonia plant are relevant for the ammonia plant as they serve to improve efficiency and directly serve to reduce GHG emissions from the CO_2 vents. Given that Cronus will be required to implement good design and operational practices for the ammonia plant, environmental, energy or economic impacts of these practices need not be examined.

Step 5: Select BACT

Previous BACT determinations for CO_2 vents at ammonia plants are listed in "Table B.1a – CO_2 Vents," below. All of these determinations reflect operation and maintenance of the ammonia plant in conformance with process and equipment design, i.e., good operating practices. The Illinois EPA is also proposing that BACT technology for GHG for the CO_2 Vents at the Cronus facility be good operating practices, with operation and maintenance of the ammonia plant in conformance with the physical and process design.

The contribution of the CO_2 vents to the overall BACT limit for GHG emissions from the ammonia manufacturing process is set by the need to have sufficient CO_2 from the regenerator to supply the urea plant. The stoichiometric ratio of CO_2 and ammonia to make urea is 1.292 tons of CO_2 per ton of ammonia.[52] Slightly more CO_2 needs to be provided to the Urea Plant to avoid a situation where there is excess ammonia at the Urea Plant that cannot be converted into urea and must be flared. This means that the contribution of the CO_2 vents to the GHG emissions of the ammonia manufacturing process when ammonia is being made for sale is nominally 1.3 tons of CO_2 per ton of ammonia.[53]

The capital recovery factor of 0.094 is per the Cost Manual developed by USEPA's Office of Air Quality Planning and Standards for 8% interest over 25 years.

[51] This further analysis of the cost of CCS compared to total cost of the facility is generally consistent with an approach used by USEPA for a number of draft permits and issued permits. See, Celanese Clear Lake Plant, PSD-TX-1296-GHG; Equistar Chemicals La Porte Complex, PSD-TX-752-GHG; ExxonMobil Baytown Olefins Plant, PSD-TX-102982-GHG; and ExxonMobil Chemical Mont Belvieu Plastics Plant, PSD-TX-103048-GHG.

[52] The chemical equation for the formation of urea ($(NH_2)_2CO$) from carbon dioxide (CO_2) and ammonia (NH_3) is: $CO_2 + 2NH_3 \rightarrow (NH_2)_2CO + H_20$

Based on this stoichiometric ratio and considering the molecular weights of CO_2 and ammonia, to make urea, 1.292 tons of CO_2 are needed for each ton of ammonia.

In particular the molecular weights of NH_3 and CO_2 are 17.03061 and 44.00995, respectively. This yields a ratio by weight of 1.292 for the amounts of NH_3 and CO_2 that are needed to make urea. ($44.00995 \div 2 \times 17.03061 = 1.292$)

[53] This GHG emission rate for the CO_2 Vents, 1.3 tons CO_2/ton ammonia, should not be directly compared to previous BACT determinations for CO_2 vents at other facilities manufacturing nitrogen fertilizer. First, this is because these other facilities may not have been or are not being designed to convert all of their ammonia into urea. As these facilities may make different products than the proposed facility, such as solutions of urea ammonium nitrate, the emissions of CO_2 from their ammonia plants would be different. For example, at a facility that is designed to make solutions of urea ammonium nitrate, only a portion of the ammonia output of the facility needs to be directly converted into urea. The remainder of the ammonia output is used to

provide the "ammonium" in urea ammonium nitrate. There also may be differences in the amount of electrical and mechanical power that these other fertilizer manufacturing facilities generate on-site from steam rather than from electricity off the grid. As certain projects at fertilizer manufacturing involve changes to existing facilities rather than entirely new facilities, there may be other important difference between those facilities compared to the proposed facility. Considering the range of differences that are possible between fertilizer manufacturing facilities, the GHG emission rate for the CO_2 Vents at the proposed facility is not inconsistent with the previous BACT determinations for other fertilizer facilities.

Table B.1a – CO_2 Vents: Previous BACT Determinations for CO_2 Vents at Ammonia Plants for GHG					
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Plant Capacity (tons/day)**	**BACT Limit**	**Control Measure**
P0115063	PCS Nitrogen Ohio	1/17/14	2350	CO_2: 2404 lb/ton ammonia CO_2e: 1,031,413 tpy, 12 month	GOP & use in urea production & sale to CO2 plant
Indiana: T147-32322-00062	Ohio Valley Resources	9/25/13	2,800	CO_2: 1.275 tons/ton ammonia, 3-hr 3,570 tons/day	Good Operational Practices
IA-0106	CF Industries Nitrogen	7/12/13	2,668	CO_2: 1.26 tons/ton ammonia, 30-day CO_2e: 1,226,814 tpy, 12 month	Good Operational Practices
LA-0272	Dyno Nobel Louisiana	3/27/13	2,780	1,280,000 tpy annual	Energy & Solvent Use Efficiency Measures
IA-0105	Iowa Fertilizer	10/26/12	3,320	CO_2: 1.26 tons/ton ammonia, 30-day CO_2e: 1,211,847 tpy, 12 month	Good Operational Practices

GHG BACT – Reformer Furnace

Introduction

In the Reformer Furnace, natural gas feedstock mixed with medium pressure steam from the boiler is heated to an elevated temperature in the presence of a catalyst to begin the production of a hydrogen-rich synthesis gas for the production of ammonia. The fuel for the Reformer Furnace is a mixture of natural gas and recycled process off-gas. The Reformer Furnace includes a number of features to productively recover the heat or "thermal energy" that remains in the flue gas after the reforming step, including preheating the feed mixture of natural gas and steam, preheating the inlet air stream for the secondary reformimg unit and producing high-pressure steam for use elsewhere at the facility.

As already discussed, the BACT determination for GHG from the ammonia manufacturing process considered the control methods for emissions from the individual units that are integral to the production of ammonia, namely, the boiler, the reformer furnace and the CO_2 vents. However, a single BACT limit is being proposed to address overall GHG emissions from this process.

Proposal

Cronus proposed the following as GHG BACT for the Reformer Furnace:[54,55]

---

[54] For the Reformer Furnace, Cronus also proposed that the fuel selected, i.e., a mix of natural gas and process off-gases derived from natural gas, be part of the BACT technology as these fuels are low-carbon fuels. However, the use of this fuel for the Reformer Furnace is part of Cronus' basic design for the facility. The generation of off-gases with fuel value is inherent in the production of a synthesis gas for ammonia production, most notably because of the methanation step. As such, the fuel used in the Reformer Furnace does not reflect consideration by Cronus of the possible use of other fuels as a means to further reduce the GHG emissions.

In addition, for purposes of the Top-Down BACT Analysis for the Reformer Furnace, use of natural gas and off-gases derived from natural gas is not a lower emitting process or practice for the Reformer Furnace for GHG. It is the practice that is part of Cronus' basic design for the proposed facility including the Reformer Furnace. As specifically addressed in the NSR Manual, as related to processes and practices that would reduce emissions from a emissions unit, the focus of the Top-Down BACT Process is on inherently lower-emitting processes and practices.

> Potentially applicable control alternatives can be characterized in three ways.
> · Inherently Lower-Emitting Processes/Practices, including the use of materials and production processes and work practices that prevent emissions and result in lower "production-specific" emissions; …
> NSR Manual, p. B.10.

[55] As already discussed, Cronus also proposed an overall BACT limit for the GHG emissions of the facility, including the GHG emissions from the CO^2 vents, reformer furnace and the boiler, as well as other GHG emission units at the facility. Its proposed limit was flawed as it was expressed in terms of ammonia production as it failed to account for both modes of operation of the facility. It also extended to units whose GHG emissions are not directly related to the energy efficiency of the ammonia manufacturing process. It would also have been unnecessarily complicated to implement in practice as it extended to all GHG emission source at the facility, rather than the emission sources that comprise the ammonia manufacturing process.

1. Energy efficient design;

2. Good combustion practices; and

3. A limit for GHG emissions for the facility, including the CO_2 vents, the Reformer Furnace and other units at the facility, in tons of CO_2e/ton of urea, annual average, rolled monthly.

The Illinois EPA is proposing that BACT technology for GHG for the Reformer Furnace be equipment design and good operating practices.[56] As already discussed, the proposed limit for overall GHG emissions of the ammonia manufacturing process will address the CO_2 Vents, as well as the Reformer Furnace and the boiler. This is because the CO_2 Vents will potentially emit about one third of the GHG emissions of the facility. This BACT limit for GHG will also be expressed in terms of ammonia production to appropriately address the two modes of operation of the facility, i.e., production of urea with ammonia being an intermediate and production of ammonia with it being a final product for sale.

Step 1: Identify Available Control Technologies

The following GHG control technologies were identified for the Reformer Furnace:

1. Carbon Capture and Sequestration (CCS);

2. Energy Efficiency (Equipment Design and Good Operating Practices); and

3. Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Carbon Capture and Sequestration (CCS)**

CCS would capture CO_2 from the flue gas of the Reformer Furnace and purify, compress, and transport this CO_2 by pipeline to either a sequestration site or for use for Enhanced Oil Recovery (EOR). The concentration of CO_2 in the flue gas from the Reformer Furnace is significantly lower than that of the CO_2 Vents. As a dilute exhaust stream, CCS for the Reformer Furnace presents a

[56] For purposes of this discussion and the analysis of BACT for the proposed facility, a distinction is made between "good combustion practices" and "good operating practices." The term "good combustion practices" is used for the various practices that are available for fuel combustion units, like the reformer furnace and boiler at the proposed facility, to specifically maintain efficient combustion. For these units at this facility, these practices will include use of automated combustion management systems. The term "good operating practices" is used for operation and maintenance practices that result in equipment performing in accordance with its engineering and process design. The term "good operating practices" is appropriate to describe the operational practices that are required as BACT for the reformer furnace and boiler as related to their energy efficiency. This term is also appropriate to describe the operational practices for the flares at the proposed facility to ensure that flares are operated and maintained in conformance with their designs.

"significant and challenging technical issue that may not be readily suitable for CCS."[57] The flue gases of the Reformer Furnace contain nitrogen, oxygen and water, along with CO_2 and other pollutants. In theory, carbon capture could be accomplished by scrubbing CO_2 from the flue gas with an appropriate liquid sorbent, solid sorbent, or membrane. To date, sorbent scrubbing of CO_2 has only been used commercially on a small (slip stream) scale, while solid sorbents and membranes are only in the research and development phase.[58] A number of post-combustion carbon capture projects have taken place on small, slip streams at coal-fired power plants. Although these projects have demonstrated the technical feasibility of small-scale CO_2 capture of a power plant's emissions using various solvent-based scrubbing processes, significant uncertainty remains in scaling these technologies up for cost-effective use.[59] These factors suggest that CCS is generally not a feasible control technology for the proposed Reformer Furnace.[60]

With regard to technical feasibility of CCS for a proposed project, USEPA indicates in its GHG Permitting Guidance that:

> CCS is composed of three main components: CO_2 capture and/or compression, transport, and storage... CCS may be eliminated from a BACT analysis in Step 2 if the three components working together are deemed technically infeasible for the proposed source, taking into account the integration of the CCS components with the base facility and site-specific considerations (e.g.,... access to suitable geologic reservoirs for sequestration, or other storage options).
>
> GHG Permitting Guidance, pp. 35-36.

Cronus examined the use of pre-combustion systems, post-combustion systems and oxy-combustion as a means to produce a pure CO_2 stream from the Reformer Furnace that could be sequestered. Since the fuel for the Reformer Furnace is natural gas and process off-gases derived from natural gas, pre-combustion systems, like those used to produce a fuel gas or substitute natural gas at a coal gasification plant, are not applicable. Post-combustion systems that extract the CO_2 from the Reformer Furnace's flue gases are still in their development. Not only does this flue gas stream pose the same technical issues for capture of CO_2 as present for combustion of coal, but the concentration of CO_2 in the flue gas may be lower because natural gas has lower carbon content than coal. Similarly, oxy-combustion, whereby a higher concentration of oxygen rather than air is combusted with a fuel to produce a flue gas stream containing higher concentrations of CO_2, is also in its early stages of development.

---

[57] Report of the Interagency Task Force on Carbon Capture and Storage, *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.

[58] Plains CO_2 Reduction Partnership, Carbon Separation and Capture, http://www.undeerc.org/PCOR/newsandpubs/pdf/CarbonSeparationCapture.pdf

[59] *Report of the Interagency Task Force on Carbon Capture & Storage*, August 2010, p. 32.

[60] When considering if a control technology is technically feasible, it must be applicable. A control technology is applicable if it can reasonably be installed and operated on the type of source under consideration. If a given technology has not been used on the emission unit, thought should be given on transferring technology from similar gas streams with the same physical and chemical properties.

In addition, for CCS technology to be considered feasible for the Reformer Furnace, as well as for other fuel combustion emission units at the facility, consideration must be given to:

- Land acquisition;
- The need for funding as a demonstration project;
- Transportation infrastructure; and
- Developing a site for permanent sequestration.

Various developmental projects are underway to address these challenges. They target coal-fired units and are facilitated by governmental funding so do not demonstrate that CCS is technically feasible for a gas-fired unit at a commercial facility like the proposed Cronus facility.[61] Given the technical challenges with capturing CO_2 from the Reformer Furnace and the lack of a demonstration of CCS on a natural gas-fired Reformer Furnace or boiler, CCS is not a feasible control technology for the Reformer Furnace. The Reformer Furnace is very different from the CO_2 Vents at the facility, which will emit essentially pure CO_2 streams.

2. **Energy Efficient Design**

The design of the Reformer Furnace and use of good operating practices will lower the fuel usage and GHG emissions of the Reformer Furnace. As discussed, the Reformer Furnace will include features to efficiently recover

---

[61] The feasibility of CCS as a BACT technology for fuel combustion units is also uncertain as a general matter because CCS is not yet a demonstrated technology for fuel combustion units. As discussed in a report prepared by the Congressional Research Service by Peter Folger, *Carbon Capture: A Technology Assessment*, Congressional Research Service, 7-5700, R41325, November 5, 2013.

> This report assesses prospects for improved, lower-cost technologies for each of the three current approaches to CO_2 capture: post-combustion capture; pre-combustion capture; and oxy-combustion capture.
>
> While all three approaches are capable of high CO_2 capture efficiencies (typically about 90%), the major drawbacks of current processes are their high cost and the large energy requirements for operation. Another drawback in terms of their availability for greenhouse gas mitigation is that at present, there are still no full-scale applications of CO_2 capture on a coal-fired or gas-fired power plant (i.e., a scale of several hundred megawatts of plant capacity). To address the current lack of demonstrated capabilities for full-scale CO_2 capture at power plants, a number of large-scale demonstration projects at both coal combustion and gasification-based power plants are planned or underway in the United States and elsewhere. Substantial research and development (R&D) activities are also underway in the United States and elsewhere to develop and commercialize lower-cost capture systems with smaller energy penalties. Current R&D activities include development and testing of new or improved solvents that can lower the cost of current postcombustion and pre-combustion capture, as well as research on a variety of potential "breakthrough technologies" such as novel solvents, sorbents, membranes, and oxyfuel systems that hold promise for even lower-cost capture systems. Carbon Capture: A Technology Assessment, p. i.

thermal energy, such as preheating the feed gas to the reformer. The good operating practices for the Reformer Furnace may also include measures to facilitate efficient operation of the Reformer Furnace, such as use of an automated combustion management system and oxygen trim, to lower the level of excess air. These measures improve combustion efficiency by reducing the amount of air that must be heated during combustion and the loss of heat energy with the exhaust gas. Energy efficient design and combustion practices are technically feasible for the Reformer Furnace.

3. Good Combustion Practices

Good combustion practices are relevant for GHG as they serve to improve the combustion efficiency of a fuel combustion unit as they improve fuel efficiency and directly serve to reduce emissions of methane. USEPA has relied on good combustion practices as the technology to address emissions of organic hazardous air pollutants from process heaters in 40 CFR 63 Subparts DDDDD, the National Emission Standards for Hazardous Air Pollutants (NESHAP) for boilers and process heaters at major sources of hazardous air pollutants. Good combustion practices are technically feasible for the reformer furnace.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Cronus will utilize all feasible control technologies so no ranking of these technologies is needed.

Step 4: Evaluate the Most Effective Controls

The proposed Reformer Furnace will utilize the top ranking control technologies so no further evaluation is needed.

Incidentally, even if CCS were feasible for this dilute flue gas stream, as a technology that is transferable to a Reformer Furnace, the economic impacts of CCS would be much more difficult to justify. The costs of just capture would be over $100/ton CO_2, with an annual cost of over $49 million dollars.[62,63] Based simply on an annualized cost of $49 million dollars for CCS, the cost of CCS for the Reformer Furnace would represent a more than 43 percent increase in the annualized capital cost for the facility, compared to a facility that would not use CCS for this unit.[64]

Step 5: Select BACT

Previous BACT determinations for reformer furnaces are listed in "Table B.1a – Reformer Furnaces," below. All of these BACT determinations rely upon good combustion practices as the control technology for GHG. A number of

[62] Unlike the "pure" CO_2 streams from the CO_2 Vents, cost for capture of CO_2 would be present for the Reformer Furnace, in addition to costs for compression. Capture of CO_2 from a dilute flue gas stream, like that of the Reformer Furnace, represent a larger portion of the total capital and operating costs of CCS.

[63] 488,159 tons CO_2 per year x $100/ton ≈ $49,000,000.

[64] Annualized cost of CCS, $49 million/year ÷ Annual capital recovery cost for the facility, $112.8 million/year = 43%.

determinations also rely on energy efficient design. Cronus' proposal is consistent with previous determinations of BACT for reformer furnaces.

The Illinois EPA is proposing the following technologies as BACT for GHG for the Reformer Furnace.

1. Equipment design and good operating practices for energy efficiency; and

2. Good combustion practices.

As already discussed, the Illinois EPA is proposing that GHG emissions of the Reformer Furnace be addressed by an overall BACT limit for GHG emissions of the ammonia manufacturing process. After the shakedown and commissioning of the ammonia plant is complete, the "contribution" of the Reformer Furnace to this limit would be 0.48 tons CO_2e/ton ammonia.[65]

[65] The contribution of the Reformer Furnace to the overall emission limit for the ammonia manufacturing process after the shakedown and commissioning of the ammonia plant is complete was calculated from the permitted GHG emissions of this unit divided by the permitted annual ammonia production of the facility. This yields a contribution of 0.48 tons CO_2e per ton of ammonia (488,159 tons CO_2e/year ÷ 1,018,000 tons ammonia/year = 0.48 tons CO_2e/ton ammonia).

Table B.1a – Reformer Furnaces: Previous BACT Determinations for Reformer Furnaces for GHG						
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Description**	**Capacity**	**BACT Limit**	**Control Measure(s)**
P0115063	PCS Nitrogen Ohio	1/17/14	Primary Reformer	750 mmBtu/hr	390,357 tpy, 12 mo. rolling	Low C Gas fuel Burner Tuning & Inspections
Indiana: T147-32322-00062)	Ohio Valley Resources	9/25/13	Primary Reformer	1006 mmBtu/hr	CO_2: 59.61 tons/ mmcf 3-hr. CO_2: 515,246 t/12mo 90% thermal efficiency	Energy Efficient Design
IA-0106	CF Industries	7/12/13	Primary Reformer (NG)	1,063 mmBtu/hr	CO_2: 117 lb/mmBtu, 30-day CH_4: 0.0023 lb/mmBtu, 3 tests N_2O: 0.0006 lb/mmBtu, 3 tests CO_2e: 545,647 tpy, 12 mo.	Good Combustion Practices & NG
LA-0272	Dyno Nobel Louisiana	3/27/13	Primary Reformer Furnace	956 mmBtu/hr	CO_2e: 490,025 tpy, 12 mo.	Energy Efficiency & Improved Combustion Measures & Process Integration
IA-0105	Iowa Fertilizer	10/26/12	Primary Reformer	1.1 mmcf/hr	CO_2: 117 lb/mmBtu; 30-day CH_4: 0.0023 lb/mmBtu, 3 tests N_2O: 0.0006 lb/mmBtu, 3 tests CO_2e: 596,905 tpy, 12 mo.	Good Combustion Practices
LA-0263	Phillips 66 Alliance Refinery	7/25/12	Reformer (refinery fuel gas)	216 mmBtu/hr	CO_2e: 183,784 tpy, 12 mo.	GCP, combustion air controls Process integration/Heat recovery/air preheater

<u>GHG BACT</u> – Boiler

The boiler will supply steam to the reforming process in the ammonia plant. The fuel for the boiler will be natural gas. The GHG emissions of the boiler are due to the combustion of fuel. Over 99 percent of these emissions will be CO_2, due to the carbon in the natural gas that is burned in the boiler. The boiler will also emit small amounts of methane and N_2O.

Proposal

Cronus proposed the following as BACT for the boiler for GHG emissions.[66, 67]

1. Energy efficient design; and

2. Good combustion practices.

The Illinois EPA is proposing that the BACT technology for GHG emissions for the boiler be a combination of design and operational practices that enhance the thermal efficiency of the boiler, thereby lowering GHG emissions, and implementation of good combustion practices.

Step 1: Identify Available Control Technologies

The available control technologies for GHG emissions that have been identified for the boiler are as follows:

1. Energy Efficiency (Equipment Design and Good Operating Practices);

2. Good Combustion Practices; and

3. Carbon Capture and Sequestration (CCS).

Step 2: Eliminate Technically Infeasible Options

1. **Energy Efficiency**

Energy efficient design and good operational and maintenance practices will reduce the GHG emissions of the boiler. In particular, several design elements are technically feasible for the boiler for improved energy efficiency that reduce the amount of natural gas that must be fired in the

[66] Cronus also proposed that the fuel selected for the boiler, natural gas, be part of BACT for the boiler as natural gas is a low-carbon fuel. However, the use of natural gas as the fuel for the boiler is part of Cronus' design for the facility. As such, the analysis did not reflect consideration of the possible use of other fuels as a measure to further control GHG emissions.

[67] Cronus also proposed a limit for GHG emissions for the combination of the reformer furnace and the boiler, in tons of CO_2e/ton of urea, annual average, rolled monthly. As discussed, it is appropriate that the BACT limit for GHG extend to the entire ammonia manufacturing process and be expressed relative to ammonia production.

.

boiler to produce steam for the ammonia manufacturing process and other operation at the facility. As a result, less CO_2 and other GHGs will be emitted by the boiler. These energy efficient design elements are discussed below:

- Boiler Blowdown Heat Recovery – Periodically or continuously, some water in the boiler is removed to maintain water quality, i.e., avoiding build-up of impurities in the water in the boiler. This blowdown is hot and this heat can be productively used instead of being wasted. A heat exchanger is used to transfer some of the heat in the hot blowdown water for preheating feedwater, thereby increasing the boiler's thermal efficiency.

- Condensate Recovery – As steam from the boiler is used in heat exchangers, it condenses. Hot condensate that is not returned to the boiler represents a loss of energy. Energy savings come from the fact that most condensate is returned at a relatively hot temperature compared to the cold makeup water. Accordingly, when the hot condensate is returned to the boiler to be reused as feedwater, the boiler heating load is reduced and the thermal efficiency increases.

- Air Preheater – This device recovers heat in the boiler exhaust gas to preheat combustion air thereby resulting in a reduction in boiler heating load and an increase in thermal efficiency. Additionally, air preheaters may increase NO_X emissions from the boiler by anywhere from 10 to 60 percent, depending upon the NO_X control measures that are present.[68,69]

2. Good Combustion Practices

Good combustion practices are relevant for GHG as they serve to improve the combustion efficiency of a boiler as they reduce emissions of CO and as they directly serve to reduce emissions of methane. USEPA has relied on good combustion practices as the technology to address emissions of organic hazardous air pollutants from boilers in 40 CFR 63 Subparts DDDDD and JJJJJJ, the National Emission Standards for Hazardous Air Pollutants (NESHAP) for boilers and certain other fuel combustion units. Good combustion practices include a modern, combustion management system on a boiler to monitor and manage the level of oxygen in the flue gas and the flows of combustion air into a boiler for improved thermal efficiency. Good combustion practices are feasible for the boiler.

3. Carbon Capture and Sequestration (CCS)

---

[68] Baukal, Charles E., *Air Preheat Effects on NOx*. Retrieved from: http://industrialcombustion.net/files/2003_AWMA_Paper.pdf.

[69] The boiler will use the final heat in its flue gases to pre-heat combustion air rather than having an economizer, i.e., a heat exchanger to heat the incoming boiler feedwater. This is because the preheating of the feedwater for the boiler will occur at the Reformer Furnace. In any case, there is only enough "final heat" in the back end of a boiler to either preheat the boiler feed water with an economizer or the air to the burners with an air preheater). There is not enough approach temperature to exchange heat with both cold inputs and also maintain the temperature of flue gas above the dew point to avoid corrosion of the stack.

For the boiler, the use of CCS would be similar to the use of CCS for the Reformer Furnace, as already discussed in detail. CCS would be used to capture CO_2 from the exhaust of the boiler and purify, compress, and transport this CO_2 via pipeline to either a sequestration location or another pipeline for use in Enhanced Oil Recovery. The concentration of CO_2 in the flue gas from the boiler is significantly lower than that of the CO_2 Vents. For dilute flue gas streams, CCS is a "significant and challenging technical issue that may not be readily suitable… ."[70] Consistent with this, CCS has not been demonstrated on a gas-fired boiler. CCS is not considered a feasible technology for the boiler.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Given the only feasible control technologies, improved energy efficiency and good combustion practices, would be required, a ranking of these technologies is not necessary.

Step 4: Evaluate the Most Effective Controls

Cronus will utilize all feasible control technologies so no further evaluation is needed.

With respect to CCS, as already discussed, a number of technological and practical challenges currently exist that result in CCS not being technically feasible for the boiler. These challenges would need to be overcome before the cost-effectiveness of CCS would be reasonable for the boiler. For CCS, the costs simply to capture CO_2 would be in excess of $100 per ton of CO_2 captured.[71] Considering that 442,399 tons per year of CO_2e would potentially be available for capture from the boiler, this represents an annual cost for CCS for the boiler that would be in excess of $44 million. The annualized cost of CCS for the boiler would represent a more than 39 percent increase in the annualized capital cost for the facility, compared to a facility that would not use CCS for this unit.[72]

Step 5: Select BACT

Previous BACT determinations for GHG for gas-fired boilers are listed in "Table B.1a – Gas-Fired Boilers," below. None of the previous BACT determinations for GHG from boilers require the use of an add-on control device. GHG emissions are controlled by energy efficiency and good combustion practices. Cronus proposes the same control technologies.

Only two BACT determinations, one for a boiler at an industrial facility

---

[70] Report of the Interagency Task Force on Carbon Capture and Storage, *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.

[71] Unlike the "pure" CO_2 streams from the CO_2 Vents, costs for capture of CO_2 would be present for the boiler, in addition to costs for compression of CO_2. Capture of CO_2 from a dilute flue gas stream, like that of the boiler, represents a large portion of the total capital and operating costs of CCS.

[72] Annualized cost of CCS, $44 million/year ÷ Annual capital recovery cost for the facility, $112.8 million/year = 39%.

proposed by Indiana Gasification and one for the boilers at the facility proposed by Ohio Valley Resources, directly address the energy efficiency of the boilers.[73,74] These determinations required that the boilers achieve thermal efficiencies, on a high heating value basis, of 81 and 80 percent, respectively. However, the permits do not identify a specific means to verify compliance with these limits on an ongoing basis. As discussed, given the nature of the ammonia manufacturing process, it is appropriate for an overall limit to be set for the GHG emissions of this process.

The Illinois EPA is proposing the following technologies as BACT for GHG for the boiler:

1. Equipment design for energy efficiency, including the following: air preheater, condensate recovery, and blowdown heat recovery, and good operating practices.

2. Good combustion practices, including automated combustion management system with oxygen trim and inlet combustion air controls.

As already discussed, the Illinois EPA is proposing that the GHG emissions of the boiler be addressed by the overall BACT limits for GHG emissions of the ammonia manufacturing process. The “contribution” of the boiler to this limit after the shakedown and commissioning of the ammonia plant is complete would be 0.43 tons CO_2e/ton ammonia.[75]

---

[73] The other BACT determinations were not informative. In general, they simply reflect use of natural gas. The BACT limits are simply emission rate(s) or emission factor(s) that applies to combustion of natural gas, typically in pounds per million Btu of heat input or in other similar terms. As such, these BACT limits do not directly address energy efficiency of the subject boilers.

[74] Incidentally, none of the determinations of BACT for other new boilers specified use of control technologies for GHG that are different than proposed for Cronus’ new boiler. GHG emissions are controlled by good combustion practices.

[75] The contribution of the boiler to the overall GHG emission limit for the ammonia manufacturing process after the shakedown and commissioning of the ammonia plant is complete was calculated from the permitted GHG emissions of the boiler divided by the permitted annual ammonia production of the facility. For example, for CO_2e, this contribution is 0.43 tons CO_2e per ton of ammonia (442,339 tons CO_2e/year ÷ 1,018,000 tons ammonia/year = 0.43 tons CO_2e/ton ammonia).

Table B.1a – Gas-Fired Boilers: Previous BACT Determinations for Gas-Fired Boilers for GHG						
RBLC ID/ Permit No.	Facility	Date	Type and Number of Boilers	Rated Heat Input (mmBtu/hr, each) and Fuel	BACT	
					Limit	Identified BACT Technology
P0115063	PCS Nitrogen Ohio	1/17/14	Boiler	227	CO_2e: 117,212 tpy, 12-mo. Other GHG based on AP-42, 3 1-hr tests	NG, Energy Efficient Design, GCP
Indiana: T147-32322-0062	Ohio Valley Resources	9/25/13	Auxiliary Boiler	218 Natural gas	CO_2: 59.61 ton/mmcf, 3-hr ave. Thermal Efficiency: 80%, HHV basis**	Good combustion practices (GCP) Limit on Fuel Usage
NE-0054	Cargill	9/12/13	Boiler	300	CO_2e: 153,743 tpy, 12 mo. CO_2: 0.178 lb/lb steam, 12 mo.	GCP
IA-0106	CF Industries Nitrogen	7/12/13	Industrial Boilers	456 (NG)	CO_2: 117 lb/mmBtu N_2O: 0.0006 lb/mmBtu, 3 tests CH_4: 0.0023 lb/mmBtu, 3 tests CO_2e: 234168 tpy, 12 mo.	Proper Operation Use of Natural Gas
LA-0272	Dyno Nobel Louisiana	3/27/13	Commissioning Boilers (4400 hours)	217.5	CO_2e: 55,986 tpy, 12 mo.	Energy efficiency measures: use of economizers and boiler insulation; improved combustion measures
IA-0105	Iowa Fertilizer	10/26/12	Auxiliary Boiler	472 Natural gas*	CO_2: 117 lb/mmBtu, 30-day CH_4: 0.0023 lb/mmBtu, 3 tests N_2O: 0.0006 lb/mmBtu, 3 tests CO_2e: 51748 tpy, 12-mo.	GCP
TX-0629	BASF Total Petro-chemicals	8/24/12	Industrial Boilers (2)	425.4 Natural gas or fuel gas	CO_2: 420,095 tpy 12-mo rolling	SCR

Indiana: T147-30464-00060	Indiana Gasification	6/27/12	Auxiliary Boilers (2)	408 Natural gas	CO_2 Thermal Efficiency: 81%, HHV basis** CO_2: 88,167 tons/mmcf 3-hr ave.	Use of Natural Gas Energy Efficient Design***
FL-0330	Port Dolphin Energy	12/01/11	Industrial Boilers (4)	278 Natural gas	CO_2: 117 lb/mmBtu, 8-hr. rolling ave.	Tuning, Optimization, Instrumentation & Controls, Insulation, Turbulent Flow
LA-0254	Entergy Louisiana	08/06/11	Industrial Boiler	338 Natural gas	CO_2: 117 lb/mmBtu CH_4: 0.0022 lb/mmBtu N_2O: 0.0002 lb/mmBtu	Proper Operation Good Combustion Practices

* Natural gas is identified as the primary fuel.
** Compliance verified by operational testing.
*** Economizer, condensate recovery, inlet air controls and blowdown heat recovery.

Subsection B.1b – CO_2 Vents – BACT for CO, VOM and Methane

As already discussed, in the ammonia plant, CO_2 is removed from the process gas stream that is used for synthesis of ammonia. Most of the CO_2 is removed from the gas by an absorbent solution containing an amine compound. This solution is then processed in a regenerator that drives the CO_2 out of the solution. When urea is being produced, most of the CO_2 stream from the regenerator is fed to the urea plant where it is used in making urea and is not emitted.[76] The full CO_2 stream is only emitted to the atmosphere when ammonia is produced for direct sale, which is limited to at most 25 percent of the permitted production of the facility. The emissions of this CO_2 stream occur from the Main CO_2 vent.

The emissions of CO_2 from the CO_2 Vents have already been addressed. In addition to CO_2, the CO_2 Vents will emit small amounts of VOM, CO and methane. VOM will be present because a small amount of the amine compound used in the CO_2 absorption system (activated methyldiethanolamine or aMDEA) will be carried over into the CO_2 stream. Side reactions in the upstream shift reactors will also produce trace quantities of organic compounds, including methanol, that may be carried over into the CO_2 vent stream. Some CO in the process gas stream may also be carried over into the CO_2 stream by the CO_2 absorption solvent. Lastly, some methane may be carried over in the CO_2 stream. It is being addressed along with CO and VOM since it also results from carryover from the process stream and the possible approaches for control of emissions of methane and emissions of CO and VOM in the CO_2 stream are the same. Because of the design of the CO_2 absorption system, the exhaust of the CO_2 Vents is almost pure CO_2 with only a very small carryover of VOM, CO and methane.

Proposal

Cronus proposed the design of the facility, as the majority of the CO_2 from the ammonia plant would be used to make urea, as BACT for the CO_2 Vents.

The Illinois EPA is proposing that BACT technology for CO, VOM and methane for the CO_2 Vents be process design and good operating practices for the ammonia plant as they will reduce carryover of CO, VOM and methane into the CO_2 stream. To directly address the amount of carryover of CO, VOM and methane in the CO_2 stream, BACT limits would be set in pounds/hour for the amount of these materials in the CO_2 stream.

Step 1: Identify Available Control Technologies

The following control technologies are available for the CO_2 Vents for CO, VOM and methane emissions:

1. Thermal Oxidation;

[76] Because the facility is designed with a slight excess of CO_2, only a small percentage of the CO_2 (approximately 0.2 percent) would be emitted when urea is being produced. This would occur through a pressure release CO_2 Vent at either the Ammonia Plant or the Urea Plant.

2. Catalytic Oxidation;

3. Flaring; and

4. Process design and good operating practices.

Step 2: Eliminate Technically Infeasible Options

1. Thermal Oxidation

A thermal oxidizer removes a combustible pollutant from an exhaust stream by burning or combusting the pollutant. A fuel-fired burner operating within the exhaust stream is used to heat the gas stream to a temperature at which the target pollutant will combust thoroughly. This technology is typically applied for destruction of organic vapors or solvents from processes where the process itself does not entail collection of the material or combustion.[77] When applied to organic vapors, thermal oxidizers function most effectively when the inlet concentration is at least 1,000 ppm. However, thermal oxidation is also a technology for controlling emissions of CO when present above a minimum concentration, nominally 1400 ppm. The concentrations of both CO and VOM from the CO_2 Vent will be less than one ppm. These concentrations are below the concentration needed for a thermal oxidizer to be effective. The use of thermal oxidation is not technically feasible for the CO or VOM emissions from the CO_2 Vents. Similarly, the use of thermal oxidation is not feasible for methane.

2. Catalytic Oxidation

Catalytic oxidizers are applicable to exhaust streams with inlet concentrations of CO and VOM that are at least 500 ppm. Given the very low concentrations of CO and VOM in these streams, the use of catalytic oxidation is not technically feasible for the CO_2 Vents for CO or VOM. Similarly, the use of catalytic oxidation is not feasible for methane.

3. Flares

The heat content or heating value of the CO, VOM and methane in the CO_2 Vent stream is far too low to support combustion. Flaring is a technology for an exhaust stream that has substantial heating value so that the exhaust stream is combustible or can be made combustible by a small addition of a fuel to the exhaust stream. This is not the case for the exhaust streams from the CO_2 Vents. Accordingly, flaring is not technically feasible for the CO_2 Vents.

4. Process Design and Good Operating Practices

The ammonia manufacturing process will be designed to provide a very pure CO_2 stream and minimize the carryover of CO, VOM and methane. This is because CO,

---

[77] An example of a common application for thermal oxidizers is large rotogravure printing presses. In the printing process, the printed material is dried in ovens where the solvent in the solvent-based ink evaporates. Thermal oxidizers are then used to control these emissions of solvent.

VOM and methane have value as fuel for the Reformer Furnace when removed from the process gas stream. As these compounds are present in the CO_2 stream, they also reduce the operational efficiency of the urea synthesis process. Process design and good operating practices are technically feasible.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only feasible control technology for CO, VOM and methane from the CO_2 Vents is process design and good operational practices. As this will be required, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

Cronus has proposed utilizing the only feasible technology, process design and good operational practices, so no further evaluation is needed.

Step 5: Select BACT

Previous BACT determinations for similar emission units for CO and VOM are listed below. (Previous BACT determinations were not found for CO_2 Vents at ammonia plants for emissions of methane.) These determinations confirm that add-on control devices are not required as BACT for CO or VOM. BACT for CO and VOM is based on process and equipment design with good operational practices. Similar conclusions can be made for methane because it would also be present at trace levels. Because of the low concentrations of these pollutants in the CO_2 stream and because the focus is on carryover of pollutants, it is appropriate that BACT limits be set in terms of the hourly rates of emissions.

The Illinois EPA is proposing BACT for emissions of CO, VOM and methane from the CO_2 Vents as:

1. Process and equipment design and good operating practices.

2. CO, VOM and methane content of the CO_2 stream not to exceed 3.11, 13.1 and 31.1 lbs/hr, 3-hour average, respectively.

Table B1b: BACT Determinations for CO_2 Vents for CO and VOM							
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Process Description**	**Capacity**	**Pollutant**	**BACT Limit**	**Control Measures**
Indiana: T147-32322-0062	Ohio Valley Resources	9/25/13	CO_2 Purification Process	3570 CO_2 ton/day	CO	0.0117 lb/ton ammonia 3-hr. avg.	Use Catalyst, Throughput Limit
					VOM	0.0558 lb/ton ammonia 3-hr. avg.	None, Limit Usage
IA-0106	CF Industries Nitrogen	7/12/13	CO_2 Regenerator	111.15 ton/hr ammonia	CO	0.02 lb/ton ammonia, 3 tests 9.65 tpy rolling 12 mo.	Good Operational Practices
					VOM	0.106 lb/ton ammonia, 3 tests; 51.2 tpy rolling 12 mo.	
LA-0272	Dyno Nobel Louisiana	3/27/13	CO_2 Stripper	115.83 ton/hr	CO	1.49 lb/hr	Design Efficiency & GCP
					VOM	21.78 lb/hr	GCP
IA-0105	Iowa Fertilizer Company	10/26/12	CO_2 Regenerator	Ammonia: 3,320 ton/day	CO	0.02 lb/ton ammonia	Good Operational Practices
					VOM	0.106 lb/ton ammonia	
LA-0236	CF Industries Donaldson Nitrogen Complex	3/03/09	CO_2 Vents #1 to #4	Ammonia, ton/ day: #1 & #2: 1620 ea. #3 & #4: 1785 ea. Total ammonia: 283.75 tons/hr	CO	0.08 lb/ton #1: 5.59 lb/hr, 6.55 tpy #2: 5.59 lb/hr, 6.55 tpy #3: 5.08 lb/hr #4: 5.95 lb/hr	Optimum catalytic conversion of CO to CO_2 + use of alkanol amine solution

Subsection B.1c – BACT for Ammonia Plant Flares

During startup, shutdown and upsets or "malfunctions" of the Ammonia Plant, streams of process gases from various equipment in the plant would be ducted to two flares if the composition or other properties of these streams preclude its use to make ammonia. The flares would combust these streams. Flares are used to control these types of streams because they have the ability to handle sudden releases of pressurized process gases that may vary in volume. The flaring of these releases eliminate the safety risk that would otherwise be posed if combustible gas streams were directly released to the atmosphere. At the ammonia plant, a "Front End Flare" will handle the releases from the reforming processes. A "Back End Flare" will handle the releases from the later process steps, including regeneration, methanation and ammonia synthesis. The draft permit is based on the flaring of process gases occurring for at most 144 hours per year after commissioning of the facility is complete.

In addition to emissions from the combustion of process gases during startup, shutdown and malfunctions of the Ammonia Plant, these flares will have emissions from pilot burners, which will fire natural gas. These burners must operate whenever the Ammonia Plant is operating, even when process gas is not being sent to the flare. This is so that a flame is always present at the flare to immediately ignite process gases if there is a release to the flare system. The purge gas used in the flare system will also contribute to emissions from a flare during this "standby mode" if the purge gas is combustible.[78]

Emissions of CO, VOM and methane, i.e., the organic pollutants, in the process gas streams from flaring would be addressed as the flares are generally required to be operated and maintained to meet the design criteria for flares established by USEPA at 40 CFR 60.18(b). These criteria were developed to assure effective destruction of organic compounds in the gas streams that are sent to a flare. In addition, emissions from the flares will be generally reduced by requiring implementation of practices that will act to reduce the occurrence and magnitude of flaring. These measures will act to reduce emissions of NOx, PM and GHG, as well as emissions of CO, VOM and methane. These required practices to reduce flaring include the development of a "Flare Minimization Plan" to ensure that the flare system and the operating procedures for the Ammonia Plant are developed and maintained to prevent unnecessary flaring of process gases. The required practices to reduce flaring also include the performance of "Root Cause Analyses" to determine whether malfunctions that lead to significant flaring of process gases could be avoided in the future by changes to operating procedures or to operational instrumentation or equipment in the flare system, followed by appropriate corrective actions.

NOx BACT – Ammonia Plant Flares

[78] The purge gas is a stream of gas that is introduced into the ductwork serving a flare to maintain positive pressure in this ductwork, with flow of gas toward the flare. This prevents the risk that would be present if combustible process gases accumulated in the ductwork due to a leak in a pressure relief vent connected to this ductwork. Purge gases may be noncombustible, like nitrogen or CO_2, or fuel materials, like natural gas or, at a petroleum refinery, refinery fuel gas. The draft permit would also require that nitrogen be used as the "purge gas" for the flares.

Proposal

Cronus proposed the following as BACT for NOx for the flares:[79, 80]

1. Design of the flare system and good operating practices.

2. Implementation of practices to minimize flaring.

3. Use of pilot burners designed to not exceed a NOx rate of 0.068 lb/mmBtu.[81]

4. Use of natural gas as the purge gas for the flare.

5. Hourly emission limits for NOx when process gas is being flared.

The Illinois EPA is generally proposing that BACT for NOx for the flares include the first three elements for BACT proposed by Cronus, i.e., design of the flare system, flaring minimization and pilot burners designed for low NOx. The specific practices to minimize flaring would be more thoroughly developed than the practices proposed by Cronus. In particular, development of a formal Flare Minimization Plan is required, in addition to Root Cause Analyses for flaring incidents. This was done to ensure that these practices clearly specify the measures that must be taken to prevent unnecessary flaring.

The Illinois EPA is proposing to require that nitrogen be used as the purge gas, rather than natural gas.[82] Use of nitrogen of the purge gas will act to lower NOx emissions because nitrogen is not combustible.

---

[79] Cronus also proposed that the fuel selected for the flare, natural gas, be part of BACT for the flares as natural gas is a low-carbon fuel. However, the use of natural gas as the fuel for the flares is part of Cronus' design for the facility. Another fuel would not be available for use as fuel in the flares. As such, the BACT analysis for the ammonia plant flares did not reflect consideration of the possible use of other fuels as a measure to further control GHG emissions.

[80] Cronus also proposed that BACT for the flares include limiting flaring of process gases from each flare to no more than 144 hours per year. However, this constraint is inherent in Cronus' design for the facility since process gases would only be flared during startup, shutdown and malfunction. Accordingly, this operational restriction proposed by Cronus was not considered as part of the BACT analysis for the flares.

[81] In its application, Cronus actually proposed a NOx emission rate of 0.07 lb/mmBtu. It is assumed that Cronus intended to propose the NOx emission factor for flares in USEPA's *Compilation of Air Pollutant Emission Factors*, AP-42. This factor is actually 0.068 lb/mmBtu. However, this value was at some point rounded up to 0.07 lb/mmBtu.

[82] A requirement for use of nitrogen as the purge gas in the flares is proposed because its use will not directly contribute to emissions of any pollutants. Nitrogen, itself, is not a pollutant. Because nitrogen is not combustible, use of nitrogen will not result in additional emissions of combustion pollutants at the flares, as would occur if natural gas or other combustible fuel gas were used as the purge gas. In its application, Cronus did not address the economic and environmental impacts that would result from using nitrogen as the purge gas instead of natural gas so as to show that these impacts should be considered excessive so as to justify use of natural gas rather than nitrogen. In its application, Cronus also did not propose to use CO_2 as the purge gas for the flares.

To directly address NOx emissions of the flares, the Illinois EPA is proposing that the annual NOx emissions of the flares be limited rather than their hourly emissions. This is because the hourly emission limits proposed by Cronus merely reflect design data for the maximum hourly NOx emissions during flaring of process gases. They do not reflect use of any measures to reduce hourly emissions of NOx.

Step 1: Identify Available Control Technologies

The following control technologies are available for the NOx emissions of the flares.[83,84]

1. Flare design and good operating practices; and

2. Flaring minimization practices.

Step 2: Eliminate Technically Infeasible Options

1. **Flare design and good operating practices**

Flare design and monitoring are important in the emissions performance of flares. The flare must be properly operated and maintained in order to achieve the emission rates guaranteed by the flare manufacturer. Flare design and good operating practices are technically feasible for the flares.

2. F**laring minimization practices**

To the extent that actions are taken to minimize the amount of process gas that is flared, NOx emissions will be less. The use of flaring minimization practices is technically feasible for the flares.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Design and good operating practices and flare minimization practices are all required as BACT for NOx. Therefore, a ranking of technologies is not needed.

---

[83] Certain control technologies that are used on other types of combustion units, such as selective catalytic reduction (SCR), selective non-catalytic reduction (SNCR), and flue gas recirculation (FGR), are not applicable to flares because the outlet exhaust of an elevated process flare is not enclosed or contained. Therefore, the emissions or flue gases cannot be routed to an add-on control device, and such add-on controls have not been utilized on flares.

[84] Flare gas recovery is also not available for the flares at the facility. Flare gas recovery is implemented at some facilities, such as petroleum refineries, that produce and use internally generated gas streams as fuel. However, flare gas recovery cannot be applied at the proposed facility because, as related to the use of fuel, it only has a “single process.” During events when off-gases are flared, there will not be other units at the facility that are operating normally that are available to use the recovered gas streams as fuel.

Step 4: Evaluate the Most Effective Controls

As all feasible control technologies will be required for the flares, a further evaluation of technologies is not needed.

Step 5: Select BACT

Previous BACT determinations for NOx from similar flares are listed in Table B.1c, below. These BACT determinations generally involve design and proper operation of flares in conformance with their designs. However, there are different approaches to the actual limits and requirements that are set as BACT. A significant number of these previous determinations simply require proper operation without setting emission limits. Some set emission limits for NOx and other pollutants, in lb/mmBtu, that are comparable to the limits proposed by Cronus for the pilot burner.

Only two of the seven previous BACT determinations directly address the mass of emissions from flaring. These two determinations, which are more recent, confirm that it is appropriate for these flares to address the mass of emissions as part of BACT. However, one of these previous determinations limits annual emissions and the other determination limits hourly emissions, along with a limit on the number of hours annually on flaring of process gases. Both approaches to these limits on the mass of emissions effectively only restrict emissions to the level that will potentially result from the source’s design and the design of equipment for the proposed facility or plant. As annual limits would represent the overall consequences of these design elements on emissions, it is more appropriate to set annual limits on emissions from flaring. This is also consistent with the requirement for flare minimization practices whose objective would be to eliminate any unnecessary flaring. Accordingly, in addition to other requirements, the Illinois EPA is proposing to limit the annual NOx emissions of the flares as an element of BACT for NOx.

In summary, the Illinois EPA is proposing BACT for NOx for the Ammonia Plant Flares as:

1. Implementation of practices to minimize flaring.

2. Flare design, including pilot burners designed to not exceed a NOx rate of 0.068 lb/mmBtu, and good operating practices.

3. Use of nitrogen as the purge gas for the flare.

4. An annual limit on NOx emissions of the flares that addresses the overall emissions from both flaring of process gas and the pilot burners.

Table B.1c: BACT Determinations for Process Flares for NOx, CO, VOM, PM and G						
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Process Description**	**Capacity**	**Pollutant**	**BACT Limit**
Indiana: T147-32322-0062	Ohio Valley Resources	9/25/13	Front & Back End Flares	0.253 mmBtu/hr	NOx	Pilot: 0.068 lb/mmBtu Venting: 624.94 lb/hr (front) 624.94 lb/hr (back)
					CO	Pilot: 0.37 lb/mmBtu, Venting: 47.26 lb/hr (front) 804.76 lb/hr (back)
					VOM	Pilot: 0.0054 lb/mmBt 47.26 lb/hr (front) 11.73 lb/hr (back)
					PM	PM: 0.0019 lb/mmBtu $PM_{10}/PM_{2.5}$: 0.0075 lb/m
					GHG (CO_2)	Pilot: 116.89 lb/mmBt Venting: 511.8 ton/hr (front) 127.12 ton/hr (back)
AK-0076	Exxon, Point Thomson	8/20/12	Combustion Flares	35 mmcf/yr	NOx	0.068 lb/mmBtu
					CO	0.37 lb/mmBtu
IA-0105	Iowa Fertilizer Company	10/26/12	Ammonia Flare	0.4 mmBtu/hr	NOx, CO, VOM, PM & GHG	No Limit
IA-0089	Homeland Energy Solutions	8/08/07	Startup & Shutdown Flares	25 mmBtu/hr	VOM	0.006 lb/mmBtu
LA-0213	Valero Refining, St. Charles	11/17/09	Flare 1-5	Not Specified	All	No Limit
ID-0217	Southeast Idaho Energy	2/10/09	Process Flare SRC21	Pilot: 1.5 mmBtu/hr process/ purge	NOx	No Limit
					CO	No Limit
					PM	No Limit
LA-0257	Sabine Pass LNG Terminal	12/06/11	Marine Flare	1590 mmBtu/hr	GHG	CO_2e: 2909 tpy
			Wet/Dry Gas Flares	0.26 mmBtu/hr	GHG	CO_2e: 133 tpy

CO and VOM BACT – Ammonia Plant Flares

The gas streams that would be flared will contain CO and VOM. In addition, CO will be present as a product of incomplete combustion from flaring organic compounds.

Proposal

Cronus proposed the following as BACT:

1. Flare design and good operating practices, including conformance with the requirements of 40 CFR 60.18(b).

2. Implementation of flare minimization practices.

3. Use of pilot burners design to not exceed CO and VOM rates of 0.37 and 0.05 lb/mmBtu, respectively.

4. Use of natural gas as the purge gas for the flare.

3. Hourly emission limits for CO and VOM when process gas is being flared.

The Illinois EPA is proposing that BACT for CO and VOM for the flares generally include the first two elements for BACT proposed by Cronus, i.e., flare design and good operating practices and flaring minimization. As related to flare design, requirements for design destruction efficiencies for pollutants in waste gases would be set, i.e., 98 percent destruction for CO and VOM and 99 percent destruction for methane. As already discussed for NOx, the practices to minimize flaring would be more thoroughly developed than the practices proposed by Cronus. In addition,

The Illinois EPA is also proposing that the pilot burner be designed to comply with a CO emission rate of 0.37 lb/mmBtu. However, a design emission rate would not be specified for VOM. This is because the CO emission rate will be sufficient to address design of the pilot burner for good combustion.[85]

The Illinois EPA is proposing to require that nitrogen be used as the purge gas, rather than natural gas, because this will also act to lower CO and VOM emissions.

To address the amount of CO and VOM emissions of the flares, the Illinois EPA is proposing that the annual emissions of the flares be limited rather than their hourly emissions. This is because the hourly emission limits proposed by Cronus are simply based on design data for the maximum hourly rates of

[85] In addition, compliance with the emission rates that are specified for the pilot burners in the flares will not be able to be verified by emission testing. The specified performance requirements for the pilot burner should be set at levels with which the manufacturers of burners should be familiar and compared to which they should be able to provide reliable design and performance guarantees. These levels are generally the USEPA's current emission factors for flares, as provided in the Compilation of Emission Factors. While this document includes a CO emissions factor for flares, it does not include an emission factor for VOM (See Table 13.5-1, Compilation of Emission Factors).

emissions during flaring of process gases. They do not reflect use of additional measures to reduce hourly emissions of CO or VOM beyond the destruction provided by the flares. Accordingly, it is more appropriate to explicitly address the destruction efficiency of the flares for different pollutants in the gas streams send to the flare, as is proposed.

Step 1: Identify Available Control Technologies

The following control technologies are available for the flares for CO and VOM.[86]

1. Flare design and good operating practices; and

2. Process flare minimization practices.

Step 2: Eliminate Technically Infeasible Options

1. **Flare design and good operating practices**

Flare design and monitoring are key elements of the performance of flares. The flare must be properly operated and maintained in order to operate in accordance with its design. Flare design and good operating practices are technically feasible for the flares.

2. F**laring minimization practices**

As discussed for NOx BACT, flaring minimization practices will act to reduce the volume of process gases that are flared, acting to reduce emissions of CO and VOM. Practices to minimize flaring are technically feasible for the flares.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Design and good operating practices and flare minimization practices are all required as BACT. Therefore, a ranking of technologies is not needed.

Step 4: Evaluate the Most Effective Controls

As all feasible control technologies will be required for the flares, a further evaluation of technologies is not needed.

Step 5: Select BACT

[86] Certain controls that may be used on other types of units, such as thermal or catalytic oxidation are not applicable to flares because process flares are not enclosed. Therefore, the emissions or flue gases cannot be routed to an add-on control device, and such add-on controls have not been utilized on flares.

Previous BACT determinations for CO and VOM for similar flares are listed in Table B.1c, above. These BACT determinations generally involve good design and proper operation of the flares in conformance with their design. The approach to BACT limits for CO and VOM in these determination is similar to that already described for the previous BACT determinations for NOx. Similar conclusions are made for purposes of BACT for CO and VOM.

The Illinois EPA is proposing BACT for CO and VOM for the Ammonia Plant Flares as:

1. Proper flare design and good operating practices, including flares designed for destruction efficiencies of at least 98 percent for CO and VOM and 99 percent for methane and compliance with USEPA’s general requirement for flares, 40 CFR 60.18(b).

2. Implementation of practices to minimize flaring.

3. Pilot burners designed to meet a CO emission rate of 0.37 lb/mmBtu.

4. Use of nitrogen as the purge gas for the flare.

5. Annual limits for CO and VOM emission of the flares that address the overall emissions from both flaring of process gas and the pilot burners.

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Ammonia Plant Flares

Particulate will be present as a product of incomplete combustion from flaring organic compounds.

Proposal

Cronus proposed:

1. Proper flare design and good operating practices, including conformance with the requirements of 40 CFR 60.18(b).

2. The use of flare minimization practices.

3. Annual limits on particulate emissions.

The Illinois EPA is generally proposing that BACT for particulate for the flares include the first three elements for BACT proposed by Cronus, as previous discussed for NOx and for CO and VOM.[87]

The Illinois EPA is also proposing that BACT technology for particulate include the use of nitrogen as the purge gas.

Step 1: Identify Available Control Technologies

The available control technologies for particulate are as follows:[88]

1. Flare design and good operating practices; and

2. Flaring minimization practices.

Step 2: Eliminate Technically Infeasible Options

1. **Flare design and good operating practices**

Flare design and good operation are important for the emissions performance of flares for particulate. The flares will be designed and operated to be "smokeless," thereby reducing particulate emissions. Flare design and good

[87] A performance specification for the pilot burners for particulate emissions is not proposed because USEPA's current emission factors for flares, as provided in the Compilation of Emission Factors, do not include a factor that can be used for this purpose. (See Table 13.5-1, Compilation of Emission Factors).

The emissions of particulate during flaring of process gas is addressed by requiring compliance with 40 CFR 60.18(b), as it further requires compliance with 40 CFR 60.18(c)(1). 40 CFR 60.18(c)(1) provides that visible emissions should not be present for flaring of process gases for more than 5 minutes in any 2 consecutive hours.

[88] Add-on particulate control devices, such as cyclones, baghouses, ESPs, or scrubbers, which may be used on other types of units, are not used on flares because the outlet exhaust of an elevated process flare is not enclosed or contained. Therefore, the emissions or flue gases cannot be routed to an add-on control device, and such add-on controls have not been utilized on flares.

operating practices are technically feasible for the flares.

2. F**laring minimization practices**

To the extent actions can be taken to minimize the volume of process gas going to the flares, particulate emissions will be less. The use of flaring minimizing practices is technically feasible for the flares.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

All feasible control technologies will be required for the flares so a ranking of control technologies is not needed.

Step 4: Evaluate the Most Effective Controls

As all feasible control technologies will be required for the flares, a further evaluation of technologies is not needed.

Step 5: Select BACT

Previous BACT determinations for particulate for similar flares are listed above in Table B.1c, above.[89] These determinations confirm that add-on controls are not used. These BACT determinations generally involve good design and proper operation of the flares in conformance with their design. The approach to BACT limits for particulate in these determination is similar to that already described for the previous BACT determinations for NOx and for CO and VOM. Similar conclusions are made with respect to BACT for particulate.

Illinois EPA is proposing the following as BACT for particulate for the flares:

1. Proper flare design and good operating practices, including compliance with relevant provisions of USEPA’s general requirement for flares, 40 CFR 60.18(b).

2. Implementation of practices to minimize flaring.

3. Use of nitrogen as the purge gas for the flare.

4. Annual limits for particulate emission of the flares that address the overall emissions from both flaring of process gas and the pilot burners.

[89] There are additional entries for natural gas flares in the Clearinghouse. However, these entries are for flares that are operated continuously, including flares used for control of landfill gas and municipal solid waste landfills.

<u>GHG BACT</u> – Ammonia Plant Flares

GHG, primarily CO_2, will be emitted from the flares at the Ammonia Plant as a product of combustion from flaring CO and organic compounds. GHG will also be emitted from the combustion of fuel in the pilot burner.

Cronus proposed:

1. Proper flare design and good operating practices, including conformance with the requirements of 40 CFR 60.18(b).

2. The use of flare minimization practices.

The Illinois EPA is also proposing that BACT for GHG for these flares be design and good operating practices and the implementation of flare minimization practices. The Illinois EPA is also proposing that BACT include a limit on annual GHG emissions.

Step 1: Identify Available Control Technologies

The following control technologies for GHG are available for the Ammonia Plant Flares:[90]

1. Design and Good Operating Practices; and

2. Flare Minimization Practices (FMP).

Step 2: Eliminate Technically Infeasible Options

1. D**esign and Good Operating Practices**

As discussed, proper design and good operating practices are feasible for the flares.

2. **Flare Minimization Practices (FMP)**

Flare minimization practices are also a feasible for the flares.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

All feasible control options have been selected. Therefore, a ranking is not needed.

[90] Carbon Capture and Sequestration (CCS) is not an available control technology for the flares. This is because flares are not enclosed combustion devices. In addition, as discussed earlier for the reformer furnace, USEPA indicates in its GHG Permitting Guidance that CCS is generally not feasible for dilute industrial CO_2 streams from fuel combustion units. This is certainly the case for the pilot burners of flares. CCS is not feasible.

Step 4: Evaluate the Most Effective Controls

Because all feasible technologies will be required, a further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for GHG for similar flares are listed above in Table B.1c. These determinations confirm that add-on controls are not used. They show that GHG emissions are typically controlled by design and good operating practices.

Illinois EPA is proposing BACT for GHG for the flares as:

1. Flare design and good operating practices, including flares designed for a destruction efficiency of at least 99 percent for methane and compliance with USEPA's general requirement for flares, 40 CFR 60.18(b).

2. Implementation of practices to minimize flaring.

3. Use of nitrogen as the purge gas for the flare.

4. An annual limit for GHG emission of the flares that addresses the overall emissions from both flaring of process gas and the pilot burners.

Section B.2 – Reformer Furnace – BACT for Pollutants Other Than GHG

The Reformer Furnace is a process heater used in the production of hydrogen for the Ammonia Plant. In the Reformer Furnace, steam from the boiler and pre-treated natural gas are catalytically converted to an intermediate, hydrogen-rich, process stream that will ultimately be used for synthesis of ammonia. The fuel fired in this unit is a combination of natural gas and process off-gases from the Ammonia Plant.

NOx BACT – Reformer Furnace

The NOx emissions from the Reformer Furnace result from the formation of NOx during combustion.

Proposal

Cronus proposes the following as BACT:

1. Low-NOx Burners (LNB) and Selective catalytic reduction (SCR); and

2. NOx emissions not to exceed 9 ppmv at 3 percent oxygen (equivalent to 0.109 lb/mmBtu), 30-day average, rolled daily.

The Illinois EPA is proposing that BACT technology for NOx for the Reformer Furnace be use of LNB and SCR.

Step 1: Identify Available Control Technologies

NOx emissions from the reformer furnace can be controlled with the following control technologies.

1. Selective Catalytic Reduction (SCR);

2. Selective Non-Catalytic Reduction (SNCR);

3. Low NOx Burners (LNB); and

4. Low NOx Burners (LNB) and SCR.

Step 2: Eliminate Technically Infeasible Options

1. **Selective Catalytic Reduction (SCR)**

SCR involves injection of ammonia into the flue gas and then passing the flue gas through a catalytic reactor to chemically reduce NOx to nitrogen and water. Under ideal conditions, SCR has removal efficiencies of over 90% when used on steady state processes. The efficiency of removal is lower for processes that are variable or entail frequent changes in the mode of operation. The key factor affecting SCR efficiency is the temperature of the flue gas. SCR generally operates in a window ranging from 500°F to 1100°F, with the exact temperature range depending on the type of catalyst and the composition of the flue gas. Outside the ideal temperature range, catalyst activity is lower. Until the flue gas reaches the minimum temperature, the

SCR is not operated, i.e., ammonia is not injected. If ammonia is injected, at the top of the temperature range, the ammonia will oxidize to create additional NOx. SCR is technically feasible for the Reformer Furnace.

2. Selective Non-Catalytic Reduction (SNCR)

With selective non-catalytic reduction (SNCR), NOx is selectively removed by the injection of ammonia or urea into the flue gas in the appropriate temperature window of 1600°F to 2000°F in the absence of a catalyst. Because SNCR does not involve a catalyst, it does not present the concerns for fouling of the catalyst that may be present with SCR. It is also less effective than SCR. As such, the temperature window and residence time are critical for the desired chemical reaction to occur. At higher temperatures, the oxidation of ammonia, to actually create NOx, becomes significant. At lower temperatures, the reaction rate slows resulting in slip, i.e., emissions of unreacted reagent. Effective implementation of SNCR requires an injection system that can thoroughly mix reagent with the flue gas within the temperature window while accommodating variability in the temperature and flow rate of the gas stream due to variation in the operating load of a unit.

SNCR is most commonly used on units that are not amenable to SCR, such as coal-fired fluidized bed boilers. The uncontrolled NOX emissions of those boiler are high enough that SNCR is possible. Their design also provides the appropriate conditions for SNCR technology relative to the location of the reaction temperature range and steady operation within that temperature window. The circumstances are not present for the Reformer Furnace so SNCR is not technically feasible for the Reformer Furnace. Most significantly, the Reformer Furnace would not include a zone in its ductwork where the flue gas would be in the temperature range for the SNCR NOx reduction reaction to take place.

3. **Low NOx Burners (LNB)**

Low NOx burners (LNB) can reduce formation of NOx through careful control of the fuel-air mixture during combustion. Techniques used in LNBs includes staged air and staged fuel, as well as other techniques that act to lower the peak flame temperature. Experience suggests that significant reduction in NOx emissions can be realized with LNB. The USEPA reports that LNBs have achieved reduction up to 80%, but actual reduction depends on the type of fuel and varies considerably from one installation to another. Typical reductions range from 40-50% but under certain conditions, higher reductions are possible. The use of LNBs is technically feasible for the Reformer Furnace.

4. Low NOx Burners (LNB) and Selective Catalytic Reduction (SCR)

LNB and SCR can be used in conjunction to achieve higher overall emission reductions than either technology by itself. The combination of LNB and SCR is technically feasible for the reformer furnace.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The following control technologies have been identified and ranked for the control of NOx from the Reformer Furnace. Cronus proposes the use of the highest reduction control method, SCR, for NOx emissions from the Reformer

Furnace.

1. Low NOx Burners and SCR (80-90 percent reduction);

2. SCR (70-90 percent reduction); and

3. LNB (40-85 percent reduction).

Step 4: Evaluate the Most Effective Controls

Given Cronus selected the highest ranking control methods, further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for NOx for similar units are listed in Table B.2 below. These determinations show that LNB and SCR, used together, are routinely required for control of NOx from reformer furnaces. Cronus proposed use of this technology to comply with a NOx emission limit of 9 ppm, which it indicates would be equivalent to 0.109 lb/mmBtu. The previous BACT limits for NOx for reformer furnaces at fertilizer plants, in lbs/mmBtu, range from 0.015 to 0.017 lb/mmBtu. The equivalent limit for NOx proposed by Cronus, 0.0109 lb/mmBtu, is appropriate as a BACT limit. It would be equal to or more stringent than previous BACT limits, including BACT limits for reformer furnaces at several facilities that are under construction or may never be built.

The Illinois EPA is proposing NOx BACT for Reformer Furnace as:

1. Use of LNB and SCR; and

2. NOx emissions not to exceed 0.0109 lb/mmBtu, 30-day average, rolled daily.

Table B.2: **Determinations of BACT for Reformer Furnaces for NOx, CO, VOM and PM**							
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Process**	**Capacity (mmBtu/hr)**	**Pollutant**	**BACT Limit**	**Control Measure**
Indiana: T147-32322-0062	Ohio Valley Resources	9/25/13	Primary Reformer	1006	NOx	9 ppmvd, 30-day rolling	SCR, 90% Control
					CO	43.45 lb/mmscf, 3-hr	GCP
					VOM	5.5 lb/mmscf, 3-hr	GCP
					PM	1.9/7.6/7.6 lb/mmscf, 3-hr	GCP Fuel Usage Limit
IA-0106	CF Industries Nitrogen	7/12/13	Primary Reformer	1063	CO	0.0194 lb/mmBtu; 3 tests	GOP + NG
					VOM	0.0014 lb/mmBtu; 3 tests	GOP + NG
					PM	0.0024 lb/mmBtu; 3 tests	GOP and NG
LA-0272	Dyno Nobel Louisiana	3/27/13	Primary Reformer	956	NOx	16.15 lb/hr; 0.014 mmBtu annual	SCR and LNB
					CO	16.49 lb/hr	GCP + Design + Fuel/Air + Temperature
					VOM	6.19 lb/hr	GCP + Design + Fuel/Air + Temperature
					$PM_{10}/PM_{2.5}$	8.55 lb/hr	GCP + Design + Fuel/Air + Temperature
IA-0105	Iowa Fertilizer	10/26/12	Primary Reformer	1133	NOx	9 ppmv, 30-day	SCR
					CO	0.0194 lb/mmBtu, 3 tests	GCP
					VOM	0.0014 lb/mmBtu, 3 tests	GCP
					$PM/PM_{10}/PM_{2.5}$	0.0024 lb/mmBtu, 3 tests	GCP
LA-0264	Air Products Norco Hydrogen	9/04/12	Reformer	1320	NOx	0.015 lb/mmBtu; annual	SCR and ULNB
					$PM/PM_{10}/PM_{2.5}$	0.0075 lb/mmBtu; annual	Proper Equipment Design, GCP, Gaseous Fuel
OH-0329	BP Husky Refining	8/7/09	Reformer (Refinery Fuel Gas)	519	VOM	0.0054 lb/mmBtu	-

LA-0236	CF Industries Donaldsonville	3/03/09	Four Reformers	6810 total	CO	303/333 lb/hr	Combustion Control Use of NG
OK-0135	Pryor Plant Chemical	2/23/09	Primary Reformer	(700 tons ammonia per day)	NOx	11.93 lb/hr; 3 tests, 168-hour, rolling cumulative	LNB and GCP
					CO	18.5 lb/hr; 1-hr/8-hr	GCP
					VOM	1.21 lb/hr	-
					PM PM_{10}	1.68 lb/hr 1.26 lb/hr	-

<u>CO and VOM BACT</u> – Reformer Furnace

The Reformer Furnace will emit CO and VOM as products of incomplete combustion.

Proposal

Cronus proposed the following as BACT for CO and VOM:

1. Use of good combustion practices;

2. CO emissions not to exceed 0.043 lb/mmBtu, 30-day average, rolled daily; and

3. VOM Emissions not to exceed 0.0054 lb/mmBtu, 3-hour average.

The Illinois EPA is also proposing that BACT for CO and VOM for the Reformer Furnace be the use of good combustion practices and a VOM limit of 0.0054 lb/mmBtu. However, the Illinois EPA is proposing a more stringent limit for CO, 0.020 lb/mmBtu. As these requirements will address products of incomplete combustion, they will also serve to address emissions of methane from the Reformer Furnace, since methane would also be emitted as a product of incomplete combustion.

Step 1: Identify Available Control Technologies

The following CO and VOM control technologies have been identified as being available for the Reformer Furnace.

1. Thermal Oxidation;

2. Catalytic Oxidation;

3. Flaring; and

4. Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Thermal Oxidizers**

Thermal oxidizers are used in applications where CO and VOM are not combusted in the process that is being controlled or are still present in significant concentrations in the exhaust stream. Thermal oxidizers have not been installed on natural gas-fired boilers and process heaters to control CO or VOM. Thermal oxidation is not a demonstrated technology for these pollutants and is not technically feasible for the Reformer Furnace.

2. **Catalytic Oxidation**

Catalytic oxidizers are also used in applications where CO and VOM are not combusted in the process that is being controlled or are still present in significant concentrations in the exhaust stream. Catalytic oxidizers have not been installed on natural gas-fired boilers and process heaters to control CO or VOM. Catalytic oxidation is not a demonstrated technology for these pollutants and is not technically feasible for the Reformer Furnace.

3. **Flaring**

Flaring is used in applications where CO and VOM are not combusted in the process that is being controlled and the heating value of the exhaust stream is such that it is combustible or combustible with only the minor addition of fuel. Flares have not been used or demonstrated as a control device for CO or VOM. Flaring is not technically feasible for the Reformer Furnace.

4. **Good Combustion Practices**

Good Combustion Practices are generally appropriate for process heaters to reduce emissions of CO and VOM. Good combustion practices are technically feasible for the Reformer Furnace.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only feasible control technology is Good Combustion Practices.

Step 4: Evaluate the Most Effective Controls

Given the only feasible control technology is selected, further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for CO and VOM for similar emission units are listed in Table B.2 above. These determinations confirm that add-on control technology is not used for CO or VOM. Cronus's proposal is consistent with many of these BACT determinations. These emission limits are based on the uncontrolled emission factors from USEPA's *Compilation of Air Pollutant Emission Factors*, AP-42. However, the BACT limits set by the Iowa Department of Natural Resources (Iowa DNR) in two recent permits for reformer furnaces are lower than the limits proposed by Cronus.[91] In its application, Cronus argued that these lower limits, 0.0194 and 0.0014 lb/mmBtu for CO and VOM, respectively, should not be considered achievable. This is because these limits have not been shown to be achievable in practice and were derived from results of emission testing of a single boiler.[92]

---

[91] These two permits addressed reformer furnaces at fertilizer manufacturing facilities proposed by Iowa Fertilizer Company and CF Industries Nitrogen, LLC.

[92] Since neither of the new reformer furnace has begun operation, the ability of those units to meet these limits has not been confirmed by testing.
Cronus also argued that the recent BACT limits for CO and VOM set by the Iowa DNR were not an appropriate basis to set a BACT limit for the proposed Reformer Furnace because they were based on a statistical analysis of the results of stack tests on a single boiler, an auxiliary boiler with a capacity of 429 mmBtu/hr at the Walter Scott

Notwithstanding Cronus' arguments, a numerical CO limit that is essentially identical to that set by Iowa DNR, 0.02 lb/mmBtu, is considered achievable by the new reformer furnace at the proposed facility. This limit is not significantly lower than the CO BACT limits for other new reformer furnaces. Modern automated boiler operating systems make lower CO emission rates achievable. It is also noteworthy that neither of the facilities in Iowa appears to be pursuing a revision to its construction permit to obtain a higher BACT limit for CO.[93] For the reformer furnace at Cronus, continuous emission monitoring for CO is proposed to be required so that the CO BACT limit would apply on a rolling 30-day average.[94] This would be consistent with the averaging period for NOx, for which continuous emission monitoring would also be required.

The circumstances are different for VOM. The BACT limit for VOM set by Iowa DNR for reformer furnaces is significantly lower than the BACT limits for VOM set for other new reformer furnaces. Testing for VOM emissions of fuel combustion emission units is not as accurate or precise as testing for CO. This limit was also derived from emission testing of a boiler, rather than a reformer furnace.[95] Accordingly, it is appropriate that the BACT limit for VOM for the reformer furnace be set at 0.0054 lb/mmBtu, as proposed by Cronus.

Illinois EPA is proposing BACT for CO and VOM for the Reformer Furnace as:

1. Good combustion practices;

2. CO emissions not to exceed 0.020 lb/mmBtu, 30-day average, rolled daily; and

3. VOM emissions not to exceed 0.0054 lb/mmBtu, 3-hour average.

Generating Plant in Council Bluffs, Iowa. That testing was conducted while that boiler was operating with high levels of excess air. As such, that testing should not be considered representative since high levels of excess air, while conducive to low CO and VOM, are inconsistent with operation of a boiler for thermal efficiency, as is relevant for lowering GHG emissions.

[93] Iowa DNR is currently engaged in processing a number of revisions to the construction permits for Iowa Fertilizer. These revisions do not include a change to the CO limit for the reformer furnace.

[94] 40 CFR 60 Subpart JJJJJ, the NESHAP for boilers and process heaters at major sources, also sets CO standards that apply on a 30-day average if continuous emission monitoring is conducted.

[95] Testing for VOM is more difficult than testing for CO because VOM testing must address a class of pollutants, i.e., organic compounds, excluding methane and ethane. In contrast, testing for CO only involves measurements for a single pollutant that is present in higher concentrations than VOM in the flue gas of a fuel combustion unit.

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Reformer Furnace

The Reformer Furnace will emit particulate as a product of incomplete combustion.

Proposal

Cronus proposed the following as BACT for particulate:

1. The use of good combustion practices; and

2. Limits of 0.0019 and 0.0075 lb/mmBtu for PM and $PM_{10}/PM_{2.5}$, respectively.

The Illinois EPA is proposing that BACT for particulate for the Reformer Furnace be the use of good combustion practices to comply with limits of 0.0019 and 0.0024 lb/mmBtu for PM and $PM_{10}/PM_{2.5}$, respectively.

Step 1: Identify Available Control Technologies

The available control technologies include the following:

1. Cyclones;

2. Wet Scrubbers;

3. Electrostatic Precipitators (ESP);

4. Fabric Filter Dust Collectors (Baghouses); and

5. Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Cyclones**

Cyclones mechanically separate particulate from an exhaust stream through inertial forces. Cyclones are used in applications with loadings of PM in the flue gas of 1 to 100 gr/scf. They are a low-cost, low-maintenance method for exhaust streams containing larger particulates, such as sawdust from wood working or dust from grain handling. However, the loading and size of particulate in the exhaust of the Reformer Furnace are below the levels at which cyclone technology would be effective in controlling emissions. Cyclones have not been demonstrated as a control technology device for natural gas-fired units like the Reformer Furnace. Cyclones are not a technically feasible control option for the Reformer Furnace.

2. **Wet Scrubber**

Wet scrubbers use a spray of liquid to remove particulate from an exhaust stream, either physically or in combination with a chemical reaction. Wet scrubbers can be designed to remove PM from exhaust streams whose PM loading are more than 0.1 gr/scf. Wet scrubber technology has not been demonstrated as a control for particulate from natural gas-fired units like the Reformer Furnace. Wet scrubbing is not a technically feasible control option for the Reformer Furnace.

3. **Electrostatic Precipitators**

Electrostatic precipitators (ESPs) use electrical forces to remove PM from an exhaust stream onto collector plates. ESPs can be designed to remove PM from exhaust streams whose PM loading are more than 0.5 gr/scf. The concentration of PM in the Reformer Furnace exhaust is already orders of magnitude lower. ESPs have not been demonstrated as a control for particulate from natural gas-fired units like the reformer. As such, ESPs are not a technically feasible control option for the Reformer Furnace.

4. **Fabric Filter Dust Collectors (Baghouse)**

A baghouse uses a fabric filter to remove particles from an exhaust stream. Given the very low concentration of particulate in the exhaust stream of the Reformer Furnace, a baghouse would not provide further control of particulate. Baghouses have not been demonstrated as a control for particulate from natural gas-fired units like the Reformer Furnace. As such, baghouses are not technically feasible for the Reformer Furnace.

5. Good Combustion Practices

Good combustion practices will reduce particulate emissions. Good combustion practices are technically feasible for the Reformer Furnace.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only feasible control technology for the Reformer Furnace for particulate is good combustion practices

Step 4: Evaluate the Most Effective Controls

As the only feasible technology will be used on the Reformer Furnace, further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for particulate for reformer furnaces are listed in Table B.2 above. These determinations confirm that add-on control technology is not used for particulate. The limits set as BACT generally reflect the emission factors for particulate in USEPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (Compilation of Emission Factors)[96],

[96] For natural gas-fired boilers, USEPA's Compilation of Emission Factors provides factors of 0.19 and 0.55 pounds per million standard cubic feet of natural gas for filterable and condensable particulate, respectively. It further indicates that the filterable emission factor is also appropriate for use in determining emissions of PM_{10} and $PM_{2.5}$ as all filterable particulate is expected to be $PM_{2.5.}$ (Compilation of Emission Factors, Table 1.4-2, March 1998).

consistent with Cronus's proposed BACT limits. However, the Iowa DNR has recently issued permits for reformer furnaces at facilities proposed by the Iowa Fertilizer Company and CF Industries Nitrogen that set BACT limits for PM_{10} and $PM_{2.5}$, 0.0024 lb/mmBtu. This limit is lower than the relevant emission factor in the Compilation of Emission Factors, 0.0075 lb/mmBtu, which is the limit for PM_{10}/$PM_{2.5}$ proposed by Cronus. Information for the PM_{10} and $PM_{2.5}$ emission of natural gas-fired boilers confirms that this emission rate will also be achievable by the reformer furnace at the proposed facility.[97] Emissions testing will be required for the Reformer Furnace to verify that this emission limit is met.

The Illinois EPA is proposing the following as BACT for particulate for the Reformer Furnace:

1. Good combustion practices; and

2. Emissions not to exceed 0.0019 and 0.0024 lbs/mmBtu for PM and PM_{10}/$PM_{2.5}$, respectively.

[97] USEPA has informally compiled the results of emissions tests for PM_{10} and $PM_{2.5}$ from various types of units burning gaseous fuels to support more accurate reporting of emissions of these pollutants. This evaluation did not develop emission factors for reformer furnaces that burn a combination of natural gas and process off-gases derived from natural gas. However, the new emission factors recommended by this evaluation for boilers (0.52 and 0.43 lbs/million dscf of fuel for total PM_{10} and $PM_{2.5}$, respectively) confirm that lower rates of emissions will be achieved, consistent with the limits set by the Iowa DNR.

Section B.3 – Boiler – BACT for Pollutants Other Than GHG

The boiler will supply steam to the Reformer Furnace in the Ammonia Plant for production of hydrogen. The boiler is designed to fire natural gas.

NOx BACT – Boiler

NOx from the Boiler results from the combustion of natural gas with the nitrogen from the air.

Proposal

Cronus proposes the following as BACT:

1. The use of Low NOx Burners (LNB) and Flue Gas Recirculation (FGR); and

2. Emissions not to exceed 0.020 lbs/mmBtu, 30-day average, rolled daily.

The Illinois EPA is proposing that BACT for NOx for the boiler be the use of Low NOx Burners and Selective Catalytic Reduction (SCR) or other equivalent technology to meet an emission rate of 0.012 lbs/mmBtu, 30-day average, rolled daily.

Step 1: Identify Available Control Technologies

The following NOx control technologies are available for the boiler:

1. Selective Catalytic Reduction (SCR);

2. Selective Non-Catalytic Reduction (SNCR);

3. Low-NOx Burner (LNB);

4. Flue Gas Recirculation (FGR);

5. Low NOx Burner (LNB) with Flue Gas Recirculation (FGR); and

6. Low NOx Burner (LNB) with Selective Catalytic Reduction (SCR).

Step 2: Eliminate Technically Infeasible Options

1. **Selective Catalytic Reduction (SCR)**

SCR technology has been described in the discussion of BACT for NOx for the Reformer Furnace. SCR is a feasible control technology for the boiler.

2. **Selective Non-Catalytic Reduction (SNCR)**

SNCR technology has been described in the discussion of BACT for NOx for the Reformer Furnace. SNCR is also considered a feasible control technology for the boiler.

3. **Low NOx Burners (LNB)**

LNB has been described in the discussion of BACT for NOx for the Reformer Furnace. LNB is a feasible control technology for the boiler.

4. **Flue Gas Recirculation (FGR)**

Recirculating a portion of the flue gas from a boiler to the combustion zone can lower the peak flame temperature and oxygen concentrations, reducing formation of thermal NOx. FGR can be a very cost-effective technique for providing some additional reduction in NOx emissions beyond that provided by low NOx burners. FGR is technically feasible for the boiler.

5. **Flue Gas Recirculation (FGR) and Low NOx Burners (LNB)**

FGR and LNB can be used in conjunction to achieve lower emission rates than either method by itself. The use of FGR and LNB is technically feasible for the boiler.

6. Low NOx Burner (LNB) with Selective Catalytic Reduction (SCR)

LNB and SCR can be used in conjunction to achieve lower emission rates than either method by itself. The use of LNB and SCR is technically feasible for the boiler.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The ranking of feasible NOx control technologies by control efficiency is as follows:

1. LNB and SCR (80 to 90 percent);

2. SCR (70 to 90 percent);

3. LNB and FGR (55 to 85 percent);

4. SNCR (50 to 70 percent);

5. LNB (50 percent); and

6. FGR (25 percent).

Step 4: Evaluate the Most Effective Controls

Cronus examined the costs associated with the use of SCR relative to LNB and FGR and attempted to show that the cost impacts were excessive. The values of cost-effectiveness per ton of NOx controlled initially calculated by Cronus were $18,000 to $37,000/ton NOx on an incremental cost basis.[98] In a subsequent analysis, Cronus showed that the cost-effectiveness of also using SCR would be $2,140/ton NOx on an average basis and $8,577/ton NOx on an incremental basis. These assessments were not sufficient to show that the

[98] Initial Application Submittal, February 2014, p. 36.

economic cost impacts of requiring use of SCR on the boiler would be excessive. This is because these assessments were not supported by analyses for the "baseline" NOx emission rates of the boiler used in the assessments.[99] This is important since the baseline emission rate determines the reduction in emissions that is used when calculating the values of cost-effectiveness of alternative control technologies.[100] In addition, Cronus' assessments did not consider the costs that would likely not be present if SCR were used. If the boiler were equipped with SCR, FGR would almost certainly no longer be used, with a "savings" from the capital and operating costs associated with FGR that would be avoided.[101] Accordingly, Cronus' assessments were not sufficient to show that use of SCR is inappropriate as BACT for the boiler.

Equally important, Cronus did not demonstrate why the cost-impacts for use of SCR on the proposed boiler should be considered excessive when the determination of BACT for NOx for natural gas-fired boilers for another project reflects use of SCR. In particular, the Clearinghouse indicates that SCR is being used on the natural gas-fired boilers at the Port Dolphin Energy project, a compressed natural gas unloading facility proposed off the coast of Florida. The NOx BACT limit for these boilers, as achieved with SCR, is 0.0120 lb/mmBtu. (See Table B.3, below, Clearinghouse Entry FL-0330.)[102]

---

[99] As discussed by USEPA in the NSR Manual in the context of calculating cost-effectiveness,

> The baseline emissions rate represents a realistic scenario of upper boundary uncontrolled emissions for the source. The NSPS/NESHAP requirements or the application of controls, including other controls necessary to comply with State or local air pollution regulations, are not considered in calculating the baseline emissions. In other words, baseline emissions are essentially uncontrolled emissions, calculated using realistic upper boundary operating assumptions. When calculating the cost effectiveness of adding post process emissions controls to certain inherently lower polluting processes, baseline emissions may be assumed to be the emissions from the lower polluting process itself. In other words, emission reduction credit can be taken for use of inherently lower polluting processes.
> NSR Manual, p. B.37

[100] For the boiler at the Cronus' facility, the critical issue for the baseline emission rate is the NOx emission rate that is achievable simply with the modern low-NOx burners that would be installed in the boiler if flue gas recirculation were not used. The lower the NOx emission rate of these burners, the less cost-effective SCR becomes. For example, if the NOx emission rate of these burners would be 0.08 lb/mmBtu, the annual reduction in NOx emissions from use of SCR would be 303 tons, rather than 719 tons. Based on the annualized costs for SCR in Cronus' second assessment, the average cost-effectiveness of SCR would be over $5,000/ton, instead of only about $2,000/ton. ($1,538,474 ÷ 303 tons/year = $5,077/ton)

[101] Cronus' evaluation also did not include project-specific data for the costs associated with SCR. This data is appropriate for the costs of SCR given that Cronus attempted to eliminate this technology, which is commonly used on coal-fired boilers and combined cycle combustion turbines, from the BACT determination based on its economic impacts.

[102] As discussed by USEPA in the NSR Manual in the context of Step 4 of the Top-Down BACT Process,

> The determination that a control alternative to be inappropriate involves a demonstration that circumstances exist at the source which distinguish it from other sources where the control alternative may have been required previously, or that argue against the transfer of technology or application of new technology. Alternately, where a control technique has been applied to only one or a very

Step 5: Select BACT

Previous BACT determinations for NOx for natural gas-fired boilers are listed in Table B.3. These determinations show that LNB and FGR are commonly used on natural gas-fired boilers to control NOx. Cronus' proposed BACT limit for NOx, 0.02 lb/mmBtu, is lower than many of the previous BACT determinations. However, there are also BACT determinations with lower limits. As discussed, the NOx BACT limit for the boilers at Port Dolphin Energy is 0.0120 with use of SCR. The permits for the boiler at the Iowa Fertilizer Company issued by the Iowa DNR and the boilers at Indiana Gasification issued by Indiana Department of Environmental Management are based on use of LNB and FGR to comply with a NOx limit of 0.0125 lb/mmBtu. The BACT determination for the boiler at the Cronus facility should be consistent with these previous determinations, with a NOx BACT limit set that is lower than 0.02 lb/mmBtu, the limit proposed by Cronus. The limits for other projects show that a NOx limit of 0.0120 lb/mmBtu will be achievable by the boiler at the Cronus facility. If a NOx limit of 0.0125 lb/mmBtu is achievable by a natural gas-fired boiler with the combination of LNB and FGR technology, a NOx limit of 0.0120 lb/mmBtu will be achievable by the combination of LNB and SCR technology.[103] However, the fact that a limit of 0.0125 lb/mmBtu has been set for certain boilers with use of LNB and FGR, also suggests that a limit of 0.0120 lb/mmBtu may be achievable by the boiler at the Cronus facility with only use of LNB and FGR. To accommodate continuing improvements in LNB and FGR technology, the BACT determination for the boiler for NOx should provide for use of LNB and FGR if they are able to comply with a NOx limit of 0.0120 lb/mmBtu. In this regard, it is preferable that the NOx emissions of the proposed boiler be prevented by pollution prevention measures, i.e., FGR in combination with LNB, if this will result in equivalent levels of NOx emissions from the boilers. FGR should be expected be much more cost-effective than use of SCR. It would also be simpler because it would not require a catalyst or involve use of a reagent.

In summary, the Illinois EPA is proposing NOx BACT for the boiler as:

> Use of Low NOx Burners and Selective Catalytic Reduction or equivalent technology to comply with an emission limit of 0.0120 lb/mmBtu, 30-day average, rolled daily.

---

limited number of sources, the applicant can identify those characteristic(s) unique to those sources that may have made the application of the control appropriate in those case(s) but not for the source under consideration. In showing unusual circumstances, objective factors dealing with the control technology and its application should be the focus of the consideration. NSR Manual, p. B.29

[103] It should be recognized that SCR technology "overlaps" and is not additive with FGR technology for control of NOx. This is because the effectiveness of SCR technology in further lowering NOx emissions depends on the concentration of NOx in the flue gas. The effectiveness of SCR is also constrained by the need to operate at less than the stoichiometric rate for complete reduction of NOx so unreacted ammonia is not emitted.

Table B.3: BACT Determinations for NOx, CO, VOM and PM for Natural Gas-Fired Boilers							
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Description**	**Capacity (mmBtu/hr)**	**Pollutant**	**BACT Limit**	**Control Measure**
TX-0641	Pinecrest Energy Center	11/12/13	Auxiliary Boiler	150 @876 hrs	NOx	16.0 ppmvd, 3% O_2	LNB
					CO	75 ppmv, 3% O_2	NG Good Combustion
					VOC	0.9 lb/hr	
					$PM_{2.5}$	1.14 lb/hr	
Indiana: T147-32388-00062	Ohio Valley Resources	9/25/13	4 Package Boilers	218 each	NOx	20.40 lb/mmcf, 24 hr ave	LNB, FGR, Usage Limit
					CO	37.22 lb/mmcf, 3-hr. ave	GCP, Limit Usage
					VOM	5.5 lb/mmcf, 3 hr. ave	
					PM & $PM_{10}/PM_{2.5}$	1.9 & 7.6 lb/mmcf, 3 hr. ave	GCP & Design
NE-0054	Cargill	9/12/13	Boiler	300	NOx	0.04 lb/mmBtu, 30-day	LNB/FGR
					CO	0.08 lb/mmBtu, 1 hr	GCP
					$PM_{2.5}$	0.0075 lb/mmBtu, 1 hr	-
IA-0106	CF Industries Nitrogen	7/12/13	Boiler	456	CO	0.0013 lb/mmBtu, 3 tests	Oxidation Catalyst
					VOC	0.0014 lb/mmBtu, 3 tests	GOP + NG
					$PM/PM_{10}/PM_{2.5}$	0.0024 lb/mmBtu, 3 tests	GOP + NG
OH-0354	Kraton Polymers	1/15/13	2 Boilers	249 each	NOx	0.10 lb/mmBtu	LNB
IA-0105	Iowa Fertilizer	10/26/12	Boiler	472	NOx	0.0125 lb/mmBtu, 30 day	LNB/FGR
					CO	0.0013 lb/mmBtu, 3 tests	GCP
					VOM	0.0014 lb/mmBtu, 3 tests	GCP
					$PM/PM_{10}/PM_{2.5}$	0.0024 lb/mmBtu, 3 tests	GCP & Work Practices
IN-0166	Indiana Gasification	6/27/12	2 Boilers	408 each	NOx	0.0125 lb/mmBtu, 24 hr	ULNB/FGR
					CO	0.036 lb/mmBtu, 3 hr ave	GCP
					$PM/PM_{10}/PM_{2.5}$	0.0075 lb/mmBtu, 3 hr	Clean Fuel
FL-0330	Port Dolphin Energy	12/01/11	4 Boilers	278 each	NOx	0.0120 lb/mmBtu, 3 hr rolling ave	SCR
					CO	0.0150 lb/mmBtu, 3 hr rolling ave	GCP
					VOC	0.0064 lb/mmBtu, 3 hr rolling ave	

					Particulate	PM: 0.01 lb/mmBtu, 3 hr rolling ave $PM_{10}/PM_{2.5}$: 0.0075 lb/mmBtu, 3 hr rolling	Use of NG
CA-1212	City of Palmdale Hybrid Power	10/18/11	Auxiliary Boiler	110	NOx	9 ppmvd, @ 3% O_2, 3 hr	
					CO	50 ppmvd @ 3% O_2, 3 hr	None
					PM	0.8 lb/hr	NG
MI-0389	Consumers Energy	12/29/09	Auxiliary Boiler	220	NOx	0.018 lb/mmBtu, 30 day rolling	LNB
					CO	0.0350 lb/mmBtu (<10 ppm)	Efficient Combustion
					VOC	0.0013 lb/mmBtu (<10 ppm)	Efficient Combustion
OH-0310	American Municipal Power	10/08/09	Auxiliary Boiler	150	NOx	21 lb/hr (140 lb/mmcf)	None
					CO	12.6 lb/hr, 400 ppm,3% O_2 (0.084 lb/mmBtu)	None
					VOM	5.5 lb/mmcf 0.83 lb/hr 0.006 lb/mmBtu	None
					PM_{10}	1.14 lb/hr (7.6 lb/mmcf)	None
LA-0231	Lake Charles Cogen	6/22/09	Aux. Boiler	938	NOx	0.035 lb/mmBtu	ULNB
					CO	33.78 lb/hr	Good Design & Proper Operation
					PM_{10}	6.99 lb/hr (filt + cond) (0.0075 lb/mmBtu)	
OK-0135	Pryor Plant Chemical	2/23/09 Revised 4/30/12	2 Boilers	1 @ 80 1 @ 53	NOx	4.0 lb/hr, 3-hr/168-hr roll/cumulative	GCP & LNB
					CO	6.6 lb/hr, 3-hr/168-hr roll/cumulative	GCP
					VOC	0.5 lb/hr	None
					PM/PM_{10}	PM: 0.6 lb/hr PM_{10}: 0.5 lb/hr 24 hr.	
OH-0307	Biomass Energy South Point	4/04/06	Aux. Boiler	247	NOx	0.06 lb/mmBtu	None
					CO	0.11 lb/mmBtu	
					VOC	0.0040 lb/mmBtu	
					PM_{10}	0.0070 lb/mmBtu	
NC-0101	Forsyth Energy Plant	9/29/05	Aux. Boiler	110.2	NOx	0.137 lb/mmBtu	LNB + GCP
					CO	9.08 lb/hr, 3 hr. ave. (0.0824 lb/mmBtu)	LNB & GCC & Low Sulfur Fuel
					VOC	0.59 lb/hr, 3 hr. ave.	
					PM_{10}	0.82 lb/hr filt., 3 hr (0.007 lb/mmBtu)	GCP + Low Sulfur Fuel

TX-0371	Corpus Christi Energy Center	2/29/05	Aux. Boiler	315	PM	0.005 lb/mmBtu filterable	None
TX-0386	Amelia Energy	8/26/04	Aux. Boiler	155	VOM	3.1 lb/hr 0.02 lb/mmBtu	None
NJ-0043	Liberty Generating	3/28/02	Aux. Boiler	200	VOM	50 ppmvd @7% O_2 1.6 lb/hr 0.008 lb/mmBtu	None
PA-0187	Gray’s Ferry Cogeneration	3/21/01	Aux. Boiler	1119	PM	0.005 lb/mmBtu filterable	GCP

CO & VOM BACT – Boiler

The boiler will emit CO and VOM as a product of incomplete combustion.

Proposal

Cronus proposed the following as BACT:

1. Proper design and good combustion practices;
2. CO Emissions not to exceed 0.036 lb/mmBtu, 24-hour average; and
3. VOM Emissions not to exceed 0.0054 lb/mmBtu, 3-hour average.

The Illinois EPA is also proposing that BACT for CO and VOM for the boiler be the use of good combustion practices and a VOM limit of 0.0054 lb/mmBtu. However, the Illinois EPA is proposing a more stringent limit for CO, 0.020 lb/mmBtu, 30-day average, rolled daily. As these requirements address products of incomplete combustion, they will also serve to address emissions of methane from the boiler, since methane would also be emitted as a product of incomplete combustion.

Step 1: Identify Available Control Technologies

The following CO and VOM control technologies are available for the boiler:

1. Thermal Oxidation;
2. Catalytic Oxidation;
3. Flares; and
4. Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Thermal Oxidation**

Thermal oxidizers are used in applications where CO and VOM are not combusted in the process that is being controlled or are still present in significant concentrations in the exhaust stream. Thermal oxidizers have not been installed on natural gas-fired boilers to control CO or VOM. Thermal oxidation is not a demonstrated technology for these pollutants and is not technically feasible for the boiler.

2. **Catalytic Oxidation**

Catalytic oxidizers are also used in applications where CO and VOM are not combusted in the process that is being controlled or are still present in significant concentrations in the exhaust stream. Catalytic oxidizers have not been installed on natural gas-fired boilers and process heaters to control CO or VOM. Catalytic oxidation is not a demonstrated technology for these pollutants and is not technically feasible for the boiler.

3. **Flare**

Flaring is used in applications where CO and VOM are not combusted in the process that is being controlled and the heating value of the exhaust stream is such that it is combustible or combustible with only minor addition of fuel. Flares have not been used or demonstrated as a control device for CO or VOM. Flaring is not technically feasible for the boiler.

4. Good Combustion Practices

Good combustion practices are technically feasible for the boiler.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only technology that is technically feasible for CO and VOM for the boiler is good combustion practices. A ranking is not needed.

Step 4: Evaluate the Most Effective Controls

Given the only feasible control technology is selected, further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for CO and VOM for natural gas-fired boilers are listed in Table B.3, above. These determinations confirm that good combustion practices are required as BACT. None of the determinations involved add-on control devices.

Cronus's proposed BACT limits for CO and VOM are consistent with many of these BACT determinations. The limits in these determinations reflect relevant emission factors in USEPA's *Compilation of Air Pollutant Emission Factors*, AP-42. However, in its two recent permits for new fertilizer manufacturing plants, the BACT limits for CO and VOM for boilers set by Iowa DNR are lower than the limits proposed by Cronus.[104] In its application, Cronus argued that these lower limits, 0.0013 and 0.0014 lb/mmBtu for CO and VOM, respectively, should not be considered achievable. This is because these limits have not been shown to be achievable in practice and were derived from emission test results for a single boiler.[105] It is appropriate that a BACT

---

[104] The permits addressed reformer furnaces for nitrogenous fertilizer manufacturing plants proposed by Iowa Fertilizer Company and CF Industries Nitrogen, LLC.

[105] Since none of these new boilers has begun operation, the ability of those units to meet this limit has not been confirmed by testing.

Cronus also argued, as it did for the reformer furnace, that the BACT limits set by Iowa DNR were not an appropriate basis to set BACT limits for the proposed boiler because they were based on testing of a single boiler, an auxiliary boiler at the Walter Scott Generating Plant in Council Bluffs, Iowa. That testing was conducted while that boiler was operating with high levels of excess air. As such, that testing limit for CO that is lower than that proposed by Cronus be set for the boiler. For this purpose, it is proposed that the BACT limit for CO be identical to the limit for the reformer furnace, 0.020 lb/mmBtu. It is not appropriate for the BACT limit to be set at the limit selected by the Iowa DNR. The limit for CO set by Iowa DNR is a fraction of other BACT limits for CO. Modern automated boiler operating systems cannot be relied upon to lower CO emissions to this extent. The test results from which this limit was developed also appear to reflect operating conditions in the boiler that are not consistent with thermally efficient operation to lower GHG emissions. A limit of 0.020 lb/mmBtu will be achievable with modern automated boiler operating systems while still accommodating efficient boiler operation.

For VOM, the circumstances are similar to those for the reformer furnace, as already discussed. It is appropriate that the BACT limit for VOM for the boiler be set at 0.0054 lb/mmBtu, as proposed by Cronus.

Illinois EPA is proposing BACT for CO and VOM the boiler as:

1. Implementation of good combustion practices;

2. CO emissions not to exceed 0.020 lb/mmBtu, 30-day average, rolled daily; and

3. VOM emissions not to exceed 0.0054 lb/mmBtu, 3-hour average.

---

should not be considered representative since high levels of excess air, while conducive to low CO, are inconsistent with operation of a boiler for thermal efficiency, as is relevant for lowering GHG emissions.

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Boiler

The boiler will emit particulate as a product of incomplete combustion. Accordingly, particulate emissions are much lower than those of fuels that contain non-combustible "ash" materials.

Proposal

Cronus proposed the following as BACT:

1. Boiler design and good combustion practices;

2. Scheduled maintenance; and

3. Emissions not to exceed 0.0019, 0.0024 and 0.0010 lb/mmBtu for PM, PM_{10} and $PM_{2.5}$, respectively.[106]

The Illinois EPA is proposing that BACT for particulate matter be the use of good combustion practices to comply with limits of 0.0019, 0.0024 and 0.0010 lb/mmBtu for PM, PM_{10} and $PM_{2.5}$, respectively.

Step 1: Identify Available Control Technologies

The available technologies include the following:

1. Cyclones;

2. Wet Scrubbers;

3. Electrostatic Precipitators (ESP);

4. Fabric Filter Dust Collectors (Baghouses); and

5. Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Cyclones**

Cyclone technology is used for streams containing high concentrations of larger particulates. Cyclone technology has not been demonstrated as a control device for particulate from natural gas-fired units like the boiler. Cyclones are not a technically feasible control option for the boiler.

2. **Wet Scrubbers**

Similar to the Reformer Furnace, wet scrubber technology has not been

[106] For the boiler, Cronus originally proposed a BACT limit of 0.0075 lb/mmBtu for PM_{10} and $PM_{2.5}$. This limit was subsequently lowered by Cronus in conjunction with the air quality analysis for PM2.5 air quality.

demonstrated as a control for particulate from natural gas-fired units like the boiler. Wet scrubbing is not a technically feasible control option for the boiler.

3. **Electrostatic Precipitators (ESPs)**

Similar to the Reformer Furnace, electrostatic precipitators (ESPs) have not been demonstrated as a control for particulate from natural gas-fired units like the boiler. As such, an ESP is not a technically feasible control option for the boiler.

4. **Fabric Filter Dust Collectors (Baghouse)**

Similar to the Reformer Furnace, baghouses have not been demonstrated as a control technology for particulate from natural gas-fired units like the boiler. As such, a baghouse is not a technically feasible control option for the boiler.

5. **Good Combustion Practices**

Good combustion practices will reduce particulate emissions. Good combustion practices are technically feasible for the boiler.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only feasible control technology has been selected so a ranking of control technologies is not needed.

Step 4: Evaluate the Most Effective Controls

An evaluation of technologies is not needed because only one technology is feasible.

Step 5: Select BACT

Previous BACT determinations for particulate for natural gas-fired boilers are listed in Table B.3. These determinations confirm that add-on control devices are not required as BACT for particulate. Good combustion practices is required to be used. The BACT limits for particulate originally proposed by Cronus (i.e., 0.0019 and 0.0075 lbs/mmBtu for PM and $PM_{10}/PM_{2.5}$) were consistent with the limits in most of these previous BACT determinations. Those BACT limits and Cronus' original proposal for BACT limits reflect emission factors for natural gas-fired boilers in the Compilation of Emission Factors.

However, it is appropriate that BACT limits for particulate be set for the boiler that are lower than the factors in the Compilation of Emission Factors, as were originally proposed by Cronus. As already discussed when addressing BACT for the Reformer Furnace, given the body of emission test results that is now available for natural gas-fired boilers, it is generally appropriate for the BACT limits for $PM_{10}/PM_{2.5}$ for both the reformer furnace and boiler at the Cronus facility to be set at 0.0024 lb/mmBtu. In addition, Cronus used an even lower $PM_{2.5}$ emission rate for the boiler in the air quality analyses that it prepared and submitted to the Illinois EPA to address the impacts of the proposed facility of ambient air quality for $PM_{2.5}$.[107, 108] In those analyses, Cronus used a $PM_{2.5}$ emission rate of 0.0010 lbs/mmBtu. For the boiler, BACT for $PM_{2.5}$ should be set at this lower rate since it directly reflects the emission limit that is expected to be achieved with BACT technology.[109] Emission data for natural gas-fired boilers assembled by USEPA indicates that an emission rate for $PM_{2.5}$ of 0.0010 lbs/mmBtu should be achievable by the boiler. As is especially appropriate because this rate is much lower than the factor in the Compilation of Emission Factors, emission testing will be required for the boiler to verify compliance with this limit.

Accordingly, the Illinois EPA is proposing the following as BACT for particulate for the boiler.

1. Good combustion practices; and

2. Emissions to not exceed of 0.0019, 0.0024 and 0.0010 lb/mmBtu for PM, PM_{10} and $PM_{2.5}$, respectively.

[107] The initial application submittal did not include these air quality analyses, which were still underway when that submittal was made.

[108] Based solely on the Top-Down BACT Process, if Cronus had not used a lower emissions rate for $PM_{2.5}$ in its air quality analyses, it would have be appropriate for the BACT limit for the boiler for $PM_{2.5}$ to also be set at 0.0024 lbs/mmBtu.

[109] As explained by USEPA in the NSR Manual:

> Once energy, environmental, and economic impacts have been considered, BACT can only be made more stringent by other considerations outside the normal scope of the BACT analysis. . . Examples include cases where BACT does not produce the degree of control stringent enough to prevent exceedances of a national ambient air quality standard or PSD increment.
>
> NSR Manual, p. B.54.

Section B.4 – BACT for the Startup Heater

The startup heater is a natural gas-fired process heater for the ammonia plant. This heater would only operate during startup of the ammonia plant. During each startup of the ammonia plant, this unit would heat a process stream (i.e., a recycle stream in the ammonia converter) until the process temperatures are high enough that this reaction total is self-sustaining. After commissioning of the facility is complete, the annual fuel usage and emissions of the Startup Heater would be limited to the equivalent of 144 hours of operation per year.[110]

NOx BACT – Startup Heater

Proposal

Cronus proposed the following as BACT:

1. Equipment design; and

2. Emissions not to exceed 0.18 lb/mmBtu.

The Illinois EPA is proposing that BACT for NOx for the startup heater be low-NOx burners designed to comply with an emission rate of 0.08 lb/mmBtu.

Step 1: Identify Available Control Technologies

The following NOx control technologies are available for the Startup Heater.

1. Selective Catalytic Reduction (SCR);

2. Selective Non-Catalytic Reduction (SNCR);

3. Low NOx Burner (LNB);

4. Flue Gas Recirculation (FGR); and

5. Low NOx Burner (LNB) and Flue Gas Recirculation (FGR).

Step 2: Eliminate Technically Infeasible Options

1. Selective Catalytic Reduction (SCR)

[110] Similar to the flares for the ammonia plant, the draft permit would allow higher emissions before the commissioning of this plant is complete. For this purpose, the annual limits on emissions would apply on a bi-monthly basis. This will accommodate the additional startups of the ammonia that will occur during shakedown. However, this would only be relevant for the BACT determination, as it is proposed to rely on the mass limits for GHG emissions.

SCR is not technically feasible for the Startup Heater.[111] This is because the technical prerequisites for SCR to be effective are not present for the Startup Heater. Since this unit would only operate during startup of the ammonia plant, it would not operate consistently at stable loads. This is necessary for SCR so that reagent is injected into the flue gas at an appropriate rate while the temperature of the flue gas and the catalyst bed is in the range for the catalytically facilitated NOx reduction reaction to take place.

2. **Selective Non-Catalytic Reduction (SNCR)**

SNCR is not technically feasible for the Startup Heater. This is because the technical prerequisites for SNCR to be effective would not be present. Most significantly, as a process heater, the Startup Heater would not include a zone in its ductwork where the flue gas would be in the temperature range for the NOx reduction reaction to take place. In addition, as is also a concern for SCR, since this unit would only operate during startup of the ammonia plant, it would not operate consistently at stable loads.

3. **Low NOx Burners (LNB)**

The use of low NOx burners (LNB) is a technically feasible control option for the Startup Heater.

4. **Flue Gas Recirculation (FGR)**

The use of Flue Gas Recirculation (FGR) is considered a technically feasible control option for the Startup Heater.

5. **Flue Gas Recirculation (FGR) and Low NOx Burners (LNB)**

Flue gas recirculation (FGR) and low NOx burners (LNB) can be used in combination to achieve greater emission reductions. The combination of FGR and LNB is also considered technically feasible for the Startup Heater.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The feasible NOx control technologies for the Startup Heater are ranked below in order of control efficiency:

1. LNB and FGR (55 to 60 percent control);

2. LNB (50 percent control); and

3. FGR (25 percent control).

---

[111] In its application, Cronus considered SCR to be technically feasible but rejected it as BACT due to excessive cost-impacts. In this regard, after commissioning of the ammonia plant is completed, the Startup Heater would operate for at most about 1.6 percent of the time. As a consequence, the cost impacts of SCR would be over 50 times greater than typical applications of SCR, where it is used on units that routinely operate over 85 percent of the time.

Step 4: Evaluate the Most Effective Controls

A further evaluation has been conducted since the most effective control, the combination of LNB and FGR, has not been selected for the startup heater. This analysis focuses on the implications of the function of this unit on the cost-effectiveness of the use of FGR. The potential NOx emissions of this unit after commissioning of the ammonia plant is complete would be only 0.60 tpy. Based on the addition of FGR providing a further 20 percent reduction in emissions, the use of FGR would at most reduce NOx emissions by 0.12 tpy. It is appropriate to expect that the use of FGR would have an annualized cost of at least $2,000/year. The resulting cost-effectiveness of use of FGR and LNB would be greater than $16,000 per ton of NOx controlled.[112] This is considered excessive. Accordingly, the next most-effective control technology for NOx, LNB, is proposed as BACT.

Step 5: Select BACT

Previous BACT determinations for NOx for similar units are listed in Table B.4. These determinations confirm that SCR, SNCR and FGR are not used on units like the Startup Heater. NOx emissions are typically controlled by low-NOx burners and good operating practices. A wide-range of NOx emission rates are specified, from as high as 0.18 lb/mmBtu to as low as 0.05 lb/mmBtu. it is appropriate to specify a rate that should be able to be reliably achieved by a modern LNB because compliance with the NOx rate that is set for the Startup Heater will not be able to be verified by emission testing. Based on the Illinois EPA's experience with LNB technology, that rate is 0.08 lb/mmBtu.[113]

Illinois EPA is proposing NOx BACT for the Startup Heater be low-NOx burners and design to meet an emission rate of 0.08 lb/mmBtu.

[112] $2,000 per year ÷ 0.12 ton NOx controlled = $16,666/ton controlled.
Since the Startup Heater must be equipped with burners, the baseline NOx emission rate for this analysis of cost-effectiveness is appropriately considered the rate reflected in the potential NOx emissions of the Startup Heater. The evaluation for average cost-effectiveness and incremental cost-effectiveness are identical.

[113] For gas-fired process heaters (and gas-fired boilers) with a rated heat input greater than 100 mmBtu/hr, the emission rate that has been set as reasonably available control technology, for emissions of NOx in Illinois' two major urban areas is 0.08 lb/mmBtu. (See 35 IAC 217.184 and 217.164). These limits were developed based upon use of low-NOx burner technology in subject units.

Table B.4: Previous BACT Determinations for NOx, CO, VOM, PM and GHG from Heaters

RBLC ID/ Permit No.	Facility	Issue Date	Process Description	Capacity (mmBtu/hr)	Pollutant	BACT Limit(s)	Control Measure(s)
Indiana: T147-32322-00062)	Ohio Valley Resources	09/25/13	Ammonia Catalyst Startup Heater	106.3	NOx	183.7 lb/mmcf, 3-hr avg. 200 hour/year	GCP Usage Limit
					CO	37.23 lb/mmcf, 3-hr avg.	
					VOM	5.5 lb/mmcf, 3-hr avg.	
					PM-PM_{10}/$PM_{2.5}$	1.9/7.6 lb/mmcf 3-hr ave	
					GHG	59.61 ton CO_2/mmcf, 3-hr ave	
IA-0106	CF Industries Nitrogen	07/12/13	Startup Heater	58.8	CO	0.0194 lb/mmBtu, 3 test	GOP + NG
					VOC	0.0014 lb/mmBtu, 3 test	
					PM/PM_{10}/$PM_{2.5}$	0.0024 lb/mmBtu, 3 test	
					GHG	CO_2: 117 lb/mmBtu CH_4: 0.0023 lb/mmBtu N_2O: 0.0006 lb/mmBtu CO_2e: 345 tpy	
IA-0105	Iowa Fertilizer Company	10/26/12	Startup Heater	110.0	NOx	0.119 lb/mmBtu, 3 teats	GCP
					CO	0.0194 lb/mmBtu, 3 test	
					VOM	0.0014 lb/mmBtu, 3 test	
					PM	0.0024 lb/mmBtu, 3 test 0.01 tpy	
					GHG	CO2: 0.117 lb/mmBtu N_2O: 0.0006 lb /mmBtu CH_4: 0.0023 lb/mmBtu; 3 tests for each CO_2e: 638 tpy, 12 mo.	
LA-0262	Cornerstone Chemical Co.	05/03/12	Stack Heater	61	NOx	10.15 lb/hr, hourly (0.17 lb/mmBtu)	Good Design
LA-0244	Sasol N.A. Inc.	11/29/10	NG Charge Heater	87.3	NOx	7.15 lb/hr (0.08 lb/mmBtu)	LNB
LA-0231	Lake Charles Cogen.	06/22/09	Methanator Startup Heater	56.9	NOx	5.58 lb/hr	Good Design & Proper Operation
					CO	4.69 lb/hr	
					PM	0.42 lb/hr	
SC-0115	GP Clarendon LP	02/10/09	Backup Oil Heater	75	NOx	3.57 lb/hr	LNB
					CO	6 lb/hr	GMPP, TuneUps Inspections
					VOM	0.39 lb/hr (0.0054 lb/mmBtu)	GCP
					PM_{10}	0.54 lb/hr	

CO and VOM BACT – Startup Heater

The heater will emit CO and VOM as products of incomplete combustion.

Proposal

Cronus proposed the following as BACT for CO and VOM:

1. Good design and combustion practices;

2. Emissions not to exceed 0.037 and 0.0054 lb/mmBtu for CO and VOM, respectively.

The Illinois EPA is proposing that BACT for CO and VOM for the Startup Heater be equipment design with use of burners designed to meet the emission rates for CO and VOM proposed by Cronus and implementation of good combustion practices.

Step 1: Identify Available Control Technologies

The following control technologies are available for the Startup Heater for CO and VOM.

1. Regenerative Thermal Oxidation;

2. Catalytic Oxidation;

3. Flaring; and

4. Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Thermal Oxidation**

Thermal oxidation has been described in the discussion of BACT for CO and VOM for the Reformer Furnace. It also is not a feasible control technology for the Startup Heater.

2. **Catalytic Oxidizers**

Catalytic oxidation has been described in the discussion of BACT for CO and VOM for the Reformer Furnace. It is also not a feasible control technology for the Startup Heater.

3. **Flare**

Flares have not been demonstrated as a control device for CO or VOM from natural gas-fired process heaters. Flaring is not technically feasible for the Startup Heater.

4. Equipment Design and Good Combustion Practices

For the Startup Heater, equipment design would address the burners in this unit. As discussed, because of the function of the Startup Heater, with infrequent operation for relatively short periods of time, emission testing will not be possible for this unit to verify compliance with applicable emission limits. However, burners that are designed to meet specified emission rates can be required. Good combustion practices will also act to reduce emissions of CO and VOM as they are products of incomplete combustion. Equipment design and good combustion practices are technically feasible for the Startup Heater.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only control technology that is technically feasible for the Startup Heater is design and good combustion practices. Given Cronus has selected the only feasible control technology, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

Because only one technology, design and good combustion practices, is feasible and is selected, further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for CO and VOM for similar emission units are listed in Table B.4, above. These determinations confirm that equipment design and good combustion practices are required as BACT for CO and VOM. The BACT determinations for startup heaters for projects in Indiana, Louisiana and South Carolina all appear to set performance requirements for CO and VOM that reflect the emission factors in the Compilation of Air Pollutant Factors at the time that the permits were issued. Only the Iowa DNR has set lower limits for two startup heaters. Those limits do not show that lower emission rates should be required for CO and VOM for the Startup Heater at the Cronus facility. This is because compliance with such lower rates by the Startup Heater will not be able to be verified by emission testing. In these circumstances, the specified performance requirements for CO and VOM should be the USEPA’s current emission factors.[114] The USEPA’s published emission factors, notwithstanding their weaknesses, are an authoritative determination of the particulate emissions of natural gas-fired combustion units like the Startup Heater. In addition, they are emission levels with which the manufacturers of burners should be familiar and compared to which they should be able to provide reliable design and performance guarantees.

The Illinois EPA is proposing BACT for CO and VOM the Startup Heater as:

[114] These circumstances are different than those of the Reformer Furnace and boiler. For those units, compliance with the CO emission limits will be verified by continuous emission monitoring. Compliance with the VOM limits will be able to confirmed by periodic emission testing.

1. Equipment design with burners designed to meet emissions rates of 0.037 and 0.0054 lb/mmBtu, for CO and VOM, respectively; and

2. Good combustion practices.

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Startup Heater

Proposal

Cronus proposed the following as BACT:

1. Design and good combustion practices; and
2. PM and PM_{10}/$PM_{2.5}$ emissions not to exceed 0.0019 and 0.0075 lb/mmBtu respectively.

The Illinois EPA is also proposing that BACT for particulate matter for the Startup Heater be equipment design, with burners designed to comply with the emission rates for particulate proposed by Cronus, and the use of good combustion practices.

Step 1: Identify Available Control Technologies

The available technologies for particulate control include the following:

1. Cyclones;
2. Wet Scrubbers;
3. Electrostatic Precipitators (ESP);
4. Fabric Filters (Baghouses); and
5. Design and Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Cyclones**

Cyclones have not been demonstrated as a control technology for particulate from natural gas-fired units like the Startup Heater. Cyclones are not a technically feasible control option for the Startup Heater.

2. **Wet Scrubbers**

Wet scrubber technology has not been demonstrated as a control for particulate from natural gas-fired units like the Startup Heater. Wet scrubbing is not a technically feasible control option for the Startup Heater.

3. **Electrostatic Precipitators**

Electrostatic precipitators have not been demonstrated as a control for particulate from natural gas-fired units like the Startup Heater As such, an ESP is not a technically feasible control option for the Startup Heater.

4. **Fabric Filter Dust Collectors (Baghouse)**

Baghouses have not been demonstrated as a control for particulate from natural gas-fired units like the Startup Heater. As such, a baghouse is not a technically feasible control option for the Startup Heater.

5. Design and Good Combustion Practices

For the Startup Heater, equipment design would address the burners in this unit. As discussed, emission testing will not be possible for this unit to verify compliance with applicable emission limits. However, burners that are designed to meet specified emission rates can be required. Good combustion practices, which focus on combustion efficiency, will also act to reduce particulate emissions as these emissions are products of incomplete combustion. Equipment design and good combustion practices are technically feasible for the Startup Heater.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only control technology that is technically feasible for the Startup Heater is a combination of equipment design and good combustion practices. A ranking is not needed.

Step 4: Evaluate the Most Effective Controls

Because only one technology, equipment design and good combustion practices, is feasible and is selected, further evaluation is not needed

Step 5: Select BACT

Previous BACT determinations for particulate for startup heaters are listed in Table B.4, above. These determinations confirm that equipment design and good combustion practices are required as BACT for particulate for startup heaters. As with CO and VOM, the BACT determinations for startup heaters for projects in Indiana, Louisiana and South Carolina all set performance requirements for particulate that reflect the emission factors for particulate in the Compilation of Air Pollutant Factors, i.e., 0.0019 and 0.0075 lbs/mmBtu for PM and/or $PM_{10}/PM_{2.5}$, respectively. Only the Iowa DNR has set a lower limit, 0.0024 lb/mmBtu, for startup heaters. Those limits do not show that this emission rate should be required for the proposed Startup Heater. This is because compliance with such lower rate by the Startup Heater will not be able to be verified by emission testing. In these circumstances, until and unless the USEPA formally establishes lower factor(s) for particulate emissions from natural gas-fired combustion units, including units like the Startup Heater, the specified emission rates should be USEPA's current emission factors.[115] The USEPA's published emission factors, notwithstanding their weaknesses, are an authoritative determination of the

[115] These circumstances are very different than those of the Reformer Furnace and boiler, for which compliance with limits for particulate will be able to be verified by emission testing.

particulate emissions of natural gas-fired combustion units. In addition, they are emission levels with which the manufacturers of burners should be able to provide reliable performance guarantees.

Accordingly, the Illinois EPA is proposing the following as BACT for particulate for the Startup Heater.

1. Equipment design, with burners designed to meet emission rates of 0.0019 and 0.0075 lb/mmBtu for PM and $PM_{10}/PM_{2.5}$ respectively; and

2. Good combustion practices.

<u>GHG BACT</u> – Startup Heater

GHG emissions, primarily CO_2, are due to the combustion of fuel by the Startup Heater.

Proposal

Cronus proposed proper design and good combustion practices.

The Illinois EPA is also proposing that BACT for GHG for the Startup Heater be design and the use of good combustion practices. In addition, to quantitatively address GHG emissions as part of BACT the Illinois EPA is proposing that the permit limit that would be set for the GHG emissions also be part of the BACT determination.

Step 1: Identify Available Control Technologies

The following GHG control technologies are available for the Startup Heater:

1. Carbon Capture and Sequestration (CCS); and

2. Design and Good Combustion Practices.

Step 2: Eliminate Technically Infeasible Options

1. **Carbon Capture and Sequestration (CCS)**

CCS would be used to capture CO_2 from the exhaust, purify, compress, and transport CO_2 to a location for sequestration or use for Enhanced Oil Recovery. The concentration of CO_2 in the exhaust stream from the Startup Heater will be dilute, similar to the concentration of CO_2 in the flue gas from other fuel combustion units at the facility. For dilute flue gas streams, CCS is a "significant and challenging technical issue that may not be readily suitable for CCS."[116] The intermittent nature of the operation of this units would add another challenging, if not intractable issue, for use of CCS. CCS is not a feasible technology for the Startup Heater.

2. **Design and Good Combustion Practices**

Design and good combustion practices will act to lower GHG emissions. Design and good combustion practices are technically feasible for the Startup Heater.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Cronus has selected all technically feasible control options for the Startup Heater, design and good combustion practices; therefore, there is no need to rank control options.

[116] Report of the Interagency Task Force on Carbon Capture and Storage, *Report of the Interagency Task Force on Carbon Capture and Storage*, August 2010.

Step 4: Evaluate the Most Effective Controls

An evaluation of technologies is not needed because only one technology, design and good combustion practices, is feasible,.

Step 5: Select BACT

Previous BACT determinations for GHG for similar emission units are listed in Table B.4. They confirm that good operating practices and good combustion practices are required as BACT. The limits set as BACT restrict units to their potential emissions of GHG, most commonly in pounds per mmBtu. As discussed, where it is necessary to address the potential emissions of a unit as part of BACT, it is considered better to address the annual emissions of the unit.

Accordingly, the Illinois EPA is proposing GHG BACT for the Startup Heater as:

1. Good operating practices and good combustion practices; and

2. GHG emissions, after commissioning of the ammonia plant, not to exceed 871 tpy, as CO_2e.

Section B.5 – BACT for the Ammonia Storage Flare

Introduction

The ammonia storage flare combusts ammonia at times when the pressure in the refrigerated pressure tanks in which ammonia is stored must be lowered to keep the pressure in the tanks within safe levels. The ammonia that is released is ducted to the ammonia storage flare, where it is combusted, resulting in emissions of NOx. In addition, NOx, CO, VOM, PM and GHG are emitted from the combustion of fuel by the pilot burner. The events that commonly lead to increased pressure in the tanks, with the need to flare ammonia, include loss of electrical power or mechanical failures of the refrigeration system for the storage tanks and sudden drops in atmospheric pressure, i.e., the ammonia storage flare is intended to control ammonia emissions during malfunction events.

As with the flares for the ammonia plant, the preferred method to reduce emissions from the ammonia storage flare is implementation of practices to reduce or eliminate events when ammonia must be flared. Add-on control technology that may be available for other types of units, such as thermal or catalytic oxidation, are not applicable to flares because an elevated process flare is not enclosed or contained. Therefore, the emissions cannot be routed to an add-on control device, and add-on controls are not utilized on flares.

NOx BACT – Ammonia Storage Flare

Proposal

Cronus proposes the following as BACT:[117]

1. Proper design and good combustion practices;

2. The use of flare minimization practices;

2. Use of pilot burner(s) designed to not exceed a NOx rate of 0.068 lb/mmBtu.[118]

4. Use of natural gas as the purge gas for the flare.

5. Hourly emission limits for NOx when ammonia is being flared.

The Illinois EPA is generally proposing that BACT for NOx for the flare include the first two elements for BACT proposed by Cronus, i.e., flaring minimization and pilot burners designed for low NOx. The specific practices to minimize flaring would be more thoroughly developed than the practices proposed by Cronus. In particular, development of a formal Flare Minimization

---

[117] Cronus also proposed that the fuel selected for the flare, natural gas, be part of BACT for the flares because it is a low-carbon fuel. However, this is part of Cronus' design for the facility. Another fuel would not be available for use in the flare.

[118] In its application, Cronus actually proposed a NOx emission rate of 0.07 lb/mmBtu. It is assumed that it intended to propose the NOx emission factor for flares in USEPA's *Compilation of Air Pollutant Emission Factors*, AP-42, which is 0.068 lb/mmBtu.

Plan is required, in addition to Root Cause Analyses for flaring incidents. This was done to ensure that these practices clearly specify the measures that must be taken to prevent unnecessary flaring.

The Illinois EPA is proposing to require that nitrogen be used as the purge gas, rather than natural gas.

To directly address NOx emissions of the flare, the Illinois EPA is proposing that the annual NOx emissions of the flare be limited rather than its hourly emissions.

Step 1: Identify Available Control Technologies

The following control technologies are available for the NOx emissions of the Ammonia Storage Flare:

1. Flare design and good combustion practices; and

2. Flaring minimization practices.

Step 2: Eliminate Technically Infeasible Options

1. Flare design and good combustion practices

Flare design and good operating practices are technically feasible for the e Ammonia Storage Flare.

2. Flaring minimization practices

Flaring minimization practices are technically feasible for the Ammonia Storage Flare.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Design and good operating practices and flare minimization practices are all required as BACT. Therefore, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

As all feasible control technologies will be required, a further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for NOx for similar emission units are listed in Table B.5, below. These determinations generally entail control of NOx by proper design and operation of the flare in conformance with its design. The circumstances are similar to those for the flares for the ammonia plant, as previously discussed. Similar conclusions are made.

Illinois EPA is proposing NOx BACT for the Ammonia Storage Flare as:

1. Flare design, including pilot burners designed to not exceed a NOx rate of 0.068 lb/mmBtu, and good operating practices.

2. Implementation of practices to minimize flaring.

3. Use of nitrogen as the purge gas for the flare.

4. An annual limit on NOx emissions of the flare that addresses the overall emissions from both flaring of ammonia and the pilot burners.

Table B.5: **BACT Determinations for the Ammonia Storage Flare**							
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Process Description**	**Capacity**	**Pollutant**	**BACT Limit**	**Control Measure**
Indiana: T147-32322-0062	Ohio Valley Resources	09/25/13	Ammonia Storage Flare	0.126 mmBtu/hr	NOx	0.068 lb/mmBtu pilot and 125 lb/hr venting	GCP/design FMP, NG, Limit Use
					CO	0.37 lb/mmBtu pilot	GCP, FMP Limit Hours
					VOM	0.0054 lb/mmBtu and 11.73 lb/hr venting	GCP/Usage Limit
					PM	PM: 0.0019 lb/mmBtu $PM_{10}/PM_{2.5}$: 0.0075 lb/mmBtu	NG, FMP Good Design
					GHG	CO_2-52.02 lb/hr	GCP & Usage Limit
IA-0106	CF Industries Nitrogen	07/12/13	Flares	Not Specified	All	-	GCP & NG
IA-0105	Iowa Fertilizer Company	10/26/12	Ammonia Flare	0.4 mmBtu/hr	NOx	No limit	GCP, Work Practice
					CO	No Limit	
					VOM	No limit	
					PM	No limit	
					GHG	No Limit	
AK-0076	Exxon, Point Thomson Production	8/20/12	Combustion Flares	35 mmcf/yr	NOx	0.068 lb/mmBtu	None
					CO	0.37 lb/mmBtu	None
					$PM_{2.5}$	0.0264 lb/mmBtu	None
					GHG	No limit	GCP
LA-0257	Sabine Pass LNG Terminal	12/06/11	Marine Flare	1590 mmBtu/hr	NOx	185.16 lb/hr	Proper Operation Monitor Flame
					CO	705.49 lb/hr	
					VOC	10.83 lb/hr	
					$PM/PM_{10}/PM_{2.5}$	14.97 lb/hr	
					GHG	CO_2e-2909 tpy	
			Wet/Dry Gas Flares	0.26 mmBtu/hr	NOx	0.03 lb/hr	Proper Operation Monitor Flame
					CO	0.11 lb/hr	
					VOC	0.01 lb/hr	
					$PM/PM_{10}/PM_{2.5}$	0.01 lb/hr	

					GHG, as CO2e	133 tpy	
LA-0213	Valero St. Charles Refinery	11/17/09	Flare 1-5	Not Specified	VOM	No limits	
ID-0217	Southeast Idaho Energy	2/10/09	Process Flare SRC21	1.5 mmBtu/hr pilot	NOx	No limits	None
					CO	No limits	None
					PM/PM_{10}	No limits	None
IA-0089	Homeland Energy Solutions	08/08/07	Startup & Shutdown Flares	25 mmBtu	NOx	0.2 lb/mmBtu	
					CO	1.1 lb/mmBtu	
					VOM	0.006 lb/mmBtu	
					PM/PM_{10}	0.0076 lb/mmBtu	

CO and VOM BACT – Ammonia Storage Flare

Proposal

Cronus proposed the following as BACT:

1. Flare design and good operating practices, including conformance with the requirements of 40 CFR 60.18(b).

2. Implementation of flare minimization practices.

3. Use of pilot burners design to not exceed CO and VOM rates of 0.37 and 0.05 lb/mmBtu, respectively.

4. Use of natural gas as the purge gas for the flare.

5. Hourly emission limits for CO and VOM when process gas is being flared.

The Illinois EPA is proposing that BACT for CO and VOM for the flare generally include the first two elements for BACT proposed by Cronus, i.e., flare design and good operating practices and flaring minimization.,

The Illinois EPA is also proposing that the pilot burner be designed to comply with a CO emission rate of 0.37 lb/mmBtu. However, a design emission rate would not be specified for VOM. This is because the CO emission rate will be sufficient to address design of the pilot burner for good combustion.

Step 1: Identify Available Control Technologies

The following control technologies have been identified for the control of CO and VOM from the Ammonia Storage Flare:

1. Flare design and good operating practices; and

2. Flaring minimization practices.

Step 2: Eliminate Technically Infeasible Options

1. **Flare design and good operating practices**

Flare design and good operating practices is technically feasible for the Ammonia Storage Flare.

2. F**laring minimization practices**

Practices to minimize flaring are technically feasible for the Ammonia Storage Flare.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Design and good operating practices and flare minimization practices are all required as BACT. Therefore, a ranking of technologies is not needed.

Step 4: Evaluate the Most Effective Controls

As all feasible control technologies will be required for the flare, a further evaluation of technologies is not needed.

Step 5: Select BACT

Previous BACT determinations for CO and VOM for similar emission units are listed in Table B.5. These determinations generally entail control of emissions by proper design and operation of the flare in conformance with its design. The circumstances are similar to those for the flares for the ammonia plant, as previously discussed. Similar conclusions are made.

Illinois EPA is proposing BACT for CO and VOM for the Ammonia Storage Flare as:

1. Flare design and good operating practices.

2. Implementation of practices to minimize flaring.

3. Pilot burner(s) designed to meet a CO emission rate of 0.37 lb/mmBtu.

4. Use of nitrogen as the purge gas for the flare.

5. Annual limits for CO and VOM emission of the flare that address the overall emissions from the flare.

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Ammonia Storage Flare

Proposal

1. Proper flare design and good operating practices, including conformance with the requirements of 40 CFR 60.18(b).

2. The use of flare minimization practices.

3. Annual limits on particulate emissions.

The Illinois EPA is generally proposing that BACT for particulate for the flare include the first three elements for BACT proposed by Cronus, as previous discussed for NOx and for CO and VOM.[119]

The Illinois EPA is also proposing that BACT technology for particulate include use of nitrogen as the purge gas.

Step 1: Identify Available Control Technologies

The available control technologies for particulate are:

1. Flare design and good operating practices; and

2. Process flaring minimization practices.

Step 2: Eliminate Technically Infeasible Options

1. D**esign and good** operating **practices**

Flare design and good operating practices are technically feasible for the Ammonia Storage Flare.

2. F**laring minimization practices**

The use of flaring minimization practices is technically feasible for the Ammonia Storage Flare.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

All technically feasible control options have been selected as BACT. A

[119] A performance specification for the pilot burners for particulate emissions is not proposed because USEPA’s current emission factors for flares (See Table 13.5-1, Compilation of Emission Factors) do not include a factor that can be used for this purpose.

ranking is not required.

Step 4: Evaluate the Most Effective Controls

As all technically feasible control options have been selected as BACT, further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for similar flares are listed in Table B.5, above. These determinations generally entail control of particulate by proper design and operation of the flare in conformance with its design. The circumstances are similar to those for the flares for the ammonia plant, as previously discussed. Similar conclusions are made.

Illinois EPA is proposing the following as BACT for particulate for Ammonia Storage Flare:

1. Proper flare design and good operating practices, including compliance with relevant provisions of USEPA's general requirement for flares, 40 CFR 60.18(b).

2. Implementation of practices to minimize flaring.

3. Use of nitrogen as the purge gas for the flare.

4. Annual limits for particulate emission of the flare that address the overall emissions from both flaring of ammonia and the pilot burner(s).

<u>GHG BACT</u> – Ammonia Storage Flare

Proposal

Cronus proposed the following as BACT:

1. Proper flare design and good operating practices, including conformance with the requirements of 40 CFR 60.18(b).

2. The use of flare minimization practices.

The Illinois EPA is also proposing that BACT for GHG for these flares be design and good operating practices and the implementation of flare minimization practices. The Illinois EPA is also proposing that BACT include a limit on annual GHG emissions.

Step 1: Identify Available Control Technologies

The following control technologies for GHG are available for the Ammonia Storage Flare:

1. Design and Good Operating Practices; and

2. Flare Minimization Practices.

Step 2: Eliminate Technically Infeasible Options

1. Design and Good Operating Practices

Flare design and good operating practices are feasible for the Ammonia Storage Flare.

2. Flare Minimization Practices (FMP)

Implementation of practices to minimize flaring is feasible for the Ammonia Storage Flare.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

All feasible control options have been selected. Therefore, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

All feasible control options have been selected as BACT so further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for GHG for similar flares are listed in Table B.5, above. A review of these determinations confirms that add-on controls are not used for flares. GHG emissions are controlled by design and good operating practices.

Illinois EPA is proposing GHG BACT for the Ammonia Storage Flare as:

1. Flare design and good operating practices, including compliance with USEPA's general requirement for flares, 40 CFR 60.18(b).

2. Implementation of practices to minimize flaring.

3. Use of nitrogen as the purge gas for the flare.

4. An annual limit for GHG emission of the flare that addresses the overall emissions from both flaring of ammonia and the pilot burners.

Section B.6 – BACT for the Urea Plant

In the urea plant, a water urea solution is produced from the reaction of liquid ammonia and gaseous CO_2 in a closed process. The urea solution produced in the urea plant initially is about 70 percent urea. Water is removed from the solution in evaporators to produce a concentrated solution.[120] This solution is then processed in the granulator to remove the remaining water and form dry granules of urea of uniform size. A small amount of an anti-caking additive, a urea-formaldehyde resin solution, is added to the urea solution fed to the granulator. This additive reacts with the urea granules to reduce caking and dust formation during subsequent handling of the granular urea product, both at the facility and by customers. The warm urea from the granulator is screened and processed in a final cooler. The particulate emissions of these units are also controlled by the two stage scrubbing system.

The granulator and associated units emit particulate, i.e., urea dust. The granulator will also emit VOM from the urea-formaldehyde resin solution that is incorporated into the urea in the granulation process. Cronus has proposed control of particulate emissions from the granulation operations with a two-stage control system consisting of an acid scrubber followed by a high-efficiency Venturi scrubber.[121] The flows of spent scrubbant are recycled back into the urea solution to recover the urea and ammonia. This scrubber system will also serve to control VOM emissions.[122]

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Urea Plant

Proposal

Cronus has proposed the following as BACT for particulate:[123]

1. Use of an acid scrubber followed by a high-efficiency Venturi scrubber.

[120] A portion of the water urea solution in the urea plant may be used for making diesel exhaust fluid (DEF) by adding more water. DEF would be stored in tanks pending shipment from the facility.
[121] Any particulate emissions from the evaporators are also controlled by this scrubbing systems.
[122] The exhaust stream from the granulator will also contain ammonia, which is not regulated under the PSD rules. The acid in the first-stage scrubber facilitates the collection of the ammonia in the exhaust for return to the urea synthesis process.
[123] For granulation operations, Cronus originally proposed that particulate emissions be limited to 0.0044 grains per dry standard cubic feet (gr/dscf), equivalent to 0.14 pounds per ton urea. However, Cronus used a lower emission rate for these operations in its air quality analyses to address the impacts of the proposed facility on $PM_{2.5}$ air quality. (The initial application submittal did not include these air quality analyses, which were still underway when that submittal was made.) This lowered Cronus' proposed BACT for $PM_{2.5}$ to the lower rate used in the air quality analyses, i.e., 0.121 lbs/ton. As already discussed, BACT can be made more stringent if necessary to protect air quality.

2. PM and PM_{10} emissions not to exceed 0.0044 grains per dry standard cubic feet (gr/dscf), equivalent to 0.14 pounds per ton of urea.

3. $PM_{2.5}$ emissions not to exceed 0.121 pounds per ton of urea.

In the draft permit, the Illinois EPA is proposing BACT for particulate to be the following:

1. A two-stage scrubbing system, as proposed by Cronus.

2. Limits of 0.14 and 0.121 lb/ton of urea, 3-hour average, for PM/PM_{10} and $PM_{2.5}$, respectively.

3. A PM limit of 0.005 gr/dscf for the scrubber system.[124]

Step 1: Identify Available Control Technologies

The available technologies include the following:

1. Wet Scrubbers;

2. Electrostatic Precipitators (ESP);

3. Fabric Filter Dust Collectors (Baghouses);

4. Acid Scrubber with Water Venturi Scrubber (High Efficiency Venturi Scrubber); and

5. Cyclone/Multiclone Separators.

Step 2: Eliminate Technically Infeasible Options

1. Wet Scrubbers

Wet scrubbers use a spray of liquid in a tower or chamber to contact particulate-laden exhaust streams and absorb particles in the liquid, either simply physically or in combination with a chemical reaction with an additive included in the scrubbant, typically either a base or acid. A wet scrubber is also capable of removing condensable particulate from a gas stream. Wet scrubbing is technically feasible for urea granulation operations.

2. Electrostatic Precipitator (ESP)

An electrostatic precipitator (ESP) uses static electrical forces to move particles entrained in an exhaust stream onto collector plates. The design inlet pollutant loadings for an ESP typically range from 0.5 - 50 gr/ft^3. ESPs can be both dry and wet. ESPs in some situations may not be particularly effective because their performance depends upon the electrical properties of the particulate that is being controlled. While ESPs have not been

[124] This limit would be rounded to a single digit to facilitate practical enforceability.

demonstrated in practice for urea granulation, ESPs, particularly wet ESPs, are considered a technically feasible control option for the urea plant.

3. **Fabric Filter Dust Collectors (Baghouses)**

A baghouse uses a fabric filter to capture particulate as the gas stream flows through the fabric. A typical design outlet concentration for a baghouse is 0.005 gr/scf. Baghouse technology depends on being able to remove collected particulate from the filter material. Baghouses are not feasible for particulate that is “sticky” or exhaust streams that are wet or contains high levels of humidity. These factors are present for the urea granulation operations. In a baghouse, the collected urea dust would become mud on the filter bags and the interior walls of the baghouse. The filter fabric would be blinded and its effectiveness destroyed. The dust removal equipment would be clogged. Moreover, the air flow through the baghouse would be greatly reduced interfering with the proper functioning of the granulation process. Fabric filter control technology has not been demonstrated in practice for urea granulators. It is not a technically feasible control option.

4. **Acid Scrubber with Water Venturi Scrubber (High-efficiency Venturi Scrubber)**

Venturi scrubbers are an advanced form of wet scrubbing that provides higher-control efficiency than a simple spray tower. They use the kinetic energy from the gas stream entering the scrubber device to atomize and disperse the liquid that is used to scrub particulate from the gas stream. In a Venturi scrubber, the inlet gas stream enters the converging section of the scrubber and, as the area decreases, gas velocity increases. The scrubbing liquid is introduced either at the throat or at the entrance to the converging section. The inlet gas, forced to move at very high velocities in the small throat section, shears the liquid, producing very small droplets. Removal of particulate and any associated gaseous pollutants occurs in the throat section as the gas stream interacts with these droplets. The gas stream then exits through the diverging section of the Venturi, where its velocity is reduced. The droplets, with collected pollutant(s) are then removed from the gas stream by a mist eliminator. High-efficiency Venturi scrubbing is a technically feasible control option for the urea plant.

5. **Cyclone/Multiclone Separators**

Cyclone/multiclones remove particulate from an air stream by application of centrifugal force tangentially to the general direction of air flow. This drives the particles to the wall of the collector where they agglomerate and then fall to the hopper at the bottom of the device due to gravity. Cyclones/multiclones are not effective in removing small particles from an air stream. This is because the mass of the particles is less, reducing the magnitude of the centrifugal force on the particles compared to the force of the air stream on the particle. While theoretically feasible, cyclone technology is would be less effective than scrubbing and will not be evaluated further.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The effectiveness of the various feasible control options is:

1. Wet Acid Scrubber and Venturi Scrubber combination (98 to 99.5 percent control);

2. Electrostatic Precipitator (98 to 99 percent control);

3. Wet Scrubber (70 to 90 percent control); and

4. Venturi Scrubber (70 to 99 percent control).

Step 4: Evaluate the Most Effective Controls

As Cronus is proposing to install the most effective particulate control, a wet acid scrubber followed by a water Venturi scrubber, an evaluation of other less effective controls is not needed.

Step 5: Select BACT

Previous BACT determinations for fertilizer granulation operations for particulate are listed in Table B.6. A review of these determinations indicates emissions from these operations are controlled by high-efficiency wet scrubbers. Cronus has proposed an appropriate control technology for particulate from these operations at the proposed facility, an acid wet scrubber followed by a Venturi scrubber. It has also proposed a stringent performance requirement for this system, a PM emission limit of 0.005 gr/scf, which is a rate that one would normally expect with control of emissions by a baghouse.

With respect to limiting particulate emissions in pounds/ton, only one of the previous BACT determinations is directly relevant, the determination made by the Iowa DNR for the urea granulator at the Iowa Fertilizer Company.[125, 126] The particulate emissions of the granulator are limited to 0.20 and 0.05 lbs/ton for PM/PM_{10} and $PM_{2.5}$, respectively. This confirms that the limit for

[125] While the Iowa DNR also made a BACT determination for particulate for a urea granulator for a project proposed by CF Industries Nitrogen, it addressed a different type of granulator. That granulator requires a natural gas fired-air heater to supply the heat for the granulation process, unlike the type of granulator proposed by Cronus.

The BACT determinations for the Pryor Chemical Plant and Agrium address granulation of materials other than urea, i.e., ammonium nitrate and urea ammonium nitrate.

The BACT determination for Southeast Idaho Energy is not considered credible. The reported BACT limit for PM in the Clearinghouse, 0.011 lb/ton, is an order of magnitude lower than any other limits, including the recent limit for Iowa Fertilizer Company set by the Iowa DNR. In addition, the facility proposed by Southeast Idaho Energy would have used coal as feedstock, rather than natural gas. The project has been abandoned.

[126] The BACT determination for Koch Nitrogen provides only some insight on the particulate emissions from urea granulation operations. This is because it only addresses filterable PM_{10} with a limit on hourly emissions. Based on the indicated production rate of the granulator, 1550 tons/day, the BACT limit of 6.6 lbs/hr is equivalent to 0.10 lbs/ton.

Accordingly, if condensable particulate makes up about 20 percent of the PM_{10} from a granulator controlled by a scrubber, the limit for Koch Nitrogen is comparable to a limit of 0.121 lbs/ton for $PM_{10}/PM_{2.5}$ (0.10 lb/ton ÷ (1.0 – 0.2) = 0.125 lbs/ton, ≈ 0.121 lbs/ton).

PM proposed by Cronus, 0.14 lbs/ton, would be a stringent limit. Further investigation indicates that the limit set by the Iowa DNR for $PM_{2.5}$ cannot be relied upon. It appears that this limit was based on an assumption about the percentage of $PM_{2.5}$ in the particulate that was made for a proposed fertilizer facility in Australia.[127] Accordingly, the limit for $PM_{2.5}$ set by the Iowa DNR does not constitute a sound basis to set a similar limit for $PM_{2.5}$ for the urea granulation operations at the Cronus facility. With control of particulate emissions by a scrubber, it is reasonable that the relative levels of PM and $PM_{10}/PM_{2.5}$ emissions from the urea granulator would be in the ratio reflected in the emission limits proposed by Cronus.

The Illinois EPA is proposing GHG BACT for the Urea Granulation Operations as:

1. Control by a two-stage scrubbing system, with a high-efficiency Venturi scrubber, to comply with a PM limit of 0.005 gr/dscf; and

2. Emissions, in total, not to exceed 0.140 and 0.121 lbs/ton of urea produced, 3-hour average, for PM and $PM_{10}/PM_{2.5}$, respectively.

---

[127] As explained by the Iowa DNR in its Response to Comments on the draft permit for Iowa Fertilizer Company, the BACT limit for $PM_{2.5}$ emissions of the urea granulator was established based on certain information indicating that $PM_{2.5}$ constitutes 25 percent of the particulate from these operations. The actual information was contained in a report for the Collie Urea Project in Western Australia, *Perdaman Chemical and Fertilisers: Report for Collie Urea Project – Air Quality Assessment*, November 2009, prepared by GHD. On page 18 of that report, the authors clearly state that they simply assumed that 25 percent of the particulate emissions from the granulator would be $PM_{2.5}$, "The assumption has been made that 25% of the urea particles are $PM_{2.5}$."

It is also noteworthy that the particulate emissions of the granulators at the Collie Urea Project, as addressed in the cited report, were based on a design emission rate of 50 mg/m^3, equivalent to about 0.022 gr/scf. As such, the assumption for that project that $PM_{2.5}$ would constitute 25 percent of the particulate from the granulators actually reflected an assumption that the $PM_{2.5}$ emission rate would be 0.0055 gr/scf. This $PM_{2.5}$ emission rate is higher than the performance specification for the scrubber on the granulator at the Cronus facility in terms of PM.

Table B.6: **BACT Determinations for Fertilizer Granulators for Particulate**					
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Capacity tons/day**	**BACT Limit**	**Control Measures**
IA-0105	Iowa Fertilizer Company	10/26/12	1500 Metric	PM/PM_{10}: 0.10 kg/MT; 3 tests $PM_{2.5}$: 0.025 kg/MT; 3 tests	Wet Scrubber
IA-0106	CF Industries Nitrogen	7/12/12	176.46 tph urea (4235 tpd)	PM/PM_{10}: 0.11 **lb/ton,** 3 tests $PM_{2.5}$: 0.108 lb/ton, 3 tests	Wet Scrubber + granulator Air Heater + LP Offgas Absorber
OK-0135	Pryor Chemical Plant	2/23/09	16.7 tph Dry Ammonium Nitrate; Granulator Scrubbers 1 - 3	PM/PM_{10}: 0.7 lb/hr	GOP
ID-0017	Southeast Idaho Energy	2/10/09	1800	PM: 0.011 lb/ton PM_{10}: 0.005 lb/ton	Wet Scrubber as process equipment 98% capture & recycling
WA-0318	Agrium US Inc.	7/11/08	525 (urea ammonium nitrate)	PM: 0.0960 g/dscf; 24-hour avg.	Wet Scrubber Continuous Addition of Product Hardener 99.7%
OK-0124	Koch Nitrogen Co.	5/1/08	1550	Filt. PM_{10}: 6.60 lbs/hr 90% efficiency	Wet Scrubber

<u>VOM BACT</u> – Urea Plant

A small amount of an anti-caking additive, a urea-formaldehyde resin solution, is introduced in the urea granulator from the urea-formaldehyde storage tank. This additive reacts with the urea granules becoming a constituent of the finished urea product. Its presence acts to reduce caking and dust formation during subsequent handling of the granular urea product, both at the facility and by customers. When urea is applied to farm fields, it also slows the release of the nitrogen in the soil to enhance the effectiveness of urea as a fertilizer. The use of this material in the urea granulator leads to emissions of formaldehyde and methanol. However these materials are soluble in water. After the scrubber, there should only be trace levels of VOM emissions in the exhaust from the granulator stack (approximately 0.1 ppm formaldehyde and approximately 0.015 ppm methanol).

Proposal

Cronus proposed an hourly limit on VOM emissions, 0.36 lb/hr, as BACT for VOM emissions from the urea granulator.[128]

The Illinois EPA is also proposing that BACT for VOM from the Urea Granulator be a limit of 0.36 lb/hr.

Step 1: Identify Available Control Technologies

The following VOM control technologies are available for the granulator in addition to the scrubbers that would be used for control of particulate:

1. Thermal Oxidation.

2. Catalytic Oxidation.

3. Flaring.

4. Use of an alternative material.

Step 2: Eliminate Technically Infeasible Options

1 & 2. Thermal and catalytic oxidation

[128] Cronus also proposed that the "product specifications" for urea be an element of BACT for VOM emissions from the urea granulator. However, meeting the product specifications for urea in an essential aspect of Cronus' objectives for the proposed facility. As such, it does not reflect a "lower emitting process or practice" as is appropriate for consideration when evaluating BACT for VOM for the granulator.
Likewise, Cronus suggested that BACT could include a limit for the use of urea formaldehyde solution. However most of this material is incorporated into the urea product. The remaining VOM emissions are controlled by the scrubber system. These further factors that affect VOM emissions would not be considered if a limit were simply placed on the usage of this material. Accordingly, it is not appropriate for BACT to include such a limit.

Thermal and catalytic oxidation are not feasible for control of VOM emissions from the granulator for the same reasons as they are not feasible for VOM emissions from the CO_2 Vent, namely, the low concentration of VOM in the exhaust. (See also the discussion in Section B.1b.)

2. Flares

For flaring to be feasible, exhaust streams must have a heating value approaching 300 Btu/scf. The exhaust from the urea granulator will not have any heating value. Thus, flaring is not feasible. (See also the discussion in Section B.1b.)

3. Use of Alternative Materials

The urea formaldehyde resin solution is an essential aspect of the production of granulated urea. The properties of this material are such that it becomes a constituent of the finished urea product, not only reducing dusting but also slowing the release of nitrogen from urea when it is applied. There is not an alternative material to replace this material, so an alternative material is not feasible.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only remaining feasible technology (product specification) is available for consideration as BACT. Therefore, no ranking is necessary.

Step 4: Evaluate the Most Effective Controls

The only remaining feasible technology (product specification) is available for consideration as BACT. Therefore, no further evaluation is necessary.

Step 5: Select BACT

The Clearinghouse did not include previous BACT determinations for VOM emissions from urea granulators. However, information on VOM emissions was available for the urea granulator at the proposed CF Industries' facility in Iowa. The BACT rate for VOM for that urea granulator is 0.05 pound per ton of urea, with usage of urea-formaldehyde resin related to meeting product specifications.

The BACT limit proposed by Cronus, 0.36 lb/hr, as achieved with use of a scrubber system to comply with the applicable limits for particulate, is a fraction of VOM BACT rate for CF Industries. It is equivalent to less than 0.002 pounds per ton of urea. Given, the low level of VOM in the exhaust, the Illinois EPA is proposing that BACT for VOM from the proposed urea granulator be set at the potential emission rate provided by Cronus. This rate reflects a VOM emissions rate that is consistent with compliance with the applicable particulate limits, as well as meeting specifications for the granulated urea that is being produced.

Section B.7 – BACT for the Cooling Tower

As a new facility, the facility would be designed to be a thermally efficient plant, taking advantage of improvements that have occurred in process design and equipment. The facility would productively use the thermal energy in hot process streams to heat other process streams using heat exchangers and to generate steam for use at the facility using waste heat boilers. The heating of those other streams with the hot streams serves to cool the hot streams as heat is transferred to the cooler stream.[129] However, certain streams must be cooled to levels that are below those that are practical to achieve with process heat recovery. The further cooling of these streams will be provided by cooling systems that are served by water from a central cooling tower.

A multi-cell cooling tower will supply the cooling water needed by various units in the urea and ammonia plants. The cooling tower emits particulate from mineral material present in the water supply. This material is emitted with water droplets that escape from the cooling tower or completely evaporate. These particulate emissions will be controlled by drift eliminators, which collect water droplets entrained in the air that is blown through the tower.

PM BACT – Cooling Tower

Proposal

Cronus proposed the following as BACT for particulate emissions of the cooling tower:

1. The use of high efficiency drift eliminators with a maximum drift rate of 0.0005 percent; and

2. The total dissolved solids (TDS) content of the cooling tower water not to exceed 2,000 mg/l.

Illinois EPA is proposing that BACT for particulate for the cooling tower be high efficiency drift eliminators with a water quality management system for managing total dissolved solids (TDS).

Step 1: Identify Available Control Technologies

The following control technologies are available for particulate emissions from a cooling tower:

1. Use of a dry air cooling tower;
2. Use of a hybrid cooling tower (combination of wet and dry cooling);
3. Use of once-through cooling; and

[129] Expressed conversely, certain process or feedwater streams that will be present at the facility that are cool and need to be heated to a higher temperature will be used to cool process streams that are at elevated temperatures and need to be cooled.

4. Use of a wet cooling tower with mist eliminators and management of water quality (the total dissolved solids content of the water).

Step 2: Eliminate Technically Infeasible Options

1. Wet cooling tower with mist eliminators and management of water quality (total dissolved solids content)

In a wet cooling tower, cooling is achieved by the evaporation of water in the tower. Wet cooling towers are the most common type of cooling tower used by industrial sources. A wet cooling tower emits particulate matter ($PM/PM_{10}/PM_{2.5}$) emissions from the small amount of water mist that is entrained with the cooling air as "drift". The cooling water contains small amounts of dissolved solids which become airborne particulate matter emissions (as the water is circulated and cooled through the device). The dissolved solids contained in the water mist remain in the circulated cooling water and form scale or increase the total dissolved solids (TDS). To manage this process, operators remove water from the system (blowdown) and replace it with makeup water to maintain a desired TDS concentration and a constant volume of recirculated water.[130] The proper management of the TDS concentration of the recirculation water is a technically feasible control method. Furthermore, drift eliminators contain packing which is used to limit the amount of this particulate matter which becomes airborne during the cooling process. As mist passes through the packing, the particles in the air contact and adhere to the surface of the packing. As condensed water flows down this packing, these particles are removed. The use of a high-efficiency drift eliminator is a technically feasible control option for the Cooling Tower.

2. Dry cooling towers

Dry cooling towers do not have any direct particulate emissions. They provide very high control effectiveness for particulate. Since dry cooling can be considered a lower emitting process alternative to wet cooling, it is common to evaluate dry cooling as part of the BACT analysis for any portions of a proposed plant that are intended to use wet cooling.

Dry cooling systems can have two designs: direct and indirect. Direct dry cooling systems use air to directly condense steam, whereas indirect dry systems use a closed loop water system to condense steam and the resulting heated water is then air cooled. Dry cooling systems transfer heat to the atmosphere without significant loss of water. Dry cooling systems tend to have a larger physical footprint than wet systems. Dry cooling systems are also more meteorologically sensitive than wet cooling systems given that as the difference between the temperature of the heat transfer fluid (water) and the dry bulb air temperature decreases, cooling efficiency decreases. Thus, while technically feasible, they become less effective and reliable in warmer climates like Illinois (at least on a seasonal basis).[131]

[130] The blowdown process is automated and the system normally contains a conductivity sensor and a solenoid valve to automatically remove water from the system.

[131] In the event of a meteorological period when the differential between the transfer media temperature and the dry bulb air temperature becomes zero, a plant relying on dry cooling would be required to reduce plant capacity to minimize cooling needs.

3. Once-through cooling

A variant of a wet cooling tower is once-through cooling. Once-through cooling is essentially a wet cooling tower that uses water from a nearby land or river once for cooling purposes, and then that water is returned to the lake or river after a single use for cooling. The proposed facility location does not have access to any large water body or free-flowing water source that would make once-through cooling a viable option; therefore, this technology is technically infeasible.

4. Hybrid cooling tower (combination of wet and dry cooling)

Another cooling process considered was a hybrid system. Technically feasible, a hybrid system is a combination of wet and dry cooling systems based on seasonality. Ultimately, a hybrid system may have the same limitations as a dry system in warm weather.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

1. Dry cooling system (100 percent removal – no particulate emissions);
2. Hybrid cooling system – combined dry and wet systems (85 percent removal above wet cooling system)[132]; and
3. Wet cooling tower with mist eliminators and water quality management (total dissolved solids) (base case).

Step 4: Evaluate the Most Effective Controls

With the base case (wet cooling tower option, equipped with drift eliminators and a TDS management plan), Cronus anticipates emissions of 4.42 tons/year.

The dry cooling system will have additional capital and operating costs in relation to the wet cooling system.[133] Economically, these costs would be infeasible, with a cost per ton removal rate of nearly $30,000 per ton of particulate removed.[134] Other environmental considerations of dry cooling

---

[132] For additional clarity, 85% reduction for the hybrid cooling system was calculated as follows: 100% reduction in emissions (no water usage) for 6 months, 90% reduction in emissions for 3 months, and 50% emissions reductions for the remaining 3 months.

[133] Capital costs for a dry cooling system are approximately twice that of a wet cooling system (per the 160,000 gallon/minute circulating rate wet cooling system as proposed by Cronus). Reference: http://water.epa.gov/lawsregs/lawsguidance/cwa/316b/upload/2008_06_10_316b_meetings_symposium_bekdash.pdf. Annual operating costs for a dry cooling system are approximately four times that of a wet cooling system, and somewhat less than a hybrid system. Reference: Evaluating the Economics of Alternative Cooling Technologies, Power Engineering, November 1, 2012. (http://www.power-eng.com/articles/print/volume-116/issue-11/features/evaluat-economics-alternative-cool-technologies.html)

[134] Assuming a capital cost of a wet cooling system of $8,000,000, the equivalent capital cost of a dry cooling system or a hybrid cooling system would be $16,000,000, resulting in an annualized capital cost of $2,600,000 (10 year cost recovery at 10%). Annual operating costs for the dry cooling system are estimated at a 50% of this annualized capital cost ($1,300,000). Total operating costs of a dry system would be approximately $3,900,000. Reference:

systems include increasing third-party supplied energy requirements (for moving large volumes of air), and increasing regional CO_2 secondary emissions.

Capital and operating costs of a hybrid system may be higher than those of a dry cooling system design based on the engineering optimization of a hybrid system with parallel wet and dry stream condensing loops introducing additional cooling system complexities. This increased operating cost, in addition to the reduction in overall PM removal efficiency of a hybrid system compared to a dry cooling technology, would yield a comparable if not higher cost per ton removed for the hybrid cooling technology. The hybrid system is thus no longer considered due to excessive economic cost.

Step 5: Select BACT

This analysis for the cooling tower concludes that high efficiency drift eliminators (design drift rate of 0.0005%) with a water quality management system for managing TDS represents BACT for particulate.

Previous BACT determinations for cooling towers for particulate are listed in Table B.7. These determinations show use of high-efficiency drift eliminators to reduce particulate, with drift loss rates ranging from 0.003% to 0.0005%. A design drift rate of 0.0005% appears in the most recent permit determinations and it represents the best performing control measure. The TDS concentration in the recirculated cooling tower water is listed in a handful of permits and can range from a low of 1,000 ppm (mg/l) up to 5,000 mg/l (IA-0017). The majority of permits do not list a TDS limit.

These determinations clearly indicate the use of high efficiency drift eliminators with a maximum drift rate of 0.0005% as BACT for cooling towers. Meanwhile, the Clearinghouse indicates BACT determinations for TDS range from 1,000 ppm (1,000 mg/l) to 2,000 ppm (2,000 mg/l). The two lowest BACT entries in terms of TDS are all from the same facility and use the same water source. The most recent cooling water BACT related to the proposed Cronus facility with a TDS limit was in Indiana for Ohio Valley Resources, LLC, for which Indiana DEM set a limit for TDS concentration of 2,000 mg/L.

As described above, the operation of the wet cooling tower system is based on the evaporation of water to cool a process stream. As water evaporates, the TDS concentration of the water will increase, because the dissolved solids remain behind in the cooling water. The cooling tower requires additional water (makeup water) to keep the total volume of cooling water constant and to limit the TDS contained in the cooling water. These systems typically recycle water five to seven times before it is removed from the system. In the Cronus facility, this recycle rate will result in an estimated TDS concentration that ranges from 1,500 to 2,000 mg/l. The three lowest entries in Table B.7 do not directly correspond to the cooling tower at Cronus,

---

http://water.epa.gov/lawsregs/lawsguidance/cwa/316b/phase1/upload/2009_04_02_316b_phase1_technical_ch2.pdf.

Using the methodology for determining the emissions from cooling towers in USEPA's Compilation of Air Pollutant Emission Factors, AP-42, the PM emission rate of a standard wet cooling tower with a recirculating flow of 160,000 gpm at 2000 ppm TDS would be 133 tpy (AP42, Table 13.4-1). The resulting cost of PM removed from a dry cooling system is $29,300 per ton.

either by size or by type of source.[135]

As such, the Illinois EPA is proposing that BACT for particulate for the cooling tower be a high efficiency drift eliminator with a design drift rate of no more than 0.0005% and implementation of a water quality management system for TDS, with a TDS limit of 2,000 ppm (2,000 mg/l).

[135] The cooling towers at the Nucor facility are much smaller and will use less water. The project proposed by Indiana Gasification has not proceeded so the limit for its cooling tower, 1,500 mg/l, has not been put into practice. For that cooling tower, Indiana Gasification planned to use water from the Ohio River while Cronus plans to use treated effluent from the Champaign/Urbana Sanitary District.

Table B.7: **BACT Determinations for Cooling Towers for Particulate**

RBLC ID/ Permit No.	Facility	Issue Date	Description	Capacity	BACT Limit	Control Measures
Indiana: T147-32322-00062	Ohio Valley Resources	09/25/13	Cooling Towers	179720 gpm combined	0.0005% drift 2000 mg/l TDS	High Efficiency Drift Eliminators
LA-0248	Nucor Direct Reduction Plant	01/27/11	Cooling Tower DRI-113/213	26857 gpm each	0.0005% drift <1000 mg/l TDS	Drift Eliminators
			Cooling Tower DRI-114/214	17611 gpm each	0.0005% drift 1000 mg/l TDS	Drift Eliminators
IA-0105	Iowa Fertilizer	10/26/12	Cooling Tower	-	0.0005% drift	Drift Eliminator
IA-0106	CF Industries Nitrogen	7/12/12	Cooling Tower	-	$PM/PM_{10}/PM_{2.5}$: 0.0005% drift	Drift Eliminator
					VOM: no numerical limit	Limit on VOC in chemicals
Indiana: T147-30464-00060	Indiana Gasification	6/27/12	ASU & Main Cooling Tower	A: 55000 gpm B: 405000 gpm	0.0005% drift 1500 mg/l TDS	High Efficiency Drift Eliminators
LA-0254	Ninemile Point Electric	8/16/11	Unit 6 Cooling Tower	115847 gpm	$PM/PM_{10}/PM_{2.5}$: 0.0005% drift, annual avg.	High Efficiency Drift Eliminators

Section B.8 – BACT for Equipment Components

Certain piping and equipment at the facility have components, including valves, flanges, and other connectors, pump seals, compressor seals, and pressure relief valves, that can handle fluid streams containing VOM, methane or CO_2 and have the potential to emit VOM, methane or CO_2 when they leak.

More specifically, three types of streams are present that contain or potentially contain VOM, methane or CO_2: 1) Components that handle off-gases from the ammonia plant that are transported to the reformer for use as fuel, 2) Components that handle process gases from the ammonia plant that are flared, and 3) Components that handle natural gas.[136] Additionally, two other types of streams are present that contain or potentially contain only VOM: 1) Components that handle the CO_2 absorption solvent (aMDEA) used in the ammonia plant, and 2) Components that handle the urea-formaldehyde resin solution used in the urea plant. Finally, the duct from the CO_2 regenerator to the urea plant will handle a stream that will essentially only contain CO_2.

Depending upon their service, these equipment components will have the potential for emissions of VOM, CO_2 and methane due to leaks, and thus are subject to a BACT evaluation.

VOM BACT – Equipment Components

Proposal

For the equipment components, Cronus proposed that BACT for VOM would be establishment of a Leak Detection and Repair (LDAR) program (as per specifications at 40 CFR part 60, Subpart VVa).

The Illinois EPA is proposing LDAR as BACT for VOM from equipment components. In addition, for the pumps and valves that handle the urea-formaldehyde resin solution, the Illinois EPA is proposing to require use of "leakless" equipment.

Step 1 – Identify Available Control Technologies

Emissions of VOM from equipment components may be controlled with the following available technologies:

1. "Leakless" equipment components (essentially low-leak valves and pumps);
2. Capture and ducting of releases and leaks from pressure relief valves to a control device;
3. Instrumental LDAR program;
4. An implementation of a non-instrumental LDAR program using sound, sight and smell to identify leaks; and
5. Good work practices.

[136] While not addressed by the applicant in the application materials, these two streams may also include a trivial amount of VOM (residual VOM not removed in the regenerator system when using off-gas as fuel, and residual VOM in process gas during startup, shutdown, and upsets).

Step 2 – Eliminate Technically Infeasible Options

1. Leak Detection and Repair (LDAR) Program

LDAR programs act to reduce VOM emissions due to leaks from equipment components. LDAR programs have been traditionally developed for control of VOM emissions. LDAR programs can vary in stringency as needed for control of VOM emissions. Elements for all LDAR programs include: identification of components to be included in the program, conducting routine and regularly scheduled inspection and work practice requirements (with a defined schedule for repair of leaking components), and recordkeeping of the monitoring results. A LDAR program is technically feasible.

2. "Leakless" Equipment Components

Emissions from equipment components, especially pumps and valves, can be further reduced through the use of "leakless" valves and "sealless" pumps. Common leakless valves include bellow valves and diaphragm valves, and common sealless pumps are diaphragm pumps, canned motor pumps and magnetic drive pumps. Leaks from pumps can also be reduced by using dual seals with or without barrier fluids. Leakless valves and sealless pumps are effective at further minimizing leaks (beyond that of a traditional LDAR program), but their use may be limited by materials of construction consideration and process operating conditions.[137] Leakless connectors would involve using of welded connections. Failure of leakless technology may result in temporarily higher emissions than conventional components.[138] "Leakless" valves and pumps are technically feasible. The use of leakless connectors is only feasible if it does not interfere with the safe and efficient repair or maintenance of process equipment or other equipment components.

3. Good Work Practices.

Good work practices for components are the practices that a source would implement in the absence of any legal requirements related to control of emissions for its own purposes, such as worker safety, equipment maintenance or general housekeeping. Good work practices serve to reduce VOM emissions due to leaks from equipment components.

4. Implementation of a Non-instrumental LDAR Program Using Sound, Sight and Smell to Identify Leaks

Detection of leaks by sight is problematic for components for which only gaseous material would be leaking. Detection of leaks by smell is not possible for components that handle streams that are odorless. The option of a non-instrumental LDAR program relying on sight or smell for leaks from certain types of equipment components and components handling certain streams

[137] Elevated service temperatures may have a negative effect on leakless components. For example, the tensile strength of bellow valves is degraded at higher process temperatures, which reduces the component life-cycle between maintenance events.
[138] *Analysis of Emission Reduction Techniques for Equipment Leaks*, Memorandum from C. Hancy, RTI International, to Jodi Howard, USEPA. December 21, 2011, pp. 6-7.

is not technically feasible.

5. **Capture and Ducting of Releases and Leaks from Pressure Relief Valves**

Capture and ducting of releases and leaks from all pressure relief valves (PRV) to a control device is technically infeasible given the number, location, and configuration of pressure relief valves at the proposed facility.[139] This option is not technically feasible.

Step 3 – Rank the Remaining Control Technologies by Control Effectiveness

The ranking of the feasible technologies for the control of VOM from equipment components, expressed in terms of VOM control efficiency, are as follows:

1. "Leakless" equipment components (up to 100 percent control);
2. LDAR program (approximately 50 percent control); and
3. Good work practices (< 50 percent control).

Step 4 – Evaluate the Most Effective Controls and Document the Results

Cronus selected LDAR as the proposed control option, and it is therefore considered the base control case. Since the nature of good work practices is such that they would be implemented in any case, they have not been further evaluated.

"Leakless" equipment components have generally been demonstrated by USEPA to be cost prohibitive.[140,141] Cronus has also provided cost information that concluded economic infeasibility, (i.e., an average control cost analysis for installing leakless equipment components had a cost of over $130,000 per ton

---

[139] Process gas during startup, shutdown, and upsets of the ammonia plant will be directed to the ammonia plant flare, and therefore minimize the opportunity for a release from the pressure relief valves.

[140] National Emission Standards for Hazardous Air Pollutants for Organic Hazardous Air Pollutants From the Synthetic Organic Chemical Manufacturing Industry, proposed rule, amendments (71 FR 34434, June 14, 2006): "For leaking valves in gas/vapor service and in light liquid service, the possible additional control measures available to reduce HAP emissions are to either lower the leak definition, replace valves with leakless valves, or conduct more frequent monitoring by reducing the allowable percentage of leaking valves. We evaluated requiring replacement of existing valves in gas/vapor service and in light liquid service with leakless valves. However, we concluded that this method of control is not appropriate because it is extremely expensive."

[141] National Emission Standards for Hazardous Air Pollutant Emissions: Group IV Polymers and Resins; Pesticide Active Ingredient Production; and Polyether Polyols Production (79 FR 17340, March 27, 2014) "Costs for leak-less valves were previously estimated for the synthetic organic chemical manufacturing industry (SOCMI). Using these estimates, we analyzed the costs associated with requiring leak-less valve technology for each of these source categories. Annual costs per source category ranged from $1.3 million/yr to $30.1 million/yr per facility for each of the source categories, with total capital investments ranging from $9.2 million to $220 million. Emission reductions were assumed to be 100 percent and ranged from 5.2 to 123.4 tpy of HAP per source category, resulting in a cost effectiveness of $244,000/ton HAP. We do not consider this cost effectiveness to be reasonable and, as a result, do not consider leak-less valves to be economically feasible."

of VOM emissions avoided). Illinois EPA concurs that "leakless" equipment components are economically infeasible with one notable exception.

The pumps and valves that handle the urea-formaldehyde resin solution for the urea plant are aptly suited for application of the "leakless" technology. This is because of their small size and their operating conditions, near ambient temperature avoiding the negative effect of elevated temperatures. Second, the stream contains a hazardous air pollutant, formaldehyde.

Step 5 – Select BACT

A LDAR program represents BACT for VOM from equipment components that handle off-gases from the ammonia plant, components that handle process gases from the ammonia plant, components that handle natural gas, components that handle the CO_2 absorption solvent (aMDEA) used in the ammonia plant, and components that handle the urea-formaldehyde resin solution used in the urea plant. In addition, valves that handle the urea-formaldehyde resin solution must be of "leakless" design.

Previous BACT determinations for similar operations are listed in Table B.8, below. These determinations indicate that VOM emissions from equipment components in VOM service are controlled through use of LDAR programs. For components at the proposed facility, the referenced LDAR program per the BACT determination for VOM from equipment components is generally proposed to be the appropriate provisions of the NSPS for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006, 40 CFR 60 Subpart VVa.[142, 143]

---

[142] The USEPA uses the term "volatile organic compounds" or VOC to describe the pollutant that is regulated in Illinois as volatile organic material or VOM.

[143] While the NSPS BACT "floor" would suggest that an equipment component is in VOC service if it contains a gas stream that contains or contacts a process fluid that is at least 10 percent VOC by weight (40 CFR 60.481a), the Illinois EPA has proposed a more stringent criterion as part of the BACT determination that equipment components are in VOM service if they contain a gas stream of more than 1 percent VOM by weight.

GHG (Methane and CO_2) BACT – Equipment Components

Proposal

For equipment components for GHG (methane and CO_2) Cronus proposed that BACT would be an LDAR program.

As noted above, the Illinois EPA is proposing LDAR as BACT for VOM from equipment components that handle off-gases from the ammonia plant and components that handle process gases from the ammonia plant. GHG, in the form of methane and CO_2, may also be present in these streams. The LDAR program established for VOM from these two streams will be equally effective in reducing emissions of GHG (methane and CO_2), and thus represents BACT for GHG as well. This LDAR will also be expanded to address components at the facility that handle natural gas.

For the ductwork for the CO_2 stream from the regenerator to the urea plant, which would essentially contain only CO_2, the Illinois EPA is proposing that an approach to leaks similar to that developed by USEPA for valves and connectors in heavy liquid service, NSPS, 40 CFR 60.482-8a be followed as BACT. These provisions would require timely repair of leaks in these components if identified by sound or any other detection method.

Step 1 – Identify Available Control Technologies

Emissions of GHG (methane and CO_2) can be controlled using the same techniques as previously identified for equipment components for VOM if methane or VOM are present in the stream. For components that would handle streams that would only contain trace levels of VOM or methane, leaks can be addressed using the approach developed by USEPA for the leaks from valves and connectors in heavy liquid service, which includes use of sound or other indicator to identify a possible leak.

Step 2 – Eliminate Technically Infeasible Options

The same technical feasibility discussion for equipment components is valid for GHG (methane and CO_2) as previously identified for VOM.[144] In particular, detection by sight is problematic for GHG (CO_2 and methane) because they are gases. Detection by smell is not possible for GHG (CO_2 and methane) as they are odorless. Accordingly, the option of a non-instrumental LDAR program relying on sight or smell for leaks from equipment components is technically infeasible.

Step 3 – Rank the Remaining Control Technologies by Control Effectiveness

The same ranking of control technologies by control effectiveness for equipment components is valid for GHG (methane and CO_2) as previously

[144] The elevated temperatures of both the off-gas and process-gas streams (from the CO shift converters, the methanation process, and the ammonia synthesis loop) may call into question the technical feasibility of the use of “leakless” equipment components.

identified for VOM. In addition, for components in the ductwork from the regenerator to the urea plant that handle a stream that essentially only contains CO_2, LDAR based on an instrumental method to detect leaks is not proposed because a suitable instrumental methodology has not been identified. Accordingly, provisions derived from the NSPS, 40 CFR 60.482-8a, are proposed as BACT.[145]

Step 4 – Evaluate the Most Effective Controls and Document the Results

A similar evaluation for the most effective controls for equipment components is generally valid for GHG (methane and CO_2) as previously identified for VOM.[146] In this case, Illinois EPA concludes that "leakless" components are economically infeasible to control GHG emissions (methane and CO_2) from any equipment components.

Step 5 – Select BACT

The Illinois EPA is proposing an LDAR program as BACT for GHG (methane and CO_2) from equipment components that handle off-gases from the ammonia plant and components that handle process gases from the ammonia plant.[147]

Previous BACT determinations for similar operations are listed in Table B.8, below. These determinations indicate that GHG emissions from equipment components at facilities that handle natural gas (methane) are controlled through the use of a LDAR program. For other facilities, the LDAR programs generally focus on VOM.

For components at the proposed Cronus facility, the referenced LDAR program per the BACT determination for GHG from equipment components is generally proposed to be the equivalent provisions of the NSPS for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006, 40 CFR 60 Subpart VVa. For components that handle a stream that essentially only contains CO_2, provisions derived from this NSPS, 40 CFR 60.482-8a, are proposed as BACT.

[145] These provisions would incorporate use of an instrumental LDAR program to verify the presence of a leak when such a methodology is identified and approved by the Illinois EPA.
[146] Cronus provided an cost-effectiveness analysis showing that the cost-effectiveness would be more than $3,500 per ton of GHG controlled.
[147] Illinois EPA has proposed in the draft permit that an equipment component is in "methane service" if it contains a gas stream that contains 5 percent methane by weight and a leak shall be a methane concentration of 2000 ppm or more.

Table B.8: Previous BACT Determinations for **Components for VOM and GHG**					
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Process Description**	**BACT Limit**	**Control Measure**
Indiana: T147-32322-00062	Ohio Valley Resources	9/25/13	Fugitive VOC	None	LDAR Program
			Fugitive GHG	None	None
IA-0106	CF Industries Nitrogen	7/12/13	Fugitive VOC	1.1 tpy; 12 month	Leak Detection and Repair (LDAR) Monitoring System
FL-0330	Port Dolphin Energy	12/01/11	Fugitive GHG	No numerical limits	Gas and Leak Detection System
LA-0263	Phillips 66 Alliance Refinery	07/25/12	Fugitives (Hydrogen Plant)	No numerical limits	LDAR Monitor Total HC (rather than VOC)
LA-0257	Sabine Pass LNG Terminal	12/06/11	Fugitive Emissions	CO_2e: 89,629 tpy	LDAR Program
				VOC: 5.03 lb/hr; 17.21 tpy	Mechanical seals or equivalent for pumps and compressors that serve VOC with vapor pressure of 1.5 psia and above
FL-0322	Southeast Renewable Fuels	12/23/10	Fugitive VOC	VOC: 6.52 tpy	Monthly LDAR Program, VVa
LA-0245	Valero Refining Hydrogen Plant	12/15/10	Process Fugitives	VOC: 23.74 tpy	LDAR = LA Refinery MACT w/ Consent Decree Enhancements
TX-0575	Sabina Petrochemicals	08/20/10	Process Fugitives (Olefins process)	VOC: 9.01 tpy	LDAR 98% = LAER
FL-0318	Highlands Ethanol	12/10/09	VOC Equipment Leaks	VOC: 19.6 tpy	LDAR Program, VVa
LA-0197	Alliance Refinery	07/21/09	Unit Fugitives (Ethanol Process)	VOC: 13.22 lb/hr 57.89 tpy	LDAR = LA Refinery MACT
Indiana: T147-30464-00060	Indiana Gasification	06/27/12	Fugitive GHG	No numerical limits	LDAR audio/video inspection of compressors

Section B.9 – BACT for Particulate from Handling of Urea Product

The finished urea product from the urea plant is transferred to storage, reclaimed and then loaded out by truck or rail. Emissions of particulate matter from these operations are controlled by enclosure and work practices and by a fabric filter or baghouse to collect dust that is generated.

Proposal

For these units, Cronus proposed that BACT would be:

1. Control by a baghouse, and

2. Emissions of PM from the baghouse not to exceed 0.005 gr/dscf.

The Illinois EPA is also proposing these measures as BACT for particulate. In addition, the Illinois EPA is proposing enclosure and work practices such that there are no visible emissions of particulate from these units.

Step 1 – Identify Available Control Technologies

Emissions of particulate are generally controlled with add-on control equipment. The available technologies include the following:[148]

1. Enclosure and work practices;

2. Wet Scrubbers;

3. Electrostatic Precipitators (ESP); and

4. Fabric Filtration (Baghouses).

Step 2 – Eliminate Technically Infeasible Options

1. Enclosure and Work Practices

Enclosure and work practices are generally appropriate to reduce emissions from handling of urea product. Work practices and/or enclosure are essential for effective control of particulate emissions from handling bulk materials. These measures can act to prevent or reduce the generation of emissions. These measures can also serve to prevent particulate from being emitted directly to the atmosphere and instead being directed to add-on devices for control. Enclosure and work practices are technically feasible for the handling of urea product.

[148] Cyclones have not been included in the list of available control technologies for these operations. This technology, which has already been described in the BACT discussion for the Reformer Furnace, would clearly be much less effective in controlling emissions than the baghouse technology that has been proposed by Cronus and other add-on control technologies that are available for these operations.

2. Wet Scrubber

Wet scrubbers are a technically feasible control option for the handling of urea product.

3. Electrostatic Precipitators (ESPs)

ESPs are a technically feasible control option for the handling of urea product.

4. Fabric Filtration (Baghouse)

Fabric filters are a technically feasible control option for the handling of urea product.

Step 3 – Rank the Remaining Control Technologies by Control Effectiveness

The ranking of the feasible technologies for the control of particulate from the handling of urea product, expressed in terms of nominal PM control efficiency, are as follows:

1. Enclosure and Work Practices with Baghouse Collectors (99.99+ percent);

2. Enclosure and Work Practices with Electrostatic Precipitator (90–99 percent);

3. Enclosure and Work Practices with Wet Scrubber (70–90 percent); and

4. Enclosure and Work Practices (25–50 percent).

Step 4 – Evaluate the Most Effective Controls and Document the Results

The most effective add-on control option, enclosure and work practices with baghouse, has been selected so a further evaluation is not needed.

Step 5 – Select BACT

Previous BACT determinations for similar operations are listed in Table B.9, below. These determinations confirm that particulate emissions from handling of urea product are controlled by the combination of enclosure and work practices and add-on baghouses required to meet PM emission limits of 0.005 gr/dscf.[149] As the previous BACT determinations do not explicitly address capture of emissions, it is assumed that direct emissions of particulate were not expected or indicated. Accordingly, it is appropriate to prohibit visible

[149] While the previous BACT determinations that identify use of filters for control of particulate emissions do not mention use of enclosure or work practices, this is assumed to be an oversight. Enclosure or other work practices to reduce direct emissions of particulate are implicit when emissions of particulate from handling of bulk materials are being controlled by add-on devices.

emissions of particulate from the handling of urea product at the Cronus facility. As the previous BACT determinations reflect use of filters, they confirm that baghouses are the appropriate add-on control technology for handling of urea product. Baghouses generally provide both very reliable and very effective control of the particulate dust created from the attrition of bulk materials when they are being transferred or handled.

While the Iowa DNR has also set limits for baghouses for similar operations in terms of $PM_{2.5}$, at 0.0011 and 0.0013 gr/scf, those limits should not be relied upon to set a limit for the baghouse for the subject operations at the Cronus facility. Given the higher efficiency of filters for larger particles compared to their efficiency for smaller particles, it should be expected that $PM_{2.5}$ would comprise most of the particulate emissions from these baghouses. It should not be expected that only 25 percent of the particulate emissions would be $PM_{2.5}$, as reflected in the limits set by the Iowa DNR. Moreover, it appears that the limits set by the Iowa DNR reflect an assumption about the percentage of $PM_{2.5}$ in the particulate.[150] Accordingly, the limits set by the Iowa DNR in terms of $PM_{2.5}$ do not constitute a sound basis to set a similar limit for the urea handling operations at the Cronus facility. Moreover, the performance of a baghouse in controlling particulate emissions from handling of urea can be readily addressed with a limit that is expressed in terms of PM emissions.[151]

In summary, the Illinois EPA is proposing BACT for particulate for the handling of urea product be:

1. Enclosure and work practices as needed to prevent any visible emissions from these operations.

2. Control with a baghouse or fabric filter to comply with an emission limit of 0.005 gr/dscf, for PM, 3-hour average.

[150] As already discussed, in the Iowa DNR's Response to Comments on the draft permit for Iowa Fertilizer Company, the Iowa DNR indicates that it established limits for $PM_{2.5}$ emissions for the urea granulator and handling of urea product based on information indicating that $PM_{2.5}$ constitutes 25 percent of the particulate from these operations. In fact, the document cited by Iowa DNR as the source of this information clearly states that this an assumption that was made by the authors of that document. Moreover, even in the cited document, this assumption was only being made for the urea granulator, not for the handling of urea product.

[151] If the Iowa DNR is correct that 25 percent of the particulate emissions from a baghouse controlling urea handling operations will be $PM_{2.5}$, a separate limit is not needed for $PM_{2.5}$. For such a baghouse, a limit in terms of PM at 0.005 gr/scf, as is being proposed, will limit $PM_{2.5}$ emissions to 25 percent of the PM limit, i.e., 0.00125 gr/scf (0.005 gr/scf x 0.25 = 0.00125 gr/scf).

Table B.9: Previous BACT Determinations for Particulate for Urea Handling Operations					
RBLC ID	**Facility**	**Issue Date**	**Throughput (tons urea/day)**	**BACT Limit**	**Control Measure(s)**
IA-0106	CF Industries	7/12/12	10,000	PM: 0.003 lb/ton, 3 tests $PM_{10}/PM_{2.5}$: 0.0011 lb/ton, 3 tests	Bin Vent Filter
IA-0105	Iowa Fertilizer Company	10/26/12	1,500 metric	PM_{10}: 0.005 gr/dscf, 3 tests $PM_{2.5}$: 0.0013 gr/dscf, 3 tests	Bin Vent Filter
OK-0124	Koch Nitrogen Company	5/1/08	1,550	No numerical limit	Equipment design: enclosed handling & telescoping chutes Conditioning agent to reduce friability

Section B.10 – BACT for Roadways

Roadways and parking areas at the facility may be sources of fugitive particulate matter due to vehicle traffic or windblown dust. Particulate emissions occur whenever vehicles travel over a paved surface such as a road or parking lot. Particulate emissions from paved roads are due to direct emissions from vehicles in the form of exhaust, brake wear and tire wear emissions and re-entrainment of loose material on the road surface. In general terms, re-entrained particulate emissions from paved roads originate from, and result in the depletion of, the loose material present on the surface (i.e., the surface loading). In turn, that surface loading can be replenished by other sources. At industrial sites, surface loading can be replenished by spillage of material and trackout from unpaved roads and staging areas.

PM BACT – Roadways

Proposal

Cronus proposed the following as BACT:

1. Best management practices (posted speed limits, prompt spill cleanup); and
2. Sweeping the truck loading road daily and, as needed, utilize a wet or chemical suppression to further control dust emissions.

Illinois EPA is proposing that BACT for fugitive particulate from roadways be: paving those roads subject to regular travel (serving office buildings, employee parking, or trucks transporting urea or ammonia); the implementation of work practices to reduce dust emissions documented through a written operating program; additional work practices for the handling of material collected from roadways; and an opacity limit for fugitive particulate matter from roadways and parking areas not to exceed 10 percent.

Step 1: Identify Available Control Technologies

Control techniques for paved roads attempt either to prevent material from being deposited onto the surface (preventive controls) or to remove from the travel lanes any material that has been deposited (mitigative controls). Add-on control devices, such as cyclones, scrubbers or baghouses, are not available control technologies because the roadways cannot be enclosed and ducted to a control device. Limiting vehicular traffic to and from the proposed facility is also not an available technology since the facility is being designed to serve both local and regional markets for its products.

1. Preventative controls

Preventative controls include the covering of loads in trucks (preventing material from becoming airborne and depositing on roads), control/enclosure of the handling of material collected from dust control mechanisms (preventing emissions of particulate matter from the handling of road dust that is collected), reduced speed limits (road dust generation on paved roads can increase with vehicle speed), truck wheel washing (prevents carryout onto paved roads from unpaved areas) and the paving of regularly travelled roads (paved road fugitive dust emissions are much less than unpaved roads).

2. Mitigative controls

Mitigative controls include the prompt cleanup of spillage onto roadways (minimizing the potential for the material from becoming airborne), and vacuum sweeping, broom sweeping, wet suppression, and combinations of these measures on paved roadways reducing the potential for fugitive emissions.

Step 2: Eliminate Technically Infeasible Options

1. Preventive measures

Preventive measures are all technically feasible, including requiring covering of loads in trucks, paving of roadways, handling of material collected from dust control mechanisms, truck wheel washing and reduced speed limits.

2. **Mitigative controls**

Mitigative measures are all technically feasible on paved roads, including prompt cleanup of any spillage/eroded materials on paved roadways, and broom sweeping, vacuum sweeping, wet suppression (including water flushing), and combinations of these measures on paved roadways.

In particular, wet suppression systems use liquid sprays or foam to suppress the formation of airborne dust. The primary control mechanisms are those that prevent emissions through agglomerate formation by combining small dust particles with larger aggregate or with liquid droplets. The key factors affecting the degree of agglomeration and the performance of the system are the coverage of the material by the liquid and the ability of the liquid to wet small particles. There are two types of wet suppression systems: liquid sprays which use water or a water/surfactant mix and foams. The use of a wet suppression or chemical suppression is technically feasible for the paved roadways and parking lots with public access at this source.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The ranking of control measures, with their control efficiencies for particulate emissions, are provided below.

1. Paving of regularly travelled roadways (greater than 90 percent control compared to unpaved roadways);
2. Water flushing followed by sweeping of paved roads (up to 75 percent control);
3. Wet suppression mitigative measures on paved roads (up to 70 percent control);
4. Vacuum sweeping on paved roads (up to 60 percent control);
5. Broom sweeping on paved roads (30 percent control); and

6. Other paved road work practices.[152]

Step 4: Evaluate the Most Effective Controls

The proposed facility will implement paving of all regularly travelled roadways and a combination of measures that will prevent and mitigate fugitive dust emissions from roads, including mitigative measures including vacuum sweeping and water flushing.[153] As these are the most effective mechanisms to reduce emissions of fugitive dust from roadways, a further evaluation of control measures in not needed.

Step 5: Select BACT

Previous BACT determinations for particulate for similar units are listed in Table B.10, below. Control measures include watering, sweeping, speed limits and good housekeeping. The highest emission reduction is 90% control.

The proposed BACT determination for fugitive particulate matter from roadways (paving of roads, work practice standards governed by a written operating program,[154] collected material handling provisions, and an opacity limit) is intended to require that these emissions be effectively controlled while still providing appropriate operational flexibility. This general approach has been taken because of the Illinois EPA's experience with fugitive dust control programs. This experience indicates that dust control programs must be flexible to appropriately respond to changing operations and the weather (rain, hot, dry weather in the summer, and snow and ice in the winter) which will at times reduce the need for mitigative water flushing/sweeping programs while at other times requiring more frequent applications of these work practices. To address the overall control of fugitive dust from roadways, the Illinois EPA is proposing an opacity limit, 10 percent, as part of BACT. This will directly address control of fugitive particulate matter regardless of the operations of the facility and weather conditions.

This approach will provide very effective control (greater than 90% particulate matter control) of fugitive emissions from roadways.

---

[152] Control efficiencies of other preventive and mitigative control measures (vehicle speed limits, covering of loads, prompt cleanup of spills, control of collected material handling, truck wheel washing) are more difficult to estimate a control efficiency given either a lack of published data or the non-recurring nature of these events. Sources of control efficiencies include USEPA document *Control of Open Fugitive Dust Sources*, *Paved Roads* (Section 13.2.1) of USEPA's AP-42 document, and *Fugitive Dust Mitigation Measures* (South Coast AQMD, CEQA Handbook).

[153] As all roads normally used by trucks at the Cronus facility will be required to be paved, there will be no opportunity for trackout from unpaved surfaces onto the paved roads. Thus, truck wheel washing will not be required as BACT as a work practice.

[154] The written operating program addresses mitigation of fugitive dust from roadways during both the construction phase of the facility and during the permitted facility operations.

Table B.10: Previous BACT Determinations for Roadways						
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Process Description**	**Magnitude**	**BACT Limit**	**Control Measure**
Indiana: T147-32322-00062	Ohio Valley Resources	09/25/13	Paved Roads & Parking Lots	17160 VMT/Year	90% control	Paving, Speed Limits, Sweeping, Wet Suppression
IA-0106	CF Industries Nitrogen	07/12/13	New Plant Haul Road	0.8 mile road	No Numerical Limit	Paved, Water Flushing, Sweeping
IN-0166	Indiana Gasification	06/27/12	Haul Roads	Not Indicated	90% control	Paving, Wet Suppress. Prompt Cleanup
OH-0328	V & M Star	04/10/09	Roadways (Steel Plant)	Unknown	PM: 62.6 tpy PM_{10}: 12.4 tpy AP-42	Control Measures to Minimize Emissions
OH-0317	Ohio River Clean Fuels	11/20/08	Paved Roads	736205 VMT/Year	PM - 79 tpy, 12 mo. PM_{10} - 15.4 tpy 90%	Watering, Sweeping, Speed Limit, Good Housekeeping
OH-0297	FDS Coke Company	06/14/04	Roadways	Unknown	PM- 24.9 tpy PM_{10}- 4.85 tpy	Watering
IA-0105	Iowa fertilizer	10/26/12	Paved Roads	2 miles of road	No numerical limit	Paved, Water Flushing, Sweeping

Section B.11 – BACT for Engines

The facility will have stationary diesel-fueled engines. Three engines will power emergency generators that will supply electricity to critical equipment during power outages. A smaller engine will power an emergency firewater pump that will be part of the fire protection system at the facility.

Diesel engine powered emergency generators and firewater pumps are typically sold as packages, i.e., an engine generator set or an engine pump set. Other than during an electrical power outage or a fire, each engine will normally be operated for less than one hour per week for purposes of confirming operational readiness. The potential emissions of these engines, including operation during actual emergencies, is based on operation of each engine for no more than 200 hours per year.

Emergency engines are designed for dependable and reliable operation as essential to fulfill their operational function. Manufacturers design engines to meet the applicable emission standards adopted by USEPA for various types and sizes of engines, such as the NSPS for Stationary Compression Ignition Internal Combustion Engines, 40 CFR 60 Subpart IIII, or USEPA's rules for Control of Emissions from New and In-Use Nonroad Compression Ignition Engines, 40 CFR Part 1039. For various types of engines, these standards reflect an assessment by USEPA of appropriate emission limits for emissions of the different pollutants for which limits are relevant, i.e., NOx, CO, VOM and particulate.[155] These standards reflect a holistic approach to the levels of emissions that are achievable with engine design. They recognize that changes to the design of an engine to specifically reduce NOx emissions, in the absence of other changes, generally act to increase emissions of CO and VOM, which are associated with incomplete combustion. Likewise, changes to the design of an engine simply to improve combustion efficiency will generally act to increase NOx emissions. These federal standards adopted by USEPA also reflect an assessment by USEPA of the operating practices that should accompany the limits that are established.

The manufacturers of engines now provide new engines that are certified to comply with all the relevant federal standards that apply to a particular type, size and application of engine. The owners and operators of an engine must then maintain and operate the engine to ensure compliance with those standards.

NOx BACT – Engines

Proposal

As BACT for NOx for the engines, Cronus proposed engine design, with installation of engines certified to comply with the relevant Tier IV standards for NOx for nonroad engines adopted by USEPA in 40 CFR 1039.102, Table 7,[156] and implementation of good operating practices.[157] Under the Tier IV

[155] Emissions of sulfur dioxide (SO_2) from diesel fuel fired engines are addressed by a requirement that only ultra-low sulfur diesel fuel be fired in the engines.
[156] These rules do not distinguish between emergency and non-emergency engines, with less stringent standards set for certain pollutants for emergency engines.

Standards for nonroad engines, the emergency engine generators and the firewater pump engine would need to be certified to comply with NOx rates of 0.67 and 3.5 gram/kW-hour, respectively.[158, 159]

The Illinois EPA is also proposing that BACT for NOx for the emergency engines be engine design, with installation of engines that are designed to comply with the Tier IV standards for NOx for nonroad engines at 40 CFR 1039.102, Table 7. For NOx, as well as NMHC and PM, these standards are more stringent than the standards that apply to emergency engines and firewater pump engines under the applicable NSPS, 40 CFR 60 Subpart IIII. However, Cronus has determined that manufacturers of stationary engine generator sets and emergency fire water pumps are using engines that meet these standards even though not required by USEPA rules. Implementation of good operating practices, as set forth by the NSPS, would also be required for these engines to ensure compliance with these Tier IV standards in 40 CFR 1039.102, Table 7.

Step 1: Identify Available Control Technologies

The available control technology for NOx for the emergency engines is engine design accompanied by good operating practices.

Step 2: Eliminate Technically Infeasible Options

Engine design for lower NOx emissions and good operating practices to facilitate conformance with that design is feasible for the emergency engines.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

The only feasible control option, engine design and good operating practices, has been selected. Accordingly, no further evaluation is needed.

---

[157] Cronus actually proposed that BACT for the engines include “good combustion practices.” The operation and maintenance practices that are appropriately implemented for an engine to facilitate operation in conformance with its design are better referred to as “good operating practices.” These practices also extend to proper operation of an engine as related emissions of NOx and particulate. They also do not involve the types of adjustments to the operational parameters of an engine while it is operating that are appropriate as part of good combustion practices for a boiler or process heater. For purposes of this project summary, it is assumed that Cronus inadvertently used the term “good combustion practices” to describe the implementation of “good operating practices” in its discussion of BACT for the emergency engines at the facility.

[158] In its application, Cronus expressed its proposed BACT limits in grams per horsepower-hour, rather than in grams per kW-hour.

[159] Cronus also proposed that BACT for the emergency engines include limiting their operation to no more than 200 hours per year. However, this constraint is inherent in Cronus’ design for the facility since these engines would only function as emergency engines. Accordingly, this operational restriction proposed by Cronus was not considered as part of the BACT analysis for the engines.

This operational constraint is reflected in the permitted emissions of the engines, as would be allowed by the draft permit. The permitted emissions are based on operation of the engines for at most 200 hours per year.

Step 4: Evaluate the Most Effective Controls

The only feasible control option, engine design and good operating practices, has been selected. Accordingly, a further evaluation is not needed.

Step 5: Select BACT

Previous BACT determinations for NOx for similar emergency engines are listed in Table B.11a and Table B.11b. These determinations confirm that add-on control technology for NOx is not used on emergency engines. NOx emissions are controlled by engine design and good operating practices.

As discussed, the Illinois EPA is proposing that BACT for NOx for each engine be compliance with the relevant Tier IV standards for nonroad engines at 40 CFR 1039.102, Table 7. For NOx emissions of the emergency generator engines and the firewater pump engines, these standards are 0.67 and 3.5 gram/kW-hour, respectively. Implementation of good operating practices for the engines, as set forth in the NSPS, 40 CFR 60 Subpart IIII, is also proposed as part of BACT.

Table B.11a: Previous BACT Determinations for Emergency Engine Generators							
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Description**	**Capacity**	**Pollutant**	**BACT Limit**	**Control Measure**
Indiana: T147-32322-00062	Ohio Valley Resources	9/25/13	Emergency Generator	4690 hp	NOx	4.46 g/hp-hr, 3-hr ave	GCP
					CO	2.61 g/hp-hr, 3-hr ave	GCP & Usage Limit
					VOM	0.31 g/hp-hr, 3-hr ave	Usage Limit
					PM	0.15 g/hp-hr	GCP & 200 hours
					GHG, as CO_2	526.4 g/hp-hr, 3 hr ave	CP & Usage Limit
IA-0105	Iowa Fertilizer Company	10/26/12	Emergency Generator	2680 hp 2000 kW	NOx	6.0 g/kW-hr 3 tests	GCP
					CO	3.5 g/kW-hr 3 tests (0.01 lb/hp-hr) 3.86 tpy	GCP 4.69 g/hp-hr
					VOM	0.4 g/hp-hr 3 tests	None
					PM	0.2 g/kW-hr 3 tests	0.27 g/hp-hr Subpart IIII
					GHG	CO_2e: 788.5 tpy, 12 mo. CH_4: 0.0001 g/kW-hr, 3 tests	GCP
AK-0076	Exxon Port Thomson Production	08/20/12	Diesel-fired Generators	1750 kW (ULSD)	NOx + NMHC	6.4 g/kW-hr	Subpart IIII
					CO	3.5 g/kW-hr	Subpart IIII
					PM	0.2 g/kW-hr	Subpart IIII
					GHG	CO_2: No limit	GCP, Subpart IIII
Indiana: T147-30464-00060	Indiana Gasification	6/27/12	Emergency Generators	2 @1341 hp	NOx	No Numerical Limit	GCP & Limited Hours of Non-Emergency Operation
					CO	No Numerical Limit	
					$PM/PM_{10}/PM_{2.5}$	15 ppm S	ULSD & Limited Hours
					GHG	Total CO_2: 84 tpy, 12 month (limit for non-emergency use only)	Good Design to meet NSPS & MACT
SC-0113	Pyramax Ceramics	02/08/12	Emergency Generators 1 to 8	757 hp	NOx	4.0 g/KW-hr	Subpart IIII
					CO	3.5 g/kW-hr	
					VOM	4.0 g/kW-hr	
MI-0402	Wolverine Power, Sumpter Power Plant	11/17/11	Emergency Generator	732 hp	NOx	4.85 g/hp-hr, test	GCP
					CO	0.31 g/hp-hr, test	GCP
					PM	0.05 g/hp-hr, test	
					$PM_{10}/PM_{2.5}$	0.0573 lb/mmBtu, test	
					GHG	CO_2e: 716 lb/hr, test	
FL-0332	Highland Biorefinery & Cogen	09/23/11	2000 kW Emergency Equipment	2682 hp	NOx	6.4 g/kW-hr for NOx + NMHC	Subpart IIII
					CO	3.5 g/kW-hr	
					PM	0.2 g/kW-hr	

LA-0254	Entergy Louisiana/ Ninemile Point	08/16/11	Diesel Generator	1250 hp	CO	2.6 g/hp-hr, annual ave	ULSD + GCP
					VOM	1.0 g/hp-hr, annual ave	
					$PM_{10}/PM_{2.5}$	0.15 g/hp-hr	
					GHG	CH_4: 0.0061 lb/mmBtu CO_2: 163 lb/mmBtu	Proper Operation & GCP
FL-0322	Southeast Renewable Fuels	12/23/10	Emergency Generators (2)	2000 kW (ULSD)	NOx	6.4 g/kW-hr for NOx + NMHC	Subpart IIII (model year 2006)
					CO	3.5 g/kW-hr	
					PM	0.2 g/kW-hr, (filt. & cond.)	
AK-0071	Chugach Electric Power	12/20/10	Caterpillar Black Start Generator	1500 kWe (ULSD)	NOx	6.4 g/kW-hr	Turbocharging & After Cooler
					$PM/PM_{10}/PM_{2.5}$	0.03 g/hp-hr	GCP
ID-0018	Idaho Power Company, Langley Gulch	6/25/10	Diesel Generator	750 kW	NOx + NMHC	6.4 g/ kW-hr	Tier 2 & GCP
					CO	3.5 g/kW-hr	
					PM	0.2 g/kW-hr	
NV-0050	MGM Mirage	11/30/09	Emergency Generators	3622 hp	NOx	0.01 lb/hp-hr, (37.4 lb/hr)	Turbocharging & After Cooler
					CO	0.0017 lb/hp-hr, (6.05 lb/hr)	Turbocharging & GCP
					VOM	0.0003 lb/hp-hr, (0.93 lb/hr)	
					PM_{10} (filterable)	0.0001 lb/hp-hr, (0.40 lb/hr)	
				2206 hp	NOx	0.0131 lb/hp-hr, (28.98 lb/hr)	Turbocharging, After Cooling & Lean Burn
					CO	0.0018 lb/hp-hr, (3.95 lb/hr)	Turbocharging & GCP
					VOM	0.0003 lb/hp-hr (0.71 lb/hr)	
					PM_{10}	0.0001 lb/hp-hr, (0.20 lb/hr)	

Table B.11b: Previous BACT Determinations for Firewater Pump Engines						
RBLC ID/ Permit No.	**Facility**	**Issue Date**	**Capacity**	**Pollutant**	**BACT Limit**	**Control Measure(s)**
Indiana: T147-32322-00062	Ohio Valley Resources	9/25/13	481 hp	NOx	2.86 g/hp-hr, 3-hr avg.	GCP Usage Limit
				CO	2.6 g/hp-hr, 3-hr avg.	
				VOM	0.141 g/hp-hr, 3-hr avg.	
				PM	0.15 g/hp-hr, 3-hr. avg.	
				GHG, as CO_2	527.4 g/hp-hr, 3-hr avg.	
IA-0105	Iowa fertilizer Company	10/26/12	235 kW	NOx	3.75 g/kW-hr, 3 tests (0.49 tpy, 12 mo.)	GCP
				CO	3.5 g/kW-hr 3 test)	GCP
				VOM	0.25 g/kW-hr, 3 tests (0.03 tpy)	None
				PM	0.2 g/kW-hr, 3 tests (0.27 g/hp-hr)	GCP
				GHG	CO_2: 1.55 g/kW-hr, 3 tests CH_4: 0.0001 g/kW-hr, 3 ts. CO_2e: 91 tpy, 12 mo.	GCP
SC-0113	Pyramax Ceramics	2/08/12	500 hp	NOx	4.0 g/kW-hr	Subpart IIII 100 hr/yr
				CO	3.5 g/hp-hr	
				VOM	4.0 g/kW-hr	
SD-0005	Basin Electric Power	10/14/11	577 hp	CO	None	Subpart IIII
LA-0254	Ninemile Point Electric Generating	8/16/11	350 hp	CO	2.6 g/hp-hr, annual	GCP
				VOM	1.0 g/hp-hr, annual	ULSD, GCP
				PM_{10}/$PM_{2.5}$	0.15 g/hp-hr, annual	
				GHG	N_2O: 0.0014 lb/mmBtu CO_2: 163 lb/mmBtu CH_4: 0.0061 lb/mmBtu	Proper Operation Good Combustion
LA-0254	Entergy Louisiana LLC	8/06/11	350 hp	CO	2.6 g/hp-hr, annual	GCP + ULSD
				VOM	1.0 g/hp-hr, annual	
				PM_{10}/$PM_{2.5}$	0.15 g/hp-hr, annual	
				GHG	CO_2: 163 lb/mmBtu N_2O: 0.0014 lb/mmBtu CH_4: 0.0061 lb/mmBtu	Proper Operation & GCP
LA-0251	Flopam, Inc.	4/26/11	444 hp	NOx	5.82 lb/hr (3.0 g/kW-hr)	None
				CO	0.65 lb/hr	Good Design & Proper Combustion
				PM_{10}	0.01 lb/hr	None
FL-0322	Southeast Renewable	12/23/10	600 hp	NO_2	NOx + NMHC: 3.0 g/hp-hr	Subpart IIII
				CO	2.6 g/hr-hr	Subpart IIII

	Fuels LLC			PM	0.15 g/hp-hr	Subpart IIII
ID-0018	Idaho Power Co.	6/25/10	235 kW (tier 3)	NOx + NMHC	4.0 g/kW-hr	GCP
				CO	None	GCP
				PM	2.0 g/hr-hr	GCP
MI-0389	Consumers Energy	12/29/09	525 hp	NOx + NMHC	3.0 g/hp-hr test method	Engine Design & Operation
				CO	2.6 g/hr-hr	
				PM/PM_{10}	PM: 0.15 g/hp-hr PM_{10}: 0.31 lb/mmBtu test method	
OK-0129	Associated Electric Coop.	1/23/09	267 hp	NOx	4.59 lb/hr (7.8 g/hp-hr, NSPS)	None
				CO	2.60 g/hp-hr NSPS	None
				VOM	0.66 lb/hr	Good Combustion
				PM_{10}	0.24 lb/hr (0.4 g/hp-hr, NSPS)	None
MD-0040	CPV St. Charles	11/12/08	300 hp	NOx	NOx + NMHC: 3.0 g/hp-hr	None
				CO	2.6 g/hp-hr	
				$PM/PM_{10}/PM_{2.5}$	0.15 g/hp-hr	
				CH_4	NOx + NMHC: 3.0 g/hp-hr	
IA-0095	Tate & Lyle Ingredients	9/19/08	575 hp	PM	0.2 g/hp-hr	None
IA-0088	ADM, Cedar Rapids	6/29/07	540 hp	NOx + NMHC	2.8 g/hp-hr, 3 test avg.	Tier 3
				CO	2.6 g/hp-hr, 3 test avg.	
				VOM	0.2 g/hp-hr, 3 test avg.	
				PM	0.15 g/hr-hr, 3 test avg.	

<u>CO and VOM BACT</u> – Engines

Proposal

As BACT for CO and VOM for the engines, Cronus proposed engine design, with installation of engines certified to comply with the relevant Tier IV standards for CO and nonmethane hydrocarbons (NMHC)[160] for nonroad engines adopted by USEPA in 40 CFR 1039.102, Table 7, and implementation of good operating practices. Under the Tier IV Standards for nonroad engines, the emergency generator and firewater pump engines would need to be certified to comply with CO and NHMC rates of 3.5 and 0.40 g/kW-hr, respectively.

The Illinois EPA is also proposing that BACT for CO and VOM for the engines be engine design, with installation of engines that are designed to comply with the relevant Tier IV standards for nonroad engines at 40 CFR 1039.102, Table 7. For NMHC, these standards are more stringent than the standards that apply to emergency engines and firewater pump engines under the applicable NSPS, 40 CFR 60 Subpart IIII. However, Cronus has determined that manufacturers of stationary engine generator sets and emergency fire water pumps are using engines that meet these standards even though not required by USEPA rules.[161] Implementation of good operating practices, as set forth by the NSPS, would also be required to ensure compliance with these standards.

Step 1: Identify Available Control Technologies

The available control technology for CO and VOM for the engines is engine design accompanied by good operating practices.

Step 2: Eliminate Technically Infeasible Options

Engine design for low CO and VOM emissions and good operating practices to facilitate conformance with that design is feasible for the engines.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

There is only one feasible control option, engine design and good operating

[160] The USEPA's standards for nonmethane hydrocarbons (NMHC) readily serve to address emissions of VOM. As a practical matter, the emissions of NMHC from engines are the sum of the emissions of VOM and the emissions of ethane, which is not regulated as a VOM.

The USEPA's standards for CO and NMHC also serve to address emissions of methane from the engines. Like CO and NMHC, methane is a product of incomplete combustion. The USEPA's standards for CO and NMHC will also act to address the trace emissions of methane in the exhaust from the engines.

[161] The USEPA has also adopted Final Tier IV standards for non-road engines, at 40 CFR 1039.101, Table 1, which apply after the 2014 model year. These standards set lower limits for emissions of NMHC, as well as PM. It is assumed that manufacturers of stationary emergency engine generator sets and firewater pump engines will not be using engines that are certified to meet these additional limits. This is because the additional design features in engines that would be used to also meet these lower limits would be incompatible with use of the engines in emergency applications.

practices. Accordingly, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

The only feasible control option, engine design and good operating practices, has been selected. Accordingly, no further evaluation is needed.

Step 5: Select BACT

Previous BACT determinations for CO and VOM for similar engines are listed above in Tables B.11a and B.11b. These determinations indicate add-on control technology for CO or VOM is not used on emergency engines. CO and VOM emissions are both controlled by engine design and good operating practices.

While certain limits for CO and VOM in previous BACT determinations for engines are lower than the limits that are being proposed for the emergency engines at the Cronus facility, those other limits cannot be relied upon a basis to set BACT limits. This is because the BACT limits for another pollutant, NOx, for those other engines are higher than the limits for NOx proposed for the engines at the Cronus facility. For those other engines, the BACT limits for NOx are in line with the limits that apply under the NSPS, 40 CFR 60 Subpart IIII.[162, 163] BACT limits for engines are appropriately set at levels at which compliance with the limits for all pollutants is achievable.

---

162 The BACT limits for these emergency generator engines, expressed in consistent terms from the data in the Clearinghouse, are summarized below, along with the NSPS limits and the limits that are proposed as BACT for the emergency generator engines at the Cronus facility.

BACT Limits for Certain Emergency Generator Engines (g/kW-hr)					
Project	Engine Size	Pollutant			
		NOx	CO	VOM(NMHC)	PM/PM_{10}
NSPS	>560 kW	6.7	3.5	--	0.20/--
Wolverine (2011)	732 hp	6.46	0.41	--	0.067/0.076
MGM Mirage (2009)	3622 hp	6.05	1.03	0.18	--/0.06
	2206 hp	7.93	1.09	0.18	--/0.06
Cronus (proposed)	>560 kW	0.67	3.5	0.40	0.10

163 The BACT limits for these firewater pump engines, expressed in consistent terms from the data in the Clearinghouse, are summarized below. The differences in BACT limits for CO and VOM for certain firewater pumps engines compared to the limits that are being proposed for the firewater pump engine at the Cronus facility are not as large as the differences for emergency generator engines. For firewater pump engines, the limits for NOx and PM are somewhat higher, the limits for CO are similar and the limits for VOM are slightly lower. However, the situation is similar to that for the emergency generator engines.

BACT Limits for Certain Firewater Pump Engines (g/kW-hr)					
Project	Engine Size	Pollutant			
		NOx	CO	VOM(NMHC)	PM/PM_{10}
NSPS	>560 kW	4.0*	3.5	4.0*	0.20
Ohio Valley Resources (2013)	481 hp	3.81	3.47	0.19	0.20
CPV St. Charles (2009)	300 hp	4.0*	3.47	4.0*	0.20
ADM, Cedar Rapids (2007)	540 hp	3.73	3.47	0.27	0.20
Cronus (proposed)	>560 kW	3.5	3.5	0.40	0.10

*Combination of NOx and NMHC.

These levels are now the standards for engines under USEPA rules, with which engines are now designed and sold to comply. As discussed, nonroad engines are suitable for the applications of engines at the Cronus facility. Cronus did not attempt to show that the impacts of using nonroad engines meeting Tier 4 standards would be excessive. Rather, Cronus proposed such engines. Use of such engines is preferred given the lower limits for NOx that result.

As already indicated, the Illinois EPA is proposing that BACT for CO and VOM for each engine be compliance with the relevant Tier IV standards for nonroad engines at 40 CFR 1039.102, Table 7. These standards are 3.5 and 0.40 gram/kW-hour for CO and VOM (NMHC), respectively. Implementation of good operating practices for the engines, as set forth in the NSPS, 40 CFR 60 Subpart IIII, is also proposed as an part of BACT.

Particulate (PM, PM_{10} and $PM_{2.5}$) BACT – Engines

Proposal

As BACT for particulate for the engines, Cronus proposed engine design, with installation of engines certified to comply with the relevant Tier IV standards for particulate for nonroad engines adopted by USEPA in 40 CFR 1039.102, Table 7, and implementation of good operating practices. Under the Tier IV Standards for nonroad engines, the both the emergency generator engines and the firewater pump engine would need to be certified to comply with a PM rate 0.10 g/kW-hr.

The Illinois EPA is also proposing that BACT for particulate for the engines be engine design, with installation of engines that are designed to comply with the Tier IV standard for particulate for nonroad engines at 40 CFR 1039.102, Table 7, which is identical to the standard that applies under the NSPS, 40 CFR 60 Subpart IIII.[164] Implementation of good operating practices, as set forth by the NSPS, would also be required to ensure compliance with this standard.

Step 1: Identify Available Control Technologies

The available control technologies for particulate for the engines is engine design accompanied by good operating practices.

Step 2: Eliminate Technically Infeasible Options

1. Engine design and good operating practices

Engine design for lower particulate emissions and good operating practices to facilitate conformance with that design is feasible for the engines. For particulate, this design will likely include a diesel particulate filter.[165] These devices are part of the design of new engines as such devices are needed to meet the relevant particulate limits for new engines adopted by USEPA.[166]

---

[164] As discussed, the USEPA has also adopted Final Tier IV standards for non-road engines, at 40 CFR 1039.101, Table 1, which apply after the 2014 model year. These standards set lower limits for emissions of PM. It is assumed that manufacturers of stationary emergency engine generator sets and firewater pump engines will not be using engines that are certified to meet these additional limits. This is because the additional design features in engines that would be used to also meet these lower limits would be incompatible with use of the engines in emergency applications.

[165] A diesel particulate filter collects particulate in the exhaust stream of a diesel engine on a fixed, catalytically activated ceramic filter. The catalyst facilitates combustion of the collected particulate during the periodic regeneration cycle when the filter is heated to between 480°F and 570°F.

[166] In its application, Cronus did not attempt to show that models of engines with diesel particulate filters would not be feasible for the engines because of their operating cycle. The operational and maintenance practices needed for an engine equipped with a filter, including the need to appropriately regenerate the filter, will simply be reflected in the manufacturer's standard procedures for the particular model of engine.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

There is only one feasible control option, engine design and good operating practices. Accordingly, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

The only feasible control option, engine design and good operating practices, has been selected. Accordingly, no further evaluation is needed.

Step 5: Select BACT

Previous BACT determinations for particulate for similar engines are listed in Table B.11a and B.11b. These determinations confirm that add-on control technology for particulate is not used on emergency engines. Particulate emissions are controlled by engine design and good operating practices. As with CO and VOM, a few BACT limits for particulate are lower. However, the BACT limits for NOx for those engines are higher.

As already indicated, the Illinois EPA is proposing that BACT for particulate for each engine be compliance with the relevant Tier IV standards for nonroad engines at 40 CFR 1039.102, Table 7, which limits PM emissions to 0.10 gram/kW-hour. Implementation of good operating practices for the engines, as set forth in the NSPS, 40 CFR 60 Subpart IIII, is also proposed as a part of BACT.

<u>GHG BACT</u> – Engines

Proposal

Cronus proposed good operating practices as BACT for GHG for the engines.

The Illinois EPA is proposing that BACT for GHG for the engines be use of engines that are certified to comply with applicable Tier IV emission standards for nonroad engines and implementation of good operating practices to ensure compliance with those standards. Because the Tier IV standards do not set numerical limits for GHG emissions, annual limits on GHG emissions are also proposed.

Step 1: Identify Available Control Technologies

The only available control technology available for the engines for GHG is engine design and good operating practices.

Step 2: Eliminate Technically Infeasible Options

Design and good operating practices are a technically feasible control option for GHG for the engines.

Step 3: Rank the Remaining Control Technologies by Control Effectiveness

Since one control option, engine design accompanied by good operating practices, is available and feasible, a ranking is not needed.

Step 4: Evaluate the Most Effective Controls

The only effective control option, design and good operating practices, has been selected so no further evaluation is needed.

Step 5: Select BACT

Previous BACT determinations for GHG for similar engines are also listed in Tables B.11a and B.11b, above. There are far fewer BACT determinations for GHG that for other pollutants. The BACT limits in these determinations reflect emission factors for GHG based on fuel input to an engine or limits on the hourly or annual rates of GHG emissions. As such, these determinations generally reflect use of engines that are designed to comply with regulations for engines adopted by USEPA. These regulations provide for engine design for low emissions of NOx, CO, NMHC and PM. These regulations also provide for proper operating practices to comply with these emission standards.

USEPA’s regulations for engines also address energy efficiency and, indirectly, GHG emissions. This is because USEPA’s regulations for engines set “output-based” limits, limiting emissions relative to the power output of an engine. As such, for emergency engines, it is appropriate to rely on these regulations to address energy efficiency.

Accordingly, as already indicated, the Illinois EPA is proposing that BACT for GHG for the engines be compliance with the relevant Tier IV standards for nonroad engines at 40 CFR 1039.102, Table 7, with implementation of good operating practices as set forth in the NSPS, 40 CFR 60 Subpart IIII. To explicitly address GHG emissions in the BACT determination for the engines, the Illinois EPA is proposing annual limits for GHG emissions, as CO_2e, i.e., 430 and 72 tpy for the emergency generator engines and the firewater pump engine, respectively. These proposed limits have been developed from operation of each engine for 200 hours per year, which is the "potential operation" of the engines indicated by Cronus in its application.[167] These limits will appropriately constrain the GHG emissions of these engines consistent with their function as emergency engines.

[167] Operation of the engines for no more than 200 hours per year is consistent with the role as the engines as emergency engines. As discussed, the engines would typically operate far less than this because they would only be operated periodically for short periods as needed to verify readiness in case of an emergency. Limits based on operation for 200 hours per year reasonably account for this readiness testing and actual operation for emergency situations, most likely power outages.

Section B.12: BACT for Storage Tanks (VOM)

The facility will have storage tanks for CO_2 absorbent (activated methyldiethanolamine or aMDEA), urea-formaldehyde solution and diesel oil. The aMDEA is used to absorb the CO_2 and Urea-Formaldehyde used in the urea granulation process. Diesel oil will be used as fuel in the engines. The materials stored in these tanks all have very low vapor pressure. Cronus has proposed to use fixed roof storage tanks for these materials. The potential VOM emissions of these tanks, in total, will only be 0.20 tons/year.

The technologies that are available for control of the VOM emissions of these tanks are the three options for control of VOM from organic liquid storage tanks by the NSPS, 40 CFR 60 Subpart Kb, which are also found in various NESHAP rules. These options are an appropriately fitted external floating roof, an appropriately fitted internal floating roof, or use of an add-on control device for VOM emissions, such as a vapor recovery or vapor destruction unit, with appropriate efficiency. All of these options are technically feasible.

The NSPS also includes criteria for the vapor pressure of a stored material and the size of a tank that govern whether use of one of these measures is required. For these tanks, these criteria will not be anywhere close to being met so control of VOM emissions is not required under the NSPS. This generally shows that the cost impacts of using any of these control options would be excessive. In addition, it is reasonable to expect that the annualized cost of any of these measures would be at least $2,500. Assuming that all the VOM emissions would occur from a single tank and would be reduced to zero with control, the cost-effectiveness of using any of these measures would be $12,500 per ton of VOM controlled.[168] This simple analysis is sufficient to confirm that the cost impacts of further controlling VOM emissions from any of these storage tanks would be excessive.

[168] $2,500/year ÷ 0.2 tons controlled/year = $12,500/ton controlled.