NORTH CAROLINA DIVISION OF AIR QUALITY

Application Review

Issue Date:

Region: Mooresville Regional Office
County: Iredell
NC Facility ID: 4900261
Inspector's Name: Alejandra Cruz
Date of Last Inspection: 03/02/2022
Compliance Code: 3 / Compliance - inspection

Facility Data

Applicant (Facility's Name): Cardinal FG Company

Facility Address:
Cardinal FG Company
342 Mooresville Boulevard
Mooresville, NC 28115

SIC: 3211 / Flat Glass
NAICS: 327211 / Flat Glass Manufacturing

Facility Classification: Before: Title V **After:** Title V
Fee Classification: Before: Title V **After:** Title V

Permit Applicability (this application only)

SIP: 02D .0515, 02D .0516, 02D .0521, 02D .0524, .02D .0614, 02D .1100, 02Q .0317
NSPS: NSPS CC, NSPS IIII
NESHAP: GACT ZZ
PSD: N/A
PSD Avoidance: Yes
NC Toxics: Yes
112(r): N/A
Other: N/A

Contact Data

Facility Contact	Authorized Contact	Technical Contact
Kenneth Macy Environmental and Safety Manager (704) 660-0900 342 Mooresville Boulevard Mooresville, NC 28115	James Stevens Plant Manager (704) 660-0900 342 Mooresville Boulevard Mooresville, NC 28115	Jamie Smith FG Director of Env. Compliance (704) 660-0900 342 Mooresville Boulevard Mooresville, NC 28115

Application Data

Application Number: 4900261.21A, 4900261.21B
Date Received: 05/19/2021, 09/03/2021
Application Type: Modification, Renewal
Application Schedule: Renewal

Existing Permit Data
Existing Permit Number: 08618/T11
Existing Permit Issue Date: 02/18/2019
Existing Permit Expiration Date: 03/31/2022

Total Actual emissions in TONS/YEAR:

CY	SO2	NOX	VOC	CO	PM10	Total HAP	Largest HAP
2020	83.28	225.48	7.21	105.98	21.72	1.26	1.20 [Hexane, n-]
2019	90.61	222.02	7.38	171.33	21.75	1.24	1.18 [Hexane, n-]
2018	111.35	227.77	9.12	101.21	21.75	1.23	1.17 [Hexane, n-]
2017	122.05	429.03	18.61	155.13	29.24	1.16	1.10 [Hexane, n-]
2016	194.47	711.03	25.76	225.96	49.20	1.19	1.13 [Hexane, n-]

Review Engineer: Betty Gatano

Review Engineer's Signature: **Date:**

Comments / Recommendations:
Issue 08618/T12
Permit Issue Date:
Permit Expiration Date:

1. Purpose of Application

Cardinal FG Company (Cardinal) currently holds Title V Permit No. 08618T11 with an expiration date of March 31, 2022 for a flat glass manufacturing facility in Mooresville, Iredell County, North Carolina. Cardinal submitted the following permit applications, which have been consolidated for this permit modification/renewal:

- Permit Application No. 4900261.21A – On May 19, 2021, the facility submitted a permit application as a one-step significant modification in accordance with 15A NCAC 02Q .0501(b)(1) to increase its glass production from 700 to 750 tons per 24-hours.[1] Cardinal will continue to be classified as a minor source under Prevention of Significant Deterioration (PSD) after modification, with emissions of each regulated pollutant remaining below 250 tons per year (tpy).

- Permit Application No. 4900261.21B – This permit application is for a permit renewal without modification. The renewal application was received on September 30, 2021, or at least six months prior to the expiration date. Therefore, the existing permit shall not expire until the renewal permit has been issued or denied. All terms and conditions of the existing permit shall remain in effect until the renewal permit has been issued or denied.

2. Facility Description

Cardinal manufactures flat glass by first introducing raw material into the furnace (ID No. P01) at the melter. The raw material includes silica sand, soda ash (sodium carbonate), limestone (calcium carbonate), dolomite (calcium magnesium carbonate), salt cake (sodium sulfate), cullet (broken glass), iron, carbon, and nepheline. The heat from the furnace melts the raw material to form glass. The glass then flows toward the refiner, which allows the glass to off gas bubbles that occur during the melting process. The glass then flows to the tin bath where it is formed into the desired width and thickness. After the tin bath, the glass flows to the annealing lehr (ID No. P07), where sulfur dioxide (SO_2) is injected on the rollers and surface of the glass to prevent staining. The majority of the SO_2 is retained by the glass, and unused SO_2 is released inside the building as fugitive emissions. From the lehr, the glass is then cooled for cutting and packing.

Emissions from the furnace are controlled via a Tri-Mer system consisting of dry sorbent injection for SO_2 control (ID No. C01A), ammonia injection for control of nitrogen oxides (NO_X) (ID No. C01B), and catalytic ceramic filters for particulate matter (PM) control (ID No. C01C). The following description of the Tri-Mer system was provided in the permit review for Air Permit No. 08618T09.[2]

> Furnace exhaust gases flow through a duct where hydrated lime is injected to react with the SO_2 and any other acid gases such as sulfuric acid. The dry sorbent injection is designated C01A. The solid reaction products flow with the exhaust gases for removal on the surface of the downstream ceramic filters. The ceramic filters used to collect the dust or particulate matter are embedded with a catalytic material for the control of NO_X emissions. Prior to the filters, aqueous ammonia is injected into the flue gas. The NO_X - ammonia mixture reacts on the surface area of the catalytic material in the ceramic filters to form nitrogen and water vapor. The reaction is similar to that which occurs in Selective Catalytic Reduction (SCR) systems used on industrial and utility boilers. Compared to traditional SCR systems, nearly 100% of the ammonia is reacted within the ceramic catalytic filters. Cleaned exhaust gas leaving the interior of the ceramic filters continues to the system fan and stack. The injection of ammonia to control NO_X emissions is designated C01B.

[1] The permit specifies the throughput of the furnace in units of tons per 24 hours. For simplicity, the term "tons per day" (tpd) means "tons per 24 hours" throughout this document.

[2] Permit review in support of Air Permit No. 08618T09 (Joseph Voelker, 02/28/2018).

Similar to traditional fabric filter in a baghouse, the solid ceramic filters are approximately 10 feet long and 6 inches in diameter. These filters are designated C01C. The filters are estimated to have a useful life of 4 to 10 years prior to replacement.

Cardinal operates 4 work groups that alternate 12-hour shifts. The facility operates 24 hours per day, 365 days per year.

3. Permitting History and Application Chronology

Permit History since Previous Permit Renewal

April 27, 2017	TV permit renewal issued. Air Permit No. 08618T07 was issued on April 27, 2017 with a permit expiration date of March 31, 2022. A 1,000-kW diesel-fired emergency generator (ID No. IP09) and associated fuel oil tank (ID No. IP10) were added as insignificant activities under this permit renewal.
May 5, 2017	Air Permit No. 08648T08 was issued as the first step of a two-step significant modification in accordance with 15A NCAC 02Q .0501(c)(2). As part of this permit modification, an Alternate Operating Scenario (AOS) was incorporated into the air permit allowing operation of the Tri-Mer control system.
February 28, 2018	Air Permit No. 08648T09 was issued as a significant modification. The following changes were made as part of this permit modification: • Updated the air pollution control requirements for the glass furnace; • Reduced emission limitations to below the PSD major source threshold of 250 tons per year thereby reverting to PSD minor source status; and • Increased glass production from 650 to 700 tons per day. Note that the application for this permit met the requirements for the second step of the two-step significant modification in accordance with 15A NCAC 02Q .0501(c)(2) for the AOS allowing operation of the Tri-Mer control system.
March 16, 2018	Air Permit No. 08648T10 was issued as an administrative amendment to correct an error associated with the monitoring, recordkeeping, and reporting requirements in Air Permit No. 08648T09 issued February 28, 2018.
February 18, 2019	Air Permit No. 08648T11 was issued as a minor modification in accordance with 15A NCAC 02Q .0515 to revise the SO_2 emission factor used to calculate SO_2 emissions from the furnace for avoidance of PSD. The facility also requested to modify the dry scrubber reagent usage rate for control of SO_2 emissions from the furnace.

Application Chronology

May 19, 2021	Received application (4900261.21A) for permit modification.
May 19, 2021	Sent acknowledgment letter indicating the application for permit modification was incomplete because the permit fee was not included with the application.
May 27, 2021	E-payment received, at which point the permit application was deemed complete.

July 14, 2021	Mark Yoder of the Air Quality Analysis Branch (AQAB) of the DAQ issued a memorandum approving the air dispersion modeling for this permit modification. Betty Gatano had questions regarding the air dispersion modeling, and Ms. Gatano and Mr. Yoder reviewed the air dispersion modeling in a phone call on July 16, 2021.
July 19, 2021	Forwarded questions about the permit application to Steven Klafka of Wingra Engineering, consultant for the facility.
July 21, 2021	Participated in call with Steven Klafka and James Stevens of Cardinal to discuss the permit application and address the specific questions forwarded to Cardinal earlier. Mr. Klafka provided responses to questions raised during the call in an e-mail on July 22, 2021.
July 27, 2021	Draft permit and permit review based on permit Application No. 4900261.21A forwarded for comments.
July 28, 2021	Received comments from Steven Klafka on the draft permit. These comments and DAQ's responses are addressed in Section 12 below.
August 2021	Throughout August, DAQ discussed the facility's comments on the draft permit.
September 2, 2021	Betty Gatano provided DAQ's response to Cardinal's comments to Steven Klafka.
September 30, 2021	Permit application (4900261.21B) for renewal of the TV permit received. In the application, Cardinal requested to consolidate the in-house application for a significant modification (4600261.21A) with the application for TV renewal.
October 28, 2021	Betty Gatano forwarded questions to Steven Klafka regarding Compliance Assurance Monitoring (CAM), which must be evaluated as part of the TV permit renewal.
November 3, 2021	Received comments from Steven Klafka in response to questions about CAM.
November 24, 2021	Betty Gatano forwarded Cardinal's response to DAQ staff for feedback. Cardinal's response included a request to increase the ammonia concentration in the CAM plan to 30 ppmv.
Nov. & Dec 2021	Feedback on Cardinal's response received from DAQ staff.
January 11, 2022	Cardinal requested to add an insignificant activity to the permit as part of the TV permit renewal. The updated D4 form for this insignificant activity was received on February 1, 2022.
February 9, 2022	Betty Gatano compiled DAQ's feedback to increase ammonia concentration in the CAM plan and forwarded an e-mail to Seven Klafka indicating the increase was not acceptable. Mr. Klafka replied that same day via e-mail to reiterate the need for the increase.

February 11, 2022	Betty Gatano and DAQ staff met via telephone to discuss the request. The DAQ determined an increase to 15 ppmv was appropriate given the actual monitoring data provided by Cardinal. Other changes to the CAM plan were discussed. Ms. Gatano called Steven Klafka and Jamie Smith that same day and presented DAQ's proposal. Cardinal agreed to the increase in ammonia to 15 ppmv and the additional changes in the CAM plan.
February 14, 2022	Second draft of permit and permit review forwarded for review. The second draft of the permit has been reformatted to follow DAQ's updated permitting shell.
February 15, 2022	Received comments from Samir Parekh of Stationary Source Compliance Branch (SSCB).
February 23, 2022	Received comments from Steven Klafka on the second draft of the permit and review.
March 31, 2022	Received comments from Joe Voelker of DAQ on the second draft of the permit and review.
April 12, 2022	Final drafts of permit and permit review forwarded for comments.
April 18, 2022	Jamie Smith indicated Cardinal had no additional comments.
April 19, 2022	Draft permit and review sent to public notice.

4. Permit Modifications/Changes and TVEE Discussion

The following table describes the changes to the current permit as part of this modification/renewal.

Page No.	Section	Description of Changes
Cover letter and throughout permit	--	Updated all dates and permit revision numbers.
3	--	"List of Acronyms" has been moved to Page 3 of the permit.
4	1.0 Equipment Table	• Removed page numbers. • Changed the production rate in the emission source descriptions for the glass melting furnace (ID No. P01) and the cullet return (ID No. P02) to 750 tons per 24-hour period. • Removed footnote stating glass melting furnace (ID No. P01) is listed as minor modification.
5	2.1 A Equipment List	Reformatted equipment list in accordance with current permitting shell.
5	2.1 A Regulations Table	• Added reference to ammonia being applicable to 15A NCAC 02D .1100 • Removed reference to ammonia being applicable to 15A NCAC 02Q .0711.
6	2.1 A.1.a	Reformatted equations for 15A NCAC 02D .0515 for consistency with permitting shell.
6	2.1 A.1.c	Reformatted permit condition and clarified noncompliance statement.
7	2.1 A.3.c	Required the Permittee to establish "normal" visible emissions after permit issuance and updated permit condition for 15A NCAC 02D .0521 with most current permitting language.
7	2.1 A.3.e	Updated reporting condition with most current permitting language.

Page No.	Section	Description of Changes
8	2.1 A.4.b	Referenced the filterable PM emission limit of 0.225 g/Kg, which is provided in NSPS Subpart CC. This value is equivalent to 0.45 pounds per ton.
8 – 9	2.1 A.5	Updated emission limits for NC Toxic Air Pollutants under 15A NCAC 02D .1100.
--	2.1 A.6 (old numbering)	Removed permit condition for 15A NCAC 02Q .0711 for ammonia emissions from the glass furnace (ID No. P01). With the increased production rate, ammonia emissions exceeded the TPER, and air dispersion modeling was required for ammonia emissions from the furnace.
9 – 10	2.1 A.6	• Changed the indicator range from 10 ppmv to 15 ppmv of ammonia. • Changed the QIP trigger to 6 exceedance per semiannual period rather than 3 consecutive days. • Updated CAM condition to most current format.
12	2.1 B.1.a	Reformatted equations for 15A NCAC 02D .0515 for consistency with permitting shell.
12	2.1 B.2.c	Required the Permittee to establish "normal" visible emissions after permit issuance, and updated permit condition for 15A NCAC 02D .0521 with most current permitting language.
12	2.1 B.2.e	Updated reporting condition with most current permitting language.
18	2.2 A.1.c	Added testing condition to re-establish reagent injection rate and confirm SO_2 and CO emission factors.
18	2.2 A.1.e	Revised permit condition for updating emission factors and injection rate with most current permitting language.
18	2.2 A.1.f	Updated production rate of glass furnace to 750 tons per day.
19	2.2 A.1.g	Added monitoring downtime requirement for NO_X CEMs.
19	2.2 A.1.h	Updated PSD avoidance equation for NO_X emissions by adding calculations for actual emissions from generators.
19	2.2 A.1.i	Added a requirement to calculate emissions of NO_X monthly and record the results.
20	2.2 A.1.j	Updated PSD avoidance equation for SO_2 emissions by revising the emission factor for SO_2 and adding calculations for actual emissions from generators.
20	2.2 A.1.k	Added a requirement to calculate emissions of SO_2 monthly and record the results.
20 – 21	2.2 A.1.n	Updated PSD avoidance equation for CO emissions by revising the emission factor for CO and adding calculations for actual emissions from generators.
21	2.2 A.1.o	Added a requirement to calculate emissions of CO monthly and record the results.
21	2.2 A.1.p, q, and r	Added monitoring and recording requirements for the generators for PSD avoidance.
21	2.2 A.1.s	Updated reporting condition with most current permitting language.
22	Section 3	Moved "List of Insignificant Activities" to Section 3 in accordance with the updated formatting for TV permits.
23 – 31	Section 4	Updated General Permit Conditions with most current version (version 6.0, 01/07/2022).

The following changes were made to the Title V Equipment Editor (TVEE) as part of this permit modification/renewal.

- Added the PHG100 hydrogen generation unit (ID No. IP11) as an insignificant activity.
- Changed the capacity of the furnace (ID No. P01) to 750 tpd.
- Changed the capacity of the cullet return (ID No. P02) to 750 tpd.

5. Permit Modification

The permit modification requested in Application No. 4900261.21A is intended to increase the glass production at Cardinal from 700 to 750 tpd. No change in the current glass manufacturing process described above will result from this project.

The furnace is currently permitted at 220 million Btu per hour. No increase in the heat input will be required to meet the increase in production rate, but fuel consumption in the glass furnace is expected to increase as a result of this modification.

Because a portion of the carbonate in the raw materials will be discharged as carbon dioxide, more than 750 tpd of solids must be processed to achieve this production rate. A raw materials input of up to 910 tpd may be required to achieve 750 tpd of glass output, depending on the composition of raw materials and the amount of recycled cullet used. The maximum throughput in the cullet return (ID No. P02) will also increase from 29 tons per hour (tph) cullet to 31.25 tph cullet as a result of the production increase. Other ancillary operations, including raw materials handling (ID Nos. P04 and P05), glass cutting (ID No.P08), and annealing (ID No. P07), will increase as needed to meeting production, although no change in their maximum throughput is required to meet the increased production rate.

The associated control systems will not change as part of this project. The glass furnace is controlled via a Tri-Mer system, which is designed to accommodate the increase in emissions due to the increased production rate.

Emissions

Cardinal first accepted PSD avoidance limits for NO_X, SO_2, and carbon monoxide (CO) under Air Permit No. 08618T09, issued on February 28, 2018. The facility became minor for PSD at that point.

For this modification to be considered a major modification under PSD, the emissions increase must exceed the PSD major source level of 250 tons per year of any PSD regulated pollutant. Potential emissions before and after modification are provided in Table 1A below. As shown in the table, potential emissions (as defined at 40 CFR 51.166(b)) after modification remain below the PSD major source threshold for all pollutants. Therefore, the modification to increase the production rate of glass is not considered a major modification under PSD. Detailed emission calculations are provided in Attachment 1 to this document.

Table 1A – Potential Emissions before and after Modification

Pollutant	Potential Facility-wide Emissions at Furnace Production Rate of 700 tpd (tpy)	Potential Facility-wide Emissions at Furnace Production Rate of 750 tpd (tpy)	Major Source Threshold (tpy)
PM (TSP) PM_{10} $PM_{2.5}$	134.4	142.7	250
CO	<250	<250	250
NO_X	< 250	< 250	250
SO_2	< 250	< 250	250
VOC	53.2	53.6	250
Lead	0.2	0.2	250

Pollutant	Potential Facility-wide Emissions at Furnace Production Rate of 700 tpd (tpy)	Potential Facility-wide Emissions at Furnace Production Rate of 750 tpd (tpy)	Major Source Threshold (tpy)
Fluoride	1.1	1.2	250
Sulfuric acid	21.9	20.3	250
CO_2e	149,595	160,281	100,000

Notes:

- Emissions associated with PSD avoidance conditions for NO_X, SO, and CO are discussed below.
- $PM/PM_{10}/PM_{2.5}$ emissions for the furnace and raw material and handling operations were based on previous Best Available Control Technology (BACT) emission limits. The furnace was uncontrolled at that time. Because PM from the furnace is now controlled via a ceramic filter (ID No. C01C), the $PM/PM_{10}/PM_{2.5}$ emissions provided above represent conservative estimates.
- The majority of VOC emissions result from the use of a VOC-based lubricant used during glass cutting. All the VOC used during cutting is assumed to be emitted.
- Sulfuric acid emissions assumed to be 9%of SO_2 emissions from the furnace, based on a conservative derivation from prior stack tests.
- Fluoride emissions were based on a Mooresville stack test in March 2000 for total fluorides on an uncontrolled furnace.
- The June 23, 2014 Supreme Court Decision in "Utility Air Regulatory Group v. EPA" indicates EPA may not treat greenhouse gas (GHGs) emissions as an air pollutant for the specific purpose of determining whether a source is required to obtain a PSD permit. Although CO_2e emissions exceed the PSD threshold of 100,000 tons per year, Cardinal will not become a major source under PSD due to GHG because all criteria pollutants will remain below the PSD major thresholds after modification.

Emission of hazardous air pollutants (HAPs) before and after modification are provided in Table 1B below. As shown in the table below, emission of HAPs are less than 10 tons per year of any one HAP and less than 25 tons per year of all HAPs combined. Detailed emission calculations are provided in Attachment 1 to this document.

Table 1B – Potential Emissions of HAPs before and after Modification

Pollutant	Potential Facility-wide Emissions at Furnace Production Rate of 700 tpd (tpy)	Potential Facility-wide Emissions at Furnace Production Rate of 750 tpd (tpy)	Major Source Threshold (tpy)
Largest HAP	2.02 (hexane)	2.02 (hexane)	10
Total HAP	4.5	4.7	25

Notes:

- Hexane is the largest HAP emitted from the facility, and emissions of hexane result from natural gas consumption in the glass furnace. Because the maximum fuel consumption in the furnace was assumed in calculating potential emissions, HAP emissions due to fuel consumption in the furnace are independent of throughput.
- Total HAPs includes emissions of hydrogen fluoride (HF). Fluoride emissions were determined from a Mooresville stack test in March 2000 for total fluorides on an uncontrolled furnace. Because Cardinal was unable to determine the percentage of HF in the total fluorides during testing, emission factor used for total fluoride emissions were considered to be entirely HF as a conservative estimate.

Emission Calculations for PSD Avoidance

Equations used to demonstrate compliance with PSD avoidance limits for NO_X, SO_2, and CO will be modified as part of this modification/renewal. Cardinal is also modifying the furnace emission factors (EFs) for SO_2 and CO used in the equations. The proposed emission factors were determined by back calculating emissions from the PSD avoidance conditions. The proposed emission factors as well as results of recent compliance testing for the glass furnace are provided in the Table 2 below.

Table 2 – Comparison of Emissions Measured during Testing to Proposed EFs.

Year of Testing	Test Date	Production Rate During Testing (tpd)	SO_2 Emissions Measured during Testing (lb/ton)	CO Emissions Measured during Testing (lb/ton)
2018	05/16/18	689.5	0.71	0.81
2019	04/17/19	675.9	0.55	1.37
2020	05/08/20	640.6	0.51	0.85
2021	05/05/21	698.5	0.05	0.82
		Proposed EF:	**1.65**	**1.82**

Notes:

- tpd = tons per day
- Cardinal installed the Tri-Mer controls on the glass furnace in 2017, so any testing before that date is no longer representative of emission expected from the furnace.
- Brent Hall of the SSCB approved the 2018 test results in a memorandum dated November 19, 2018.
- Shannon Vogel of the SSCB approved the 2019 test results in a memorandum dated September 12, 2019.
- Taylor Fort of the SSCB approved the 2020 test results in a memorandum dated September 10, 2020.
- Brent Hall of the SSCB approved the 2021 test results in a memorandum dated June 24, 2021.

The testing results indicate the proposed emission factors for SO_2 and CO are conservative values (i.e., resulting in higher emissions). The revised permit conditions for PSD avoidance will require continued annual testing to confirm these EFs. A NO_X EF for the furnace is not used to demonstrate compliance with PSD avoidance. Instead, Cardinal uses a continuous emissions rate monitoring system (CERMs) to monitor emissions of NO_X from the furnace.

NOx Emissions

Section 2.2 A.1.g of the current permit, Air Permit No. 08618T11, contains the following equation for PSD avoidance for NO_X emissions:

$$\sum_{i=1}^{12} NOx_{furnace,i} < 234 \qquad \text{Equation 2.2 A.1 -1*}$$

$$NOx_{furnace,i} = T_{total,i} * CERMS$$

where:	
$NO_{Xfurnace,i}$	= total NO_X emissions of glass furnace in calendar month i
CERMS	= pounds per hour of NO_X emissions from the glass furnace stack as determined by the CERMS, monthly average basis, in calendar month i
T_i	= total hours of operation of glass furnace in calendar month i

* potential NO_X emissions of the two emergency generators were subtracted from the 250 tpy limitation

This equation incorporates the potential emissions of NO_X from the emergency generators (ID Nos. P06 and IP09) assuming 500 hours of operation annually and subtracts that number (16 tpy) from the PSD avoidance limit of 250 tpy. Cardinal has requested to use the actual emissions of NO_X from the emergency generators in the revised equations.

The revised PSD avoidance equation for NO_X emissions is as follows:

$\sum_{i=1}^{12} NOx_{total,i} < 250$ per consecutive 12-month period Equation 2.2 A.1 -1

$$NOx_{total,i} = NOx_{furnace,i} + NOx_{generators,i}$$

$$NOx_{furnace,i} = T_i * CERMS$$

$$NOx_{generators,\ i} = (EF_{PO6,i} * G_{P06,i} + EF_{IPO9,i} * G_{P09,i}) * (140{,}000\ Btu/gal) * (CF)$$

Where:	
$NOx_{total,i}$	= total NO_X emissions in calendar month i, in tons
$NOx_{furnace,i}$	= total NO_X emissions from glass furnace in calendar month i
CERMS	= pounds per hour of NO_X emissions from the glass furnace stack as determined by the CERMS, monthly average basis, in calendar month i
T_i	= total hours of operation of glass furnace in calendar month i
$NOx_{generators,i}$	= total NO_X emissions from generators in calendar month i
$EF_{P06,\ i}$	= 3.2 lbs of NO_X per million Btu for emergency generator ID No. P06
$EF_{PIO9,\ i}$	= 1.584lbs of NO_X per million Btu for emergency generator ID No. IP09
$G_{P06,i}$	= total gallons of diesel used by emergency generator ID No. P06 in calendar month i
$G_{PI09,i}$	= total gallons of diesel used by emergency generator ID No. IP09 in calendar month i
140,000 Btu/gal	= Heating value of diesel fuel
CF	= Conversion factor = one million Btu/$1x10^6$ Btu

In the permit application, Cardinal used EFs in pounds per million Btu (lbs/MMBtu) for the fuel input to the generators. The EF for NO_X for emergency generator ID No. P06 was obtained from Table 3.4-1 of Chapter 3.4 of the US EPA AP-24. The EF for uncontrolled NOx emissions in Table 3.4-1 was used. The EF for NO_X from emergency generator ID No. IP09 was obtained from its specification sheet.

SO_2 Emissions

Section 2.2 A.1.h of the current permit, Air Permit No. 08618T11, contains the following equation for PSD avoidance for SO_2 emissions:

$\sum_{i=1}^{12} SO_{2_{total,i}} < 247$ Equation 2.2 A.1 -2*

$$SO_{2_{total,i}} = SO_{2_{furnace,i}} + SO_{2_{lehr,i}}$$

$$SO_{2_{furnace,i}} = TG_{furnace,i} * EF_{SO2,furnace}$$

$$SO_{2_{lehr,i}} = M_{SO_{2_{lehr,i}}}$$

where:	
$SO_{2total,i}$	= total SO_2 emissions in calendar month i, in tons
$SO_{2furnace,i}$	= SO_2 emissions of glass furnace in calendar month i, in tons
$TG_{furnace,i}$	= tons of glass produced by furnace in month i
$EF_{furnace,\ i}$	= 1.7 lbs SO_2 per ton of glass produced
$SO_{2lehr,i}$	= SO_2 emissions of annealing lehr in calendar month i, in tons
$MSO_{2lehr,i}$	= SO_2 usage of annealing lehr in calendar month i, in tons

* potential SO_2 emissions of the two emergency generators were subtracted from the 250 tpy limitation

This equation incorporates the potential emissions of SO_2 from the emergency generators (ID Nos. P06 and IP09) assuming 500 hours of operation annually and subtracts that number (3 tpy) from the PSD avoidance limit of 250 tpy. Cardinal has requested to use the actual emissions of SO_2 from the emergency generators in the revised equations.

The revised PSD avoidance equation for SO_2 emissions is as follows:

$\sum_{i=1}^{12} SO_{2_{total,i}} < 250\ tons\ per\ consecutive\ 12-month\ period$ Equation 2.2 A.1 -2

$SO_{2_{total,i}} = SO_{2_{furnace,i}} + SO_{2_{lehr,i}} + SO_{2_{generators,i}}$

$SO_{2_{furnace,i}} = TG_{furnace,i} * EF_{SO2,furnace}$

$SO_{2_{lehr,i}} = M_{SO_{2_{lehr,i}}}$

$SO_{2_{generators\ ,i}} = EF_{SO2,generators} * \left(G_{P06,i} + G_{IP09,i}\right) * (140{,}000\ Btu/gal) * CF$

Where:	
$SO_{2total,i}$	= total SO_2 emissions in calendar month i, in tons
$SO_{2furnace,i}$	= SO_2 emissions from glass furnace in calendar month i, in tons
$TG_{furnace,i}$	= tons of glass produced by furnace in month i
$EF_{furnace,\ i}$	= 1.65 lbs SO_2 per ton of glass produced
$SO_{2lehr,i}$	= SO_2 emissions from annealing lehr in calendar month i, in tons
$MSO_{2lehr,i}$	= SO_2 usage of annealing lehr in calendar month i, in tons
$SO_{2generators,i}$	= SO_2 emissions from emergency generators in calendar month i, in tons
$EF_{generators,\ i}$	= 1.52E-03 lbs of SO_2 per million Btu
$G_{P06,i}$	= total gallons of diesel used by emergency generator ID No. P06 in calendar month i
$G_{PI09,i}$	= total gallons of diesel used by emergency generator ID No. IP09 in calendar month i
140,000 Btu/gal	= Heating value of diesel fuel
CF	= Conversion factor = one million Btu/1x10^6 Btu

The EF for SO_2 for the generators is derived from the factor $1.01S_1$ in Table 3.4-1 of Chapter 3.4 of the US EPA AP-24, where S_1 is the percentage of sulfur in the diesel fuel. Cardinal has assumed the use of ultra-low sulfur diesel (ULSD) in estimating emissions of SO_2 from the furnace. ULSD is defined as having no more than 15 ppm of sulfur in the fuel. This concentration is equal to 0.0015% sulfur, resulting in an EF of 1.52E-03 lb/mm Btu for sulfur (i.e., EF = 1.01 * 0.0015). The permit will require the use of ULSD as part of this modification/renewal.

The current permit requires Cardinal to maintain a reagent injection at a rate greater than or equal to 2.6 lb/ton of glass produced averaged over a calendar day to ensure compliance with the current emission factor of 1.7 lbs SO_2 per ton of glass produced. For this permit modification/renewal, Cardinal is proposing an emission factor of 1.65 lbs SO_2 per ton of glass produced. Because of the large margin of

compliance with the current emission factor demonstrated in recent testing (See Table 2 above), compliance with the proposed emission factor is anticipated. The revised permit will require Cardinal to conduct performance testing to demonstrate compliance with the proposed SO_2 emission factor and to re-establish a reagent injection rate to achieve this emission factor.

CO Emissions
Section 2.2 A.1.k of the current permit, Air Permit No. 08618T11, contains the following equation for PSD avoidance for CO emissions:

$\sum_{i=1}^{12} CO_{furnace,i} \quad < 244$ Equation 2.2 A.1 -3*

$CO_{furnace,i} = TG_{furnace,i} * EF_{CO,furnace}$

where:	
$CO_{furnace,i}$	= total CO emissions of glass furnace in calendar month i
$TG_{furnace,i}$	= tons of glass produced by furnace in month i
$EF_{furnace,i}$	= 1.9 lbs CO per ton of glass produced

* potential CO emissions of the two emergency generators were subtracted from the 250 tpy limitation

This equation incorporates the potential emissions of CO from the emergency generators (ID Nos. P06 and IP09) assuming 500 hours of operation annually and subtracts that number (6 tpy) from the PSD avoidance limit of 250 tpy. Cardinal has requested to use the actual emissions of CO from the emergency generators in the revised equations.

The revised PDS avoidance equation for CO emissions is as follows:

$\sum_{i=1}^{12} CO_{total,i} < 250$ *tons per consecutive 12-month period* Equation 2.2 A.1 -3

$CO_{total,i} = CO_{furnace,i} + CO_{generators,i}$

$CO_{furnace,i} = TG_{furnace,i} * EF_{CO,furnace}$

$CO_{generators,i} = (EF_{P06,i} * G_{P06,i} + EF_{IP09,i} * G_{IP09,i}) * (140{,}000\ Btu/gal) * CF$

Where:	
$CO_{total,i}$	= total CO emissions of in calendar month i
$CO_{furnace,i}$	= total CO emissions from glass furnace in calendar month i
$TG_{furnace,i}$	= tons of glass produced by furnace in month i
$EF_{furnace,i}$	= 1.82 lbs CO per ton of glass produced
$CO_{generators,i}$	= total CO emissions from the generators in calendar month i
$EF_{P06,i}$	= 0.81 lbs of CO per million Btu for emergency generator ID No. P06
$EF_{IP09,i}$	= 0.42 lbs of CO per million Btu for emergency generator ID No. PI09
$G_{P06,i}$	= total gallons of diesel used by emergency generator ID No. P06 in calendar month i
$G_{PI09,i}$	= total gallons of diesel used by emergency generator ID No. IP09 in calendar month i
140,000 Btu/gal	= Heating value of diesel fuel
CF	= Conversion factor = one million Btu/1x10^6 Btu

The EF for CO for emergency generator ID No. P06 was obtained from Table 3.4-1 of Chapter 3.4 of the US EPA AP-24. The EF for CO for emergency generator ID No. IP09 was obtained from its specification sheet.

Emissions of TAPs and HAPs

Cardinal is also a minor source of HAPs. As shown in Table 1B above, Cardinal will remain a minor source of HAPs after modification.

The only sources emitting HAPs and Toxic Air Pollutant (TAPs) at Cardinal are the glass furnace (ID No. P01) and the emergency generators (ID Nos. P06 and IP09). TAP and HAP emissions result from fuel combustion in the furnace and generators and trace metals in the raw materials to the furnace. Cardinal does not intentionally add any HAP containing material, such as lead oxide, chromium oxide, etc., to its furnace to produce glass. TAP emissions result from fluoride in the raw materials, the use of ammonia to control NO_X emissions (i.e., ammonia slip) in control device C01B, and from secondary formation of sulfuric acid (H_2SO_4) from SO_2 added to the annealing lehr furnace for glass clarity.

The three TAPs emitted in the largest quantity from Cardinal are discussed below:

- Ammonia – Cardinal estimates 34.8 tons per year of ammonia emissions at a furnace production rate of 750 tpd. These emissions were estimated assuming a conservative estimate of 60 ppmv of ammonia (assuming 1 ppmv of ammonia slip and applying a safety factor of 60) and the actual stack conditions during testing. Literature on Tri-Mer controls indicate ammonia slip is less than 5 ppmv, and generally less than 2 ppmv.[3] Further, a value of 30 ppmv of ammonia slip is used as indicator of PM excursions in the facility's CAM plan. Therefore, Cardinal's approach for estimating ammonia emissions using a concentration of 60 ppmv results in a conservative estimate and is acceptable.

- Sulfuric Acid – Cardinal estimates 20 tons per year of H_2SO_4 emissions at a furnace production rate of 750 tpd. H_2SO_4 emissions are assumed equal to 9% of SO_2 emissions from the furnace, which is a conservative derivation from prior stack tests. The "9%" assumption has been used historically at Cardinal to estimate H_2SO_4 emissions.

  Prior source tests were reviewed to determine the basis for this assumption. The only recent source test where H_2SO_4 was measured occurred in 2002. Sulfur dioxide emissions were estimated at 202.6 tons per year and H_2SO_4 emissions were estimated at 2.28 tons per year at 600 tpd production rate. With these results, H_2SO_4 emissions are 1.13% of SO_2 emissions. Thus, assuming H_2SO_4 emissions are equal to 9% of the SO_2 emissions is a conservative estimate and is acceptable.

- Fluorides – Cardinal estimates 1.2 tons per year of fluoride emissions at a furnace production rate of 750 tpd. Fluoride emissions were based on a Mooresville stack test in March 2000 for total fluorides on an uncontrolled furnace. Because Cardinal was unable to determine the percentage of hydrogen fluoride (HF) in the total fluorides, emissions were considered "fluorides" under NC Air Toxics. This assumption is a conservative approach because the acceptable ambient level (AAL) for fluorides (0.016 mg/m^3 for chronic toxicants) is smaller than that for HF (0.03 mg/m^3 for chronic toxicants). NC Air Toxics is discussed in more detail in Section 9 below.

Regulatory Review

The regulatory review associated with this permit application is included below in Section 7.

6. Insignificant Activity

Cardinal requested to add a PHG100 hydrogen generation unit (ID No. IP11) as an insignificant activity as part of the TV renewal. At Cardinal, molten glass flows from the furnace into a molten tin bath and

[3] Information on NOx Control from the Tri-Mer System. Obtained on 07/27/2021 from https://www.pollutiononline.com/doc/nox-control-0002

floats on the tin. This operation utilizes a nitrogen and hydrogen atmosphere to minimize oxidation of the tin. The hydrogen is currently delivered to on-site storage by truck.

Cardinal proposes to replace hydrogen deliveries by installing an on-site hydrogen generation system manufactured by Air Products, Inc. The PHG100 unit will use natural gas as raw material to create hydrogen for the tin bath. Emissions from this new unit will be generated by the combustion of natural gas and a purge gas created by the unit. Combined heat input will be 0.85 MMBtu/hr. Estimated emissions assuming full capacity operation for 8,760 hours per year are provided in the table below. Emissions from this source meet the definition of insignificant activity pursuant to 15A NCAC 02Q .0503(8), and this source will be added to the insignificant activities list as part of this modification/renewal.

Pollutant	Emissions	
	lb/hr	tons/yr
PM (Total)	4.3E-04	1.9E-03
PM (Filterable)	1.7E-04	7.3E-04
PM (Condensable)	2.7E-04	1.2E-03
SO_2	5.0E-04	2.2E-03
NO_X	8.3E-02	3.7E-01
CO	7.0E-02	3.1E-01
VOC	4.6E-03	2.0E-02
Largest HAP (hexane)	1.50E-03	6.57E-03
Total HAPs	1.57E-03	6.87E-03
Notes: Emissions calculated using DAQ's "Natural Gas Combustion Emission Calculator: Revision N 01/05/2017)."		

7. Regulatory Review

Cardinal is subject to the following regulations. The permit will be updated to reflect the most current permitting language for all applicable regulations.

- 15A NCAC 02D .0515, Particulates from Miscellaneous Industrial Processes – The glass furnace (ID No. P01), the cullet return (ID No. P02), the bottom and top of the three elevators (ID Nos. P03 and P04), and the batch mixers (ID No. P05) are subject to 02D .0515 and must comply with the following equations:

  $E = 4.10 \times P^{0.67}$ For process rates less than or equal to 30 tons per hour
  $E = 55.0 \times P^{0.11} - 40$ For process rates greater than 30 tons per hour:

  Where E = allowable emission rate in pounds per hour
  P = process weight in tons per hour

  Liquid and gaseous fuels and combustion air are not considered as part of the process weight.

  Requirements for these emission sources are discussed below.

  - The glass furnace (ID No. P01) – PM emissions from the furnace are controlled by ceramic filters (ID No. C01C). Cardinal is required to conduct monthly visual emission inspections and annual internal inspections of the control device to ensure compliance.

The facility is also required to conduct annual compliance testing for PM unless test results are less than 80% of the allowable, and then testing is required every 5 years. The most recent test was conducted on May 16, 2018 and approved by Brent Hall of the SSCB in a memorandum issued on July 23, 2018.

Parameter	Test Results	Limit	Standard	Compliance
Total PM	1.65 lb/hr	39.1 lb/hr	02D .0515	Yes
Glass Production Rate	694.6 ton/day	700 ton/day	Permitted Max.	---

A production rate of 750 tpd equals 31.25 tph, requiring the use of the second equation above to establish allowable emissions. With the increased production rate, allowable PM emissions equal 40.31 lb/hr. Given the margin of compliance observed during the most recent testing, compliance is anticipated with the increased production rate of the furnace.

- The cullet return (ID No. P02) – PM emissions from the cullet return are controlled by a bagfilter (ID No. CD02). Cardinal is required to conduct visual emission inspections and annual internal inspections of the control device to ensure compliance.

  The throughput for the cullet return will increase to 31.25 tph, requiring the use of the second equation above to establish allowable emissions. With the increased production rate, allowable PM emissions equal 40.31 lb/hr. The estimated PM emissions are provided in the table below, and as shown in the table, compliance is anticipated.

Parameter	Results
Estimated PM from cullet return	Loading of bagfilter on cullet return = 0.0067 gf/acf This value was the previous BACT emission limit established for the cullet return (ID No. P02) with associated bagfilter (ID No. CD02). Flow rate of bagfilter = 45,000 acfm PM = 0.0067 gr/acf * 45,000 acf/m * 60 min/hr * 1 lb/7000 gr **PM = 2.58 lb/hr**

- The bottom and top of the three elevators (ID Nos. P03 and P04) and the batch mixers (ID No. P05) – PM emissions from these emissions sources are controlled by bagfilters (ID Nos. CD03, CD04, and CD05, respectively). The throughput for each of these emissions sources exceeds 30 tph, requiring the use of the second equation above to establish allowable emissions. The allowable emissions and the estimated PM emissions for each of these sources are provided in the table below, and as shown in the table, compliance is anticipated.

Parameter	Results
Bottom of the three elevators (ID No. P03)	Throughput = 300 tph PM allowable = 63.0 lbs/hour Loading of bagfilter = 0.0067 gf/acf This value was the previous BACT emission limit established for the bottom of the three elevators (ID No. P03) with associated bagfilter (ID No. CD03). Flow rate of bagfilter = 2,200 acfm PM = 0.0067 gr/acf * 2,200 acf/m * 60 min/hr * 1 lb/7000 gr **PM = 0.13 lb/hr**
Top of the three elevators (ID No. P04)	Throughput = 300 tph PM allowable = 63.0 lbs/hour Loading of bagfilter = 0.0067 gf/acf This value was the previous BACT emission limit established for the top of the three elevators (ID No. P04) with associated bagfilter (ID No. CD04). Flow rate of bagfilter = 1,200 acfm PM = 0.0067 gr/acf * 1,200 acf/m * 60 min/hr * 1 lb/7000 gr **PM = 0.07 lb/hr**
Batch mixers (ID No. P05)	Throughput = 300 tph PM allowable = 55.5 lbs/hour Flow rate of bagfilter = 1,800 acfm Loading of bagfilter = 0.0067 gf/acf This value was the BACT emission limit established for the batch mixers (ID No. P05) with associated bagfilter (ID No. CD05) under prior permits. Flow rate of bagfilter = 1,800 acfm PM = 0.0067 gr/acf * 1,800 acf/m * 60 min/hr * 1 lb/7000 gr **PM = 0.10 lb/hr**

No throughput change for these emission sources is expected as a result of increasing the glass throughput in the furnace. Cardinal is required to conduct visual emission inspections and annual internal inspections of the control devices to ensure compliance. Continued compliance is anticipated.

- 15A NCAC 02D .0516 Sulfur Dioxide Control Requirement – Emission sources subject to this rule shall not emit more than 2.3 pounds of sulfur dioxide per million Btu input. The glass furnace (ID No. P01) and the diesel-fired emergency generator (ID No. P06) are subject to this rule.

    - The glass furnace (ID No. P01) – Cardinal uses the dry sorbent injection system (ID No. C01A) for SO_2 control for PSD avoidance. (The controls are not required for compliance with 02D .0516.) Testing is not required to demonstrate compliance with 02D .0516. However, Cardinal did conduct such testing during the two most recent source tests on the furnace. As shown in the table below, compliance with 02D .0516 was demonstrated.

Year of Testing	Test Date	Production Rate During Testing (tpd)	SO_2 Emissions Measured during Testing (lb/MMBtu)	Emission Limit in 02D .0515
2020	05/08/20	640.6	0.08	2.3 lb/MMBtu
2021	05/05/21	698.5	0.008	

Notes:
- Taylor Fort of the SSCB approved the 2020 test results in a memorandum dated September 10, 2020.
- Brent Hall of the SSCB approved the 2021 test results in a memorandum dated June 24, 2021.

Due to the large margin of compliance with the emission limit as demonstrated via testing, no monitoring, reporting, or recordkeeping is required, and continued compliance is anticipated.

- The diesel-fired emergency generator (ID No. P06) – No monitoring, recordkeeping, or reporting is required when firing diesel fuel in combustion sources because of the low sulfur content of the fuel. Diesel fuel is inherently low enough in sulfur that continued compliance is expected.

- 15A NCAC 02D .0521, Control of Visible Emissions – The following equipment was manufactured after July 1, 1971 and must not have visible emissions of more than 20 percent opacity when averaged over a six-minute period, except as specified in 15A NCAC 02D .0521(d):

  - The glass furnace (ID No. P01) – The facility is required to make daily visible emission observations and conduct associated recordkeeping and reporting to demonstrate compliance with 02D .0521. A statement will be added to the permit requiring the facility to establish "normal" emissions from the furnace within the first 30 days following the issuance of Air Permit No. 08618TT12 to increase the throughput of the furnace.

  - The cullet return (ID No. P02) - The facility is required to make weekly visible emission observations and conduct associated recordkeeping and reporting to demonstrate compliance with 02D .0521. A statement will be added to the permit requiring the facility to establish "normal" emissions from the cullet return within the first 30 days following the issuance of Air Permit No. 08618T12 to increase the throughput of this emission source.

  - The bottom of the elevators (ID No. P03), the top of the elevators (ID No. P04), and the batch mixers (ID No. P05) – The facility is required to make weekly visible emission observations and conduct associated recordkeeping and reporting to demonstrate compliance with 02D .0521.

  - The diesel-fired emergency generator (ID No. P06) – No monitoring, recordkeeping, or reporting is required for compliance with 02D .0521 from firing diesel fuel in this source.

  The permit conditions will be updated to reflect the current permitting language for 15A NCAC 02D .0521 under this modification/renewal. Continued compliance for all emission sources is anticipated.

- 15A NCAC 02D .0524, New Source Performance Standards (NSPS) – Cardinal is subject to the following NSPS:
  - "Standards of Performance for Glass Manufacturing Plants," 40 CFR 60 Subpart CC.
  - "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines," 40 CFR Part 60 Subpart IIII.

See Section 8 below for more discussion of the requirements under NSPS.

- 15A NCAC 02D .0614, Compliance Assurance Monitoring (CAM) – The glass furnace (ID No. P01) is subject to CAM for PM. See Section 8 for more discussion of CAM.

- 15A NCAC 02D .1100, Control of Toxic Air Pollutants – This rule is state enforceable only. The glass melting furnace is subject to 02D .1100 for numerous TAPs. See Section 9 for further discussion regarding NC Air Toxics.

  Ammonia emissions from the furnace were previously less than the associated TAP Permitting Emission Rate (TPER), and a 15A NCAC 02Q .0711 condition was included in the permit. With the increased production rate, ammonia emissions now exceed the TPER, and air dispersion modeling was required for ammonia emissions from the furnace. The permit condition for 02Q .0711 will be removed, and ammonia emissions will be included with emissions limits under 02D .1100 for the furnace as part of this modification/renewal.

- 15A NCAC 02D .1111, Maximum Achievable Control Technology (MACT) –The emergency generators (ID Nos. P06 and IP09) are subject to the "NESHAP for Stationary Reciprocating Internal Combustion Engines," 40 CFR Part 63, Subpart ZZZZ. See Section 8 for more discussion of the requirements under General Available Control Technology (GACT).

- 15A NCAC 02Q .0317, Avoidance Conditions – The facility has accepted facility-wide emission limitations on NO_X, SO_2, and CO for PSD avoidance. As noted above, the PSD avoidance condition will be modified to account for actual emissions from the generators, and the EF for SO_2 and CO used in the avoidance equations will be revised as part of this modification/renewal. The permit condition will require testing to confirm the emission factors for the furnace and to re-establish the reagent injection rate for the control device (ID No. C01A). Cardinal will be required to conduct monthly emission calculations, track fuel consumption for the generators monthly, track the furnace production rate and reagent injection rate daily, and to retain fuel certification to ensure compliance with the PSD avoidance limits.

The glass cutting operation (ID No. P08) at Cardinal is included on the permit because emissions of volatile organic compounds (VOCs) from this source exceed 5 tons per year, pursuant to 15A NCAC 02Q .0503(8). However, there are no other applicable regulations for the glass cutting operation.

On November 1, 2016, amendments to 15A NCAC 02D .0902 were finalized to narrow applicability of work practice standards for VOC in 15A NCAC 02D .0958 from statewide to the maintenance area for the 1997 8-hour ozone standard. This change is being made primarily because the abundance of biogenic VOC emissions in North Carolina results in ozone formation being limited by the amount of available NOx emissions. Provisions of the Clean Air Act require VOC requirements previously implemented in an ozone nonattainment area prior to redesignation remain in place. However, facilities outside the maintenance area counties for the 1997 8-hour ozone standard would no longer be required to comply with the work practice standards in 15A NCAC 02D .0958. The maintenance area counties also include Coddle Creek Township and Davidson Township in Iredell County, as specified in 15A NCAC 02D .0902. Although Cardinal is in Iredell County, the facility is located just outside the Coddle Creek Township and is not subject to 15A NCAC 02D .0958. The permit requirement for this regulation was removed as part of the previous TV permit renewal, with the issuance of Air Permit No. 08618T07 on April 27, 2017.

8. NSPS, NESHAPS/MACT, NSR/PSD, 112(r), CAM

NSPS
Cardinal is subject to the following NSPS regulations.

NSPS Subpart CC
The "Standards of Performance for Glass Manufacturing Plants," 40 CFR 60 Subpart CC (NSPS Subpart CC) rule applies to glass furnaces commencing construction after June 15, 1979 with a glass melting furnace designed to produce 5 tons or greater of glass per day. The glass furnace (ID No. P01) at Cardinal began operation in 1999 and is currently permitted to produce 700 tpd of glass. (Note – the production rate will increase as part of this permit modification/renewal.) Thus, the furnace is subject to NSPS Subpart CC.

As required under NSPS Subpart CC, Cardinal must not exceed a filterable PM emission rate of 0.225 g/Kg of glass produced, or 0.45 lbs/ton of glass produced. Cardinal previously did not use an add on control device for PM controls and was required to conduct annually source tests to demonstrate compliance with the emission limit. With the issuance of Air Permit No. 08618T09, Cardinal began using the ceramic filters (ID No. C01C) to control PM emissions. Cardinal now ensures compliance with NSPS Subpart CC by conducting monthly visual emission inspections and annual internal inspections of the control device.

Annual testing is no longer required under NSPS Subpart CC. However, Cardinal was required to conduct an initial source test after startup of the add on control device. The results of this initial compliance testing are provided in the table below. Compliance was demonstrated during testing, and given the large margin of compliance, continued compliance is anticipated.

Pollutant	Test Results	Emission Limit	Standard	Compliance
Filterable PM	0.005 g/kg glass 0.01 lb/ton glass	0.225 g/kg glass 0.45 lb/ton glass	60 Subpart CC	Yes
Glass Pull Rate	694.6 ton/day	700 ton/day	Permitted Max.	---
Notes: Testing occurred on May 16, 2018, and source test report reviewed and approved in a memorandum from Brent Hall of the Stationary Source Compliance Branch on July 23, 2018.				

NSPS Subpart IIII
The diesel-fired emergency generator (ID No. IP09) is subject to "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines," 40 CFR 60, Subpart IIII (NSPS Subpart IIII). This regulation applies to owners and operators that commence construction of their compression ignition internal combustion engines after July 11, 2005, where the engines were manufactured after July 1, 2006, per 40 CFR 60.4200(a)(2)(ii). To comply with the emission standards for this emergency engine, Cardinal must purchase an emergency generator for the model year 2009 and later, certified to meet the emission standards for the same model year and maximum engine power in 40 CFR 89.112. As indicated in the compliance inspection report dated April 4, 2018, "The EPA engine certification document was attached to the 4/3/17 inspection report demonstrating compliance with NSPS IIII." Continued compliance is anticipated.

NESHAPS/MACT
Cardinal is minor source of HAPs and is subject to the following GACTs.

GACT Subpart ZZZZ
The two emergency generators (ID Nos. P06 and IP09) at Cardinal are subject to the "NESHAP for Stationary Reciprocating Internal Combustion Engines, 40 CFR Part 63," GACT Subpart ZZZZ.

Emergency generator (ID No. P06) is an existing engine, greater than 500 hp, located at an area source of HAPs. The requirements under GACT Subpart ZZZZ for this engine are summarized below:

- Install a non-resettable hour meter on the engine
- Change oil and filter every 500 hours of operation or annually
- Inspect all hoses and belts every 500 hours of operation or annually and replace if necessary
- Inspect air cleaner every 1,000 hours of operation or annually
- Operate no more than 100 hours for maintenance and readiness testing
- Recordkeeping and reporting requirements

The permit will be updated to reflect the most recent revision to GACT Subpart ZZZZ.

The emergency generator (ID No. IP09) is considered a new source under GACT Subpart ZZZZ because it will be construction on or after June 12, 2006. Per 40 CFR 63.590(c)(1), a new engine located at an area source of HAPs complies with GACT Subpart ZZZZ by meeting the requirements for NSPS Subpart IIII.

Applicability to GACT Subpart SSSSSS
The "National Emission Standards for Hazardous Air Pollutants for Glass Manufacturing Area Sources," 40 CFR 63 Subpart SSSSSS, applies to certain glass manufacturing facilities at area sources of HAPs. Specifically, it is applicable only to glass manufacturing facilities that use a glass manufacturing metal HAP, as defined in 40 CFR 63.11459, as raw materials in a glass manufacturing batch formulation. Cardinal does not use any HAP metal intentionally as raw material in its glass production, and thus, is not subject to this GACT. This modification/renewal does not affect the GACT status of the furnace.

NSR/PSD
Cardinal is classified as a minor source under PSD. The permit includes PSD avoidance conditions for CO, NO_X, and SO_2 to limit emissions of these pollutants to below 250 tons per year. This modification/renewal does not affect the PSD status of facility. However, the equations for calculating monthly emissions for avoidance of PSD will be modified as noted above in Section 5.

The glass cutting operation (ID No. P08) at Cardinal was previously subject to a PSD avoidance limit of 40 tpy of fugitive VOCs. This PSD avoidance condition was removed under Air Permit No. 08618T09, with the implementation of the facility-wide PSD avoidance condition, making the facility a PSD minor source. As indicated in permit review for Air Permit No. 08618T09,[4] Cardinal expects annual emissions VOCs from this operation of approximately 53 tpy. This source accounts for most of the VOC emissions from this facility, which total 53.6 tpy facility-wide as shown in Table 1A above. As such, a PSD avoidance condition is no longer required for VOCs because facility-wide potential emissions are much lower than 250 tpy.

112(r)
The facility is not subject to Section 112(r) of the Clean Air Act requirements because it does not store any of the regulated substances in quantities above the thresholds. This permit modification/renewal does not affect the 112(r) status of the facility.

[4] Permit review in support of Air Permit No. 08618T09 (Joseph Voelker, 02/28/2018).

CAM

Regulation 15A NCAC 02D .0614, CAM, is applicable to any pollutant-specific emission unit, if the following three conditions are met:

- the unit is subject to any (non-exempt: e.g. pre-November 15, 1990, Section 111 or Section 112 standard) emission limitation or standard for the applicable regulated pollutant.
- the unit uses any control device to achieve compliance with any such emission limitation or standard.
- unit's precontrol potential emission rate exceeds either 100 tons/yr (for criteria pollutants) or 10/25 tons/yr (for HAPs).

Exemptions to the CAM rule are specified in 15A NCAC 02D .0614(b).

A CAM analysis was conducted for this permit renewal, and the results are presented in Table 3 below. As seen in the table, precontrolled emissions of PM, NO_X, and SO_2 from the furnace (ID No. P01) exceed the TV threshold of 100 tons per year. Only PM emissions from the furnace are subject to CAM. Emissions of NO_X and SO_2 are not subject to CAM because control devices on the furnace are used to ensure compliance with the PSD avoidance limits for these pollutants. As specified in 15A NCAC 02D .0614(b)(1)(E), emission sources with "an emissions cap that is approved pursuant to the rules of Subchapters 02D and 02Q of this Chapter and incorporated in a permit issued pursuant to 15A NCAC 02Q .0500" are exempt from CAM.

In the existing CAM plan, ammonia slip is used as indicator of PM excursions. An ammonia analyzer installed downstream of the ceramic catalyst filters is used to monitor the ammonia slip. The manufacturer of the control system has determined that this parameter is the most accurate for identifying any malfunctions such as cracks in the ceramic catalyst filters that could indicate excess PM emissions.

The current indicator range of ammonia CAM plan is 10 ppmv. After a review of the actual monitoring data for a nine-month period (January to September, 2021), DAQ has approved an increase in the indicator range in the CAM plan to 15 ppmv of ammonia. The CAM plan will also be updated to change the QIP trigger to six excursions per semiannual period and will be reformatted as part of this permit modification/renewal.

Table 3 – CAM Analysis

Emission Source Description	Control Device Description	Pollutant	Regulation	Precontrolled Emissions (tpy)	Subject to CAM	Comments
Natural gas-fired glass melting furnace (ID No. P01)	Dry Sorbent Injection (ID No. C01A)	SO_2	15A NCAC 02D .0516	249	NO	Controls are not required for compliance.
			15A NCAC 02Q .0317			Controls are used to meet a SO_2 emissions cap approved pursuant to 02Q .0317 for PSD avoidance. Therefore, SO_2 emissions are not subject to CAM due to exemption in 15A NCAC 02D .0612(b)(1)(E).
	Ammonia Injection (ID No. C01B)	NO_X	15A NCAC 02D .0317	1,916	NO	Controls are used to meet a NO_X emissions cap approved pursuant to 02Q .0317 for PSD avoidance. Therefore, NO_X emissions are not subject to CAM due to exemption in 15A NCAC 02D .0612(b)(1)(E).
	Catalytic Ceramic Filters (ID No. C01C)	**PM**	**15A NCAC 02D .0515 15A NCAC 02D .0524**	**130**	**YES**	**Pre-controlled emissions greater than 100 tpy. Controls are required for compliance.**
Cullet Return (ID No. P02)	Bagfilter (ID No. C02)	PM	15A NCAC 02D .0515	6	NO	Pre-controlled emissions less than 100 tpy.
Bottom of Elevator (ID No. P03)	Bagfilter (ID No. C03)	PM	15A NCAC 02D .0515	5	NO	Pre-controlled emissions less than 100 tpy.
Top of Elevator (ID No. P04)	Bagfilter (ID No. C04)	PM	15A NCAC 02D .0515	2	NO	Pre-controlled emissions less than 100 tpy.
Batch Mixers (ID No. P05)	Bagfilter (ID No. C05)	PM	15A NCAC 02D .0515	2	NO	Pre-controlled emissions less than 100 tpy.

9. Facility Wide Air Toxics

The modification to increase the capacity of the furnace will result in an increase in TAP emissions, and Cardinal conducted a revised air dispersion modeling demonstrate compliance with NC Air Toxics. Emissions rates of TAPs were first compared with their associated TPERs in 15A NCAC 02Q .0711. Eight TAPs exceeded their TPER and were further evaluated in facility-wide modeling.

The only sources emitting TAPs at Cardinal are the glass furnace (ID No. P01) and the emergency generators (ID Nos. P06 and IP09). For this air dispersion modeling exercise, only the glass furnace was modeled because the emergency generators (ID Nos. P06 and IP09) are subject to GACT Subpart ZZZZ and are exempt from NC Air Toxics in accordance with 15A NCAC 02Q .0702(a)(27).

Air quality impacts from the furnace were evaluated at 100%, 75%, and 50% load. The stack flow rate and emissions were adjusted proportionally for each load condition. Because only the glass furnace was included in the modeling analysis, one TAP (ammonia) was modeled for all averaging periods. The ratio of ammonia emission rate to the emissions rates of the other TAPs was then used to derive the other TAP's predicted concentrations. This approach is valid because gaussian models such as AERMOD are linear with respect to emission rates. As such, results may be adjusted for each pollutant when emission characteristics are equivalent.

For this analysis, ammonia emissions of 87.0 lbs/hr at 100% load resulted in the maximum concentrations for all averaging periods, and these results were used to derive the predicted impacts of the other TAPs. An example calculation of how the emissions of ammonia were used to derive the predicted concentration is provided below:

Maximum modeled impact of Ammonia = 2.9E-02 mg/m3
Ammonia Emissions = 87.0 lbs/hr
H_2SO_4 Emissions = 4.56 lbs/hr
Predicted impact of H_2SO_4 = 2.9E-02 mg/m3 * (4.56 lb/hr /87.0 lbs/hr) = 1.5E-03 mg/m3

Although the generators were not included in the air dispersion model because they are exempt from NC Air Toxics, emissions from the generators were added to the emissions from the furnace to determine the predicted impacts of TAPs.

Mark Yoder of the AQAB issued a memorandum on July 14, 2021 approving the air dispersion modeling. The modeling demonstrates compliance on a source-by-source basis for TAPs. The impacts from facility-wide TAPs emissions as a percentage of Acceptable Ambient Levels (AALs) are presented in the following table.

Pollutant	Averaging Period	AAL (µg/m^3)	Maximum Modeled Impacts % of AAL
Ammonia	1-hour	2,700	1.08 %
Arsenic	Annual	2.1E-03	19.24 %
Benzene	Annual	0.12	0.32 %
Beryllium	Annual	4.1E-03	0.04 %
Cadmium	Annual	5.5E-03	0.76 %
Chromium (Soluble)	24-hour	0.62	0.08 %
Fluoride	1-hour	250	0.04 %
	24-hour	16	0.22 %

Pollutant	Averaging Period	AAL (µg/m^3)	Maximum Modeled Impacts % of AAL
Nickel	1-hour	6	0.29 %
Sulfuric Acid	1-hour	100	1.53 %
	24-hour	12	4.92 %

Notes:
In the memorandum dated July 14, 2021, the modeled impacts (daily and hourly) for fluoride was inadvertently compared with the AALs for HF. The fluoride AALs should have been used as a conservative approach, as noted in Section 5 above. This mistake was corrected in the table above. Regardless, for either TAP compliance with the AAL is demonstrated.

Due to the large margin of compliance with the AAL, no monitoring, recordkeeping, or reporting is required to demonstrate compliance with NC Air Toxics.

North Carolina G.S. 143-215.107(a) exempts certain emission sources subject to federal regulations from NC Air Toxics, provided their emissions do not present an unacceptable risk to human health, in accordance with NC G.S. 143-215. 107(b) as codified on May 1, 2014. As noted above, the diesel-fired emergency generators (ID Nos. P06 and IP09) are exempt from NC Air Toxics in accordance with 15A NCAC 02Q .0702(a)(27) because they are subject to GACT Subpart ZZZZ. These emission sources do not present an unacceptable risk to human health as discussed below, and a NC Air Toxics condition is not required for these generators.

Emergency generator (ID No. IP09)
The emergency generator (ID No. IP09) was added to the permit under Air Permit No. 08618T07 issued on April 27, 2017. DAQ made a demonstration at that time that the addition of this emergency generator does not pose an unacceptable risk to human health.[5]

Emergency generator (ID No. P06)
This generator has been included on the permit since the initial TV permit was issued, and no permitted emission limits under 15A NCAC 02D .1100 have been included in any permit for this generator. As an exercise to demonstrate that emissions from this generator do not present an unacceptable risk to human health, DAQ evaluate emissions from the generator as part of this modification/renewal. Emissions of TAPs from the generator were below their TPERS, as shown in the table below.

TAPS	Emissions			TPERS			Modeling Needed?
	lb/hr	lb/day	lb/yr	lb/hr	lb/day	lb/yr	
Acetaldehyde	4.0E-04	9.7E-03	2.0E-01	6.8E+00			NO
Acrolein	1.3E-04	3.0E-03	6.3E-02	9.6E-01			NO
Arsenic unlisted compounds	6.4E-05	1.5E-03	3.2E-02			5.3E-02	NO
Benzene	1.2E-02	3.0E-01	6.2E+00			8.1E+00	NO
Benzo (a) pyrene	4.1E-06	9.9E-05	2.1E-03			2.2E+00	NO
Beryllium metal (unreacted)	4.8E-05	1.2E-03	2.4E-02			2.8E-02	NO
Cadmium metal (elemental unreacted)	4.8E-05	1.2E-03	2.4E-02			3.7E-01	NO

[5] Permit review in support of Air Permit No. 08618T07 (Betty Gatano, 04/27/2017).

TAPS	Emissions			TPERS			Modeling Needed?
	lb/hr	lb/day	lb/yr	lb/hr	lb/day	lb/yr	
Chromic Acid (VI)	4.8E-05	1.2E-03	2.4E-02		1.3E-02		NO
Formaldehyde	1.3E-03	3.0E-02	6.3E-01	4.0E-02			NO
Manganese unlisted compounds	9.6E-05	2.3E-03	4.8E-02		1.3E-02		NO
Mercury vapor	4.8E-05	1.2E-03	2.4E-02		1.3E-02		NO
Nickel metal	4.8E-05	1.2E-03	2.4E-02		1.3E-01		NO
Toluene	4.5E-03	1.1E-01	2.2E+00	1.4E+01	9.8E+01		NO
Xylenes	3.1E-03	7.4E-02	1.5E+00	1.6E+01	5.7E+01		NO

Notes:
Emissions from the emergency generator were calculated using DAQ's "Large Diesel and Dual-fuel Engines Emissions Calculator LGD2012 Revision J" (06/22/2015), with 500 operating hours per year for an emergency engine and an engine output of 1500 kW.

10. Facility Emissions Review

The Title V potential emissions are provided in the table below. Actual emissions for 2016 to 2020 as reported in the emission inventories are presented in the header to this permit review.

Pollutant	Potential Facility-wide Emissions after Modification (tpy)
PM (TSP) PM_{10} $PM_{2.5}$	142.7
CO	<250
NO_X	< 250
SO_2	< 250
VOC	53.6
Lead	0.2
Fluoride	1.2
Sulfuric acid	20.3
CO_2e	160,281
Largest HAP	2.02 (hexane)
Total HAP	4.7

11. Compliance Status

During the most recent inspection, conducted on March 2, 2022 by Alejandra Cruz of the MRO, the facility appeared to be in compliance with all applicable requirements. A signed Title V Compliance

Certification (Form E5) indicating the facility was in compliance with all applicable requirements was included with the permit application.

12. Facility Comments on Draft Permit and DAQ's Responses

Cardinal submitted comments on the first permit draft on July 28, 2021. Significant comments from Cardinal are addressed here. Minor typographical errors, incorrect references, etc. are not addressed below but are corrected in the permit.

- Request to estimate emissions from generators using fuel consumption – In the permit application to increase the furnace throughput (App. No. 4900261.21A), Cardinal requested to use the actual emissions from the generators in the PSD avoidance equations rather than a calculated maximum value. The draft permit included this request. However, emissions from the generators (ID Nos. IP09 and P06) were based on monthly operating hours rather than fuel consumption. Cardinal requested that the avoidance equations use actual fuel consumption, rather than actual operating hours.

  DAQ Response
  DAQ granted this request, as this approach is an equally method to calculate emissions from the generators.

- Request to use 30 ppm ammonia for trigger level for CAM – In the permit application to increase the furnace throughput (App. No. 4900261.21A), Cardinal requested to increase the indicator range for ammonia slip in the CAM plan from 10 ppmv to 30 ppmv. This request was repeated in the Cardinal's comments on the draft permit.

  Cardinal indicated the increase was intended to address short-term increases in ammonia slip, such as when the dampers to the heat recover regenerators change direction every 10 to 15 minutes. Cardinal also noted the updated modeling analysis for NC Air Toxics shows compliance with the AAL at 87 lbs/hr. This emission rate equates to 656 ppm of ammonia, which exceeds the requested 30 ppmv indicator range for ammonia slip.

  DAQ Response
  The 10 ppmv ammonia level was not established for compliance with NC Air Toxics. The 10 ppmv was based on the manufacturer's recommendation to ensure proper operation of the ceramic catalyst filter. The following excerpt was taken from the permit review in support of Air Permit No. 08618T09.

  > On October 6, 2017, the Permittee submitted a CAM plan for PM. The plan will be based on utilizing the ammonia analyzer installed downstream of the ceramic catalyst filters. This analyzer is used to monitor the ammonia slip. The manufacturer of the control system has determined that this parameter is the most accurate for identifying any malfunctions such as cracks in the ceramic catalyst filters. The manufacturer recommends that ceramic filter leaks and cracks be investigated when ammonia concentrations exceed 10 ppmv. Typical ammonia concentrations are 1 to 3ppmv.

  This statement implies that operating at higher concentration may indicate failure of the control system. DAQ requested additional justification for the increase, and Cardinal submitted the requested information including nine months (January to September, 2021) of monitoring data on November 3, 2021.

  The monitoring data showed Cardinal never approached 30 ppmv of ammonia. Therefore, this value is not appropriate an indicator range under the CAM plan. The highest value of ammonia over the

nine-month period was 17.3 ppmv on March 4, 2021. Based on the actual data, DAQ proposed 15 ppmv as the indicator value for ammonia, and Cardinal agreed to this proposal. The CAM plan was updated as part of this modification/renewal to incorporate this change.

- Request to change the averaging period for the reagent injection rate – In the permit application to increase the furnace throughput (App. No. 4900261.21A),Cardinal requested to change the reagent injection rate to control SO_2 emissions from the furnace from a daily average to a monthly average. This request was repeated in Cardinal's comments on the draft permit.

  Because SO_2 emissions from the furnace are based on long-term compliance with the annual emission threshold of 250 tpy for avoidance of PSD, Cardinal requested reagent usage based on monthly average to accommodate short term averages.

  DAQ response
  A monthly average for reagent injection rate is not typical. It can result in days or weeks with little or no reagent injections (and little or no control) and over feeding the reagent at other times to arrive at a monthly average that meets the limit. The facility cannot ensure continued compliance under this scenario. Therefore, DAQ does not agree with allowing a monthly average for reagent injection.

13. Public Notice/EPA and Affected State(s) Review

A notice of the DRAFT Title V Permit shall be made pursuant to 15A NCAC 02Q .0521. The notice will provide for a 30-day comment period, with an opportunity for a public hearing. Consistent with 15A NCAC 02Q .0525, the EPA will have a concurrent 45-day review period. Copies of the public notice shall be sent to persons on the Title V mailing list and EPA. Pursuant to 15A NCAC 02Q .0522, a copy of each permit application, each proposed permit and each final permit shall be provided to EPA. Also, pursuant to 02Q .0522, a notice of the DRAFT Title V Permit shall be provided to each affected State at or before the time notice is provided to the public under 02Q .0521 above. South Carolina and Mecklenburg County Air Quality are affected entities within 50 miles of the facility.

14. Other Regulatory Considerations

- No P.E. seal is required for either application (App Nos. 4900261.21A or 4900261.21B).
- No zoning consistency determination is required for either application (App Nos. 4900261.21A or 4900261.21B).
- A permit fee is required for the significant modification (App No. 4900261.21A) and was received via e-payment on May 27, 2021. No permit fee was required for the application for TV permit renewal (App No. 4900261.21B).

15. Recommendations

The applications for permit modification and renewal for Cardinal FG Company located in Mooresville, Iredell County, NC has been reviewed by DAQ to determine compliance with all procedures and requirements. NC DAQ has determined that this facility is complying or will achieve compliance, as specified in the permit, with all requirements that are applicable to the affected sources. The NC DAQ recommends the issuance of Air Permit No. 08618T12.

Attachment 1

Emission Calculations for Modification (Application No. .4900261.21A)

Table 1 – Existing Plant Potential Emissions

Process	Thruput	Thruput	Schedule	Flow	PM/PM10/PM2.5		SO2		NOx		CO		VOC		Pb		H2SO4		CO2e		CAA HAP	
		Units	(hrs/yr)	(acfm)	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units
P01 – Glass Furnace	700	tpd glass	8,760		0.95	lbs/ton	1.738	lbs/ton	1.83	lbs/ton	1.9	lbs/ton	0.1	lbs/ton	0.00171	lbs/ton	0.1713	lbs/ton	1,171	lbs/ton	0.027	lbs/ton
P02 – Cullet Handling	29	tph cullet	8,760	45,000	0.0067	gr/acf																
P03 – Batch Plant – Elevator Bottom	300	tph	8,760	2,200	0.0067	gr/acf																
P04 – Batch Plant – Elevator Top	300	tph	8,760	1,200	0.0067	gr/acf																
P05 – Batch Plant – Mixers	150	tph	8,760	1,800	0.0067	gr/acf																
P06 – Emergency Generator	15.6	mmbtu/hr	500	1.5 mw	0.0697	lbs/mmbtu	0.0505	lbs/mmbtu	3.1	lbs/mmbtu	0.81	lbs/mmbtu	0.09	lbs/mmbtu							0.001617	lbs/mmbtu
IP09 – Emergency Generator	10.2	mmbtu/hr	500	1.0 mw	0.06	lbs/mmbtu	0.0505	lbs/mmbtu	1.584	lbs/mmbtu	0.42	lbs/mmbtu	0.01	lbs/mmbtu							0.001617	lbs/mmbtu
P07 – Annealing Lehr	6.3	lbs/hr SO2	8,760				100%	lbs/lbs														
P08 – Glass Cutting	9.1	lbs/hr VOC	8,760										1	lbs/lbs								
Total Emissions																						

Basis for Existing Plant Emission Estimates

Values changing with capacity project are highlighted.

P01 – Glass Furnace	PM, SO2, NOx, CO, VOC, Pb, and H2SO4 emission factors are current limitations in Air Quality Permit No. 08618T11.
	CO2e – average factor reported for 2011 to 2014 for Cardinal FG – Durant OK
P02 – Cullet Handling	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P03 – Batch Plant – Elevator Bottom	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P04 – Batch Plant – Elevator Top	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P05 – Batch Plant – Mixers	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P06 – Emergency Generator	PM, SO2, NOx, CO, and VOC emissions are based on current requirements in Air Quality Permit No. 08618T11.
IP09 – Emergency Generator	PM, SO2, NOx, CO, and VOC emissions are based on current requirements in Air Quality Permit No. 08618T11, which are based on 2016 emission calculations.
P07 – Annealing Lehr	SO2 emissions based on usage and loss factor of 100% of SO2 assumed by NCDEQ in Air Quality Permit No. 08618T11.
P08 – Glass Cutting	VOC emissions are based on usage limitation in Air Quality Permit No. 08618T11.

Table 1 – Existing Plant Potential Emissions

Process	PM/PM10/PM2.5		SO2		NOx		CO		VOC		Pb		H2SO4		CO2e		CAA HAP	
	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)
P01 – Glass Furnace	27.7	121.4	50.7	222.0	53.4	233.8	55.4	242.7	2.9	12.78	0.050	0.22	5.00	21.88	34,154	149,595	0.8	3.4
P02 – Cullet Handling	2.58	11.32																
P03 – Batch Plant – Elevator Bottom	0.13	0.55																
P04 – Batch Plant – Elevator Top	0.07	0.30																
P05 – Batch Plant – Mixers	0.10	0.45																
P06 – Emergency Generator	1.09	0.27	0.79	0.20	48.36	12.09	12.64	3.2	1.40	0.35							0.0252	0.000001
IP09 – Emergency Generator	0.61	0.15	0.52	0.13	16.16	4.04	4.28	1.1	0.10	0.03							0.0165	0.000000
P07 – Annealing Lehr			6.30	27.59														
P08 – Glass Cutting									9.1	39.86								
Total Emissions	**32.3**	**134.4**	**58.3**	**249.9**	**117.9**	**249.9**	**72.3**	**247.0**	**13.5**	**53.0**	**0.0**	**0.2**	**5.0**	**21.9**	**34,154**	**149,595**	**0.8**	**3.4**

Attachment 1

Emission Calculations for Modification (Application No. .4900261.21A)

Table 2 - Proposed Plant Potential Emissions

Process	Thruput	Thruput	Schedule	Flow	PM/PM10/PM2.5		SO2		NOx		CO		VOC		Pb		H2SO4		CO2e		CAA HAP	
		Units	(hrs/yr)	(acfm)	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units	Factor	Units
P01 - Glass Furnace	750	tpd glass	8,760		0.95	lbs/ton	1.65	lbs/ton	1.82	lbs/ton	1.824	lbs/ton	0.1	lbs/ton	0.00171	lbs/ton	0.148374	lbs/ton	1,171	lbs/ton	0.026	lbs/ton
P02 - Cullet Handling	31.25	tph cullet	8,760	45,000	0.0067	gr/acf																
P03 - Batch Plant - Elevator Bottom	300	tph	8,760	2,200	0.0067	gr/acf																
P04 - Batch Plant - Elevator Top	300	tph	8,760	1,200	0.0067	gr/acf																
P05 - Batch Plant - Mixers	150	tph	8,760	1,800	0.0067	gr/acf																
P06 - Emergency Generator	15.6	mmbtu/hr	25	1.5 mw	0.0697	lbs/mmbtu	0.001	lbs/mmbtu	3.1	lbs/mmbtu	0.81	lbs/mmbtu	0.09	lbs/mmbtu							0.001617	lbs/mmbtu
IP09 - Emergency Generator	10.2	mmbtu/hr	25	1.0 mw	0.06	lbs/mmbtu	0.001	lbs/mmbtu	1.584	lbs/mmbtu	0.42	lbs/mmbtu	0.01	lbs/mmbtu							0.001617	lbs/mmbtu
P07 - Annealing Lehr	6.3	lbs/hr SO2	--				100%	lbs/lbs														
P08 - Glass Cutting	9.1	lbs/hr VOC	8,760										1	lbs/lbs								
Total Emissions																						
Part 70 Major Source Threshold																						
PSD Major New Source Review Threshold																						
Change from Existing to Proposed																						

Basis for Proposed Plant Emission Estimates

Values and references changing with capacity project are highlighted.

P01 - Glass Furnace	PM (total) - Same emission factor used for Air Quality Permit No. 08618T11.
	SO2 - limitation reduced due to increased capacity as necessary to remain below 250 tpy.
	NOx - limitation reduced due to increased capacity as necessary to remain below 250 tpy.
	CO - limitation reduced due to increased capacity as necessary to remain below 250 tpy.
	VOC - Same emission factor used for Air Quality Permit No. 08618T11.
	Pb - 359 ppm in PM from 2015 test at Cardinal - Menomonie WI x 5 safety factor
	H2SO4 - 9% of SO2 emissions based on a review of prior H2SO4 and SO2 stack test results.
	CO2e - emissions vary with fuel and raw material usage so this is an average factor reported for 2011 to 2014 for Cardinal - Durant OK.
	Factors for the Mooresville plant in 2019 and 2020 were 932 and 950 lbs/ton, respectively.
P02 - Cullet Handling	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P03 - Materials Handling	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P04 - Materials Mixing	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P05 - Materials Elevator	PM emission factor is BACT limitation in Air Quality Permit No. 08618T08.
P06A - Emergency Generator	PM, NOx, CO, and VOC emissions are based on factors from original 1998 air permit application, USEPA, AP42, Tables 3.4-2 and 3.4-5, January 1995.
IP09 - Emergency Generator	PM, NOx, CO, and VOC emissions are based on manufacturers specification sheet.
	SO2 factor for both generators are updated based on use of ULSD with 10 ppm sulfur content, where: 144(0.001)/gal3*140,000 BTU/gal = 0.001 lbs/mmbtu
P07 - Annealing Lehr	SO2 emissions based on usage and loss factor of 100% of SO2 assumed by NCDEQ in Air Quality Permit No. 08618T11.
	Actual usage of 24.3 tpy was used for estimating emissions.
P08 - Glass Cutting	VOC emissions are based on usage limitation in Air Quality Permit No. 08618T11.

Table 2 - Proposed Plant Potential Emissions

Process	PM/PM10/PM2.5		SO2		NOx		CO		VOC		Pb		H2SO4		CO2e		CAA HAP	
	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)
P01 - Glass Furnace	29.7	130.0	51.5	225.7	56.9	249.1	57.0	249.7	3.1	13.69	0.053	0.23	4.64	20.31	36,594	160,281	0.8	3.5
P02 - Cullet Handling	2.58	11.32																
P03 - Batch Plant - Elevator Bottom	0.13	0.55																
P04 - Batch Plant - Elevator Top	0.07	0.30																
P05 - Batch Plant - Mixers	0.10	0.45																
P06 - Emergency Generator	1.09	0.01	0.02	0.0002	48.36	0.60	12.64	0.2	1.40	0.02							0.0252	0.000001
IP09 - Emergency Generator	0.61	0.01	0.01	0.0001	16.16	0.20	4.28	0.1	0.10	0.00							0.0165	0.000000
P07 - Annealing Lehr			6.30	24.3														
P08 - Glass Cutting									9.1	39.86								
Total Emissions	**34.3**	**142.7**	**57.8**	**249.9**	**121.4**	**249.9**	**73.9**	**249.9**	**13.7**	**53.6**	**0.1**	**0.2**	**4.6**	**20.3**	**36,594**	**160,281**	**0.8**	**3.5**
Part 70 Major Source Threshold		**100**		**100**		**100**		**100**		**100**		**100**		**100**		**100,000**		**25**
PSD Major New Source Review Threshold		**250**		**250**		**250**		**250**		**250**		**250**		**250**		**n/a**		**n/a**
Change from Existing to Proposed	**2.0**	**8.3**	**-0.5**	**0.0**	**3.5**	**0.0**	**1.6**	**2.9**	**0.2**	**0.6**	**0.004**	**0.02**	**-0.36**	**-1.57**	**2,440**	**10,685**	**0.0**	**0.1**

Attachment 1

Emission Calculations for Modification (Application No. .4900261.21A)

TABLE 1 - EMISSION ESTIMATES FOR TOXIC AIR POLLUTANTS FOR THE PROPOSED FACILITY

Stack	S01		Description				Furnace
Control	C01ABC		Production Rate (TPD)				750
Process	P01		Natural Gas Usage (cf/hr)				0.257
Air Pollutant	Emission Factor Units	Emission Factor Reference	Potential Emission Factor	Potential Emissions lbs/hr	Potential Emissions lbs/day	Potential Emissions lbs/yr	Potential Emissions TPY
Criteria Air Pollutants							
PM (total)	lbs/ton	A	0.95	29.7			130.0
H2SO4	lbs/ton	A	0.1458	4.6	109.4	39913	20.0
HF	lbs/ton	D	0.0068	0.3	6.6	2409	1.2
Inorganic HAP							
Arsenic	ppm in PM	B	870	0.0258	0.6199	226.25	0.1131
Beryllium	lbs/cf6	C	0.000012	0.000003084	0.0001	0.03	0.0000
Cadmium	ppm in PM	B	87	0.0026	0.0620	22.63	0.0113
Chromium	ppm in PM	B	130	0.0039	0.0926	33.81	0.0169
Cobalt	lbs/cf6	C	0.000084	0.000021588	0.0005	0.19	0.0001
Manganese	lbs/cf6	C	0.00038	0.00009766	0.0023	0.86	0.0004
Mercury	lbs/cf6	C	0.00026	0.00006682	0.0016	0.59	0.0003
Nickel	ppm in PM	B	442	0.0131	0.3149	114.95	0.0575
Selenium	lbs/cf6	C	0.000024	0.000006168	0.0001	0.05	0.0000
Organic HAP							
Acenaphthene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Acenaphthylene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Anthracene	lbs/cf6	C	0.0000024	0.0000006	0.000015	0.005403	0.000003
Benzo(a)anthracene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Benzene	lbs/cf6	C	0.0021	0.0005397	0.012953	4.727772	0.002364
Benzo(a)pyrene	lbs/cf6	C	0.0000012	0.0000003	0.000007	0.002702	0.000001
Benzo(b)fluoranthene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Benzo(g,h,i)perylene	lbs/cf6	C	0.0000012	0.0000003	0.000007	0.002702	0.000001
Benzo(k)fluoranthene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Chrysene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Dibenzo(a,h,)anthracene	lbs/cf6	C	0.0000012	0.0000003	0.000007	0.002702	0.000001
Dichloroberizene	lbs/cf6	C	0.0012	0.0003084	0.007402	2.701584	0.001351
Dimethylbenze(a)anthracene	lbs/cf6	C	0.000016	0.0000041	0.000099	0.036021	0.000018
Fluoranthene	lbs/cf6	C	0.000003	0.0000008	0.000019	0.006754	0.000003
Fluorene	lbs/cf6	C	0.0000028	0.0000007	0.000017	0.006304	0.000003
Formaldehyde	lbs/cf6	C	0.075	0.0192750	0.462600	168.849000	0.084425
Hexane	lbs/cf6	C	1.8	0.4626000	11.102400	4052.37600	2.026188
Indeno(1,2,3-cd)pyrene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Methylchloranthrene	lbs/cf6	C	0.0000018	0.0000005	0.000011	0.004052	0.000002
Methylnaphthalene	lbs/cf6	C	0.000024	0.0000062	0.000148	0.054032	0.000027
Naphthalene	lbs/cf6	C	0.00061	0.0001568	0.003762	1.373305	0.000687
Phenanathrene	lbs/cf6	C	0.000017	0.0000044	0.000105	0.038272	0.000019
Pyrene	lbs/cf6	C	0.000005	0.0000013	0.000031	0.011257	0.000006
Toluene	lbs/cf6	C	0.0034	0.0008738	0.020971	7.654488	0.003827
Ammonia Slip	lbs/ton	E	0.2546	7.95	190.9	69685	34.8
Total CAA HAP	lbs/ton		0.026	0.8043638	203.6	74322	37.2
References							
A - Proposed emission limitation. H2SO4 based on 9%of SO2 emissions, a conservative derivation from prior stack tests.							
B - Cardinal FG - Menomonie stack tests on September 2, 2015 for metals and PM.							
C - Compilation of Air Pollutant Emission Factors, Tables 1.4-3 and 1.4.4, EF from Natural Gas Combustion, July 1998.							
D - Cardinal FG - Mooresville stack test in March 2000 for fluorides on an uncontrolled furnace.							
E - Based on estimated ammonia slip of 1 ppmv with safety factor of 60 for potential emissions during a regenerator shift.							
Exhaust gas flow rate and temperature taken from May 16, 2018 stack test measuring 96,469 acfm at 582 F and 689.5 tpd.							
(acfm)	(deg F)	(scfm)	(ppmv)	(scf/lb-mole)	(lbs/lb-mole)	(lbs/hr)	(lbs/ton)
104,932	582	53,171	60	385	16	8.0	0.2546
Comparison with Thresholds under 02Q .0711							
Toxic Air Pollutant	Potential Emissions (lbs/hr)	Potential Emissions (lbs/day)	Potential Emissions (lbs/yr)	02Q .0711 Threshold (lbs/hr)	02Q .0711 Threshold (lbs/day)	02Q .0711 Threshold (lbs/yr)	02Q .0711 Threshold Exceeded?
Arsenic	0.026	0.62	226.3			0.194	Yes
Cadmium	0.003	0.06	22.6			0.507	Yes
Chromium (non-specific VI)	0.004	0.09	33.8			0.008	Yes
Nickel	0.013	0.31	114.9			0.025	Yes
Sulfuric Acid	4.556	109.35	39912.8	0.11	0.5		Yes
Ammonia (Slip)	7.955	190.92	69685.1	2.84			Yes

Attachment 1

Emission Calculations for Modification (Application No. .4900261.21A)

Stack	S06	Fuel Input (gph)		111.4			
Control	n/a	Energy Input (MMBTU/hr)		15.6			
Process	P06	Fuel Usage Limit (gal/yr)		11140			
Description	Generator	Capacity Factor		1%			
Air Pollutant	Emission Factor Units	Emission Factor Reference	Potential Emission Factor	Potential Emissions lbs/hr	Potential Emissions lbs/day	Potential Emissions lbs/yr	Potential Emissions TPY
Inorganic HAP							
Arsenic	lbs/MMBTU	B	0.000004	0.000062	0.0015	0.5465	0.00000
Beryllium	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Cadmium	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Chromium	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Lead	lbs/MMBTU	B	0.000009	0.000140	0.0034	1.2296	0.00001
Mercury	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Nickel	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Selenium	lbs/MMBTU	B	0.000015	0.000234	0.0056	2.0493	0.00001
Organic Air Toxics							
Benzene	lbs/MMBTU	C	0.000776	0.012102	0.2905	106.0179	0.00061
Toluene	lbs/MMBTU	C	0.000281	0.004382	0.1052	38.3905	0.00022
Xylenes	lbs/MMBTU	C	0.000193	0.003010	0.0722	26.3678	0.00015
Formaldehyde	lbs/MMBTU	C	0.000079	0.001231	0.0295	10.7794	0.00006
Acetaldehyde	lbs/MMBTU	C	0.000025	0.000393	0.0094	3.4428	0.00002
Acrolein	lbs/MMBTU	C	0.000008	0.000123	0.0029	1.0766	0.00001
Total PAH	lbs/MMBTU	C	0.000212	0.003306	0.0794	28.9636	0.00017
Total HAP	lbs/MMBTU		0.001617	0.02522	0.60524	220.9134	0.00126
References							
A - Fuel usage, stack flow, and emission rates provided by generator vendor.							
B - Compilation of Air Pollutant Emission Factors, Table 1.3-10 (Trace Elements from Fuel Oil), May 2010.							
C - Compilation of Air Pollutant Emission Factors, Tables 3.4-3 (Large Diesel), October 1996.							
Stack	n/a	Fuel Input (gph)		71.7			
Control	n/a	Energy Input (MMBTU/hr)		10.0			
Process	IP-09	Fuel Usage Limit (gal/yr)		7170			
Description	Generator	Capacity Factor		1%			
Air Pollutant	Emission Factor Units	Emission Factor Reference	Potential Emission Factor	Potential Emissions lbs/hr	Potential Emissions lbs/day	Potential Emissions lbs/yr	Potential Emissions TPY
Inorganic HAP							
Arsenic	lbs/MMBTU	B	0.000004	0.000062	0.0015	0.5465	0.00000
Beryllium	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Cadmium	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Chromium	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Lead	lbs/MMBTU	B	0.000009	0.000140	0.0034	1.2296	0.00001
Mercury	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Nickel	lbs/MMBTU	B	0.000003	0.000047	0.0011	0.4099	0.00000
Selenium	lbs/MMBTU	B	0.000015	0.000234	0.0056	2.0493	0.00001
Organic Air Toxics							
Benzene	lbs/MMBTU	C	0.000776	0.012102	0.2905	106.0179	0.00061
Toluene	lbs/MMBTU	C	0.000281	0.004382	0.1052	38.3905	0.00022
Xylenes	lbs/MMBTU	C	0.000193	0.003010	0.0722	26.3678	0.00015
Formaldehyde	lbs/MMBTU	C	0.000079	0.001231	0.0295	10.7794	0.00006
Acetaldehyde	lbs/MMBTU	C	0.000025	0.000393	0.0094	3.4428	0.00002
Acrolein	lbs/MMBTU	C	0.000008	0.000123	0.0029	1.0766	0.00001
Total PAH	lbs/MMBTU	C	0.000212	0.003306	0.0794	28.9636	0.00017
Total HAP	lbs/MMBTU		0.002512	0.02522	0.60524	220.9134	0.00126
References							
A - Fuel usage, stack flow, and emission rates provided by generator vendor.							
B - Compilation of Air Pollutant Emission Factors, Table 1.3-10 (Trace Elements from Fuel Oil), May 2010.							
C - Compilation of Air Pollutant Emission Factors, Tables 3.4-3 (Large Diesel), October 1996.							

Attachment 1

Emission Calculations for Modification (Application No. .4900261.21A)

	750 tpd			02Q .0711	02Q .0711	02Q .0711	02Q .0711	02Q .0711							
	Potential Emissions	Potential Emissions	Potential Emissions	Carcinogen	Chronic Toxicants	Acute Systematic	Acute Irritants	Threshold Exceeded?	Current Limitation	Current Limitation	Current Limitation	Change Current	Guideline Annual	Guideline 24-hour	Guideline 1-hour
	lbs/hr	lbs/day	lbs/yr	lb/yr	lb/day	lbs/hr	lbs/hr		lbs/hr	lbs/day	lbs/year	Limitation	µg/m³	µg/m³	µg/m³
Criteria Air Pollutants															
H2SO4	4.5563	109.35	39912.75		0.5	0.11		Yes	5	120		No		0.012	0.1
HF	0.2750	6.60	2409.00		0.34	0.064		Yes	0.66	15.8		No		0.03	0.25
Inorganic HAP															
Arsenic	0.0260	0.62	227.35	0.194				Yes			367.9	No	2.1E-06		
Beryllium	0.0001	0.00	0.85	0.378				Yes				No	4.1E-06		
Cadmium	0.0027	0.06	23.45	0.507				Yes			297.8	No	5.5E-06		
Chromium (Soluble)	0.0040	0.09	34.63		0.0026			Yes		0.61		No		0.00062	
Cobalt	0.0000	0.001	0.19	-				No							
Manganese	0.0001	0.002	0.86		1.3			No							
Mercury	0.0002	0.004	1.41		0.025			No							
Nickel (Soluble)	0.0132	0.32	115.77		0.025			Yes		0.19		No		0.0006	
Selenium	0.0005	0.01	4.15		-			No							
Organic HAP															
Acenaphthene	0.0000	0.00	0.00	-				No							
Acenaphthylene	0.0000	0.00	0.00	-				No							
Anthracene	0.0000	0.00	0.01	-				No							
Benzo(a)anthracene	0.0000	0.00	0.00	-				No							
Benzene	0.0247	0.59	216.76	11.069				Yes				Yes	0.00012		
Benzo(a)pyrene	0.0000	0.00	0.00	3.044				No							
Benzo(b)fluoranthene	0.0000	0.00	0.00	-				No							
Benzo(g,h,i)perylene	0.0000	0.00	0.00	-				No							
Benzo(k)fluoranthene	0.0000	0.00	0.00	-				No							
Chrysene	0.0000	0.00	0.00	-				No							
Dibenzo(a,h,)anthracene	0.0000	0.00	0.00	-				No							
Dichlorobenzene	0.0003	0.01	2.70				69.5	No							
Dimethylbenze(a)anthracene	0.0000	0.00	0.04	-				No							
Fluoranthene	0.0000	0.00	0.01	-				No							
Fluorene	0.0000	0.00	0.01	-				No							
Formaldehyde	0.0217	0.52	190.41				0.16	No							
Hexane	0.4626	11.10	4052.38		46.3			No							
Indeno(1,2,3-cd)pyrene	0.0000	0.00	0.00	-				No							
Methylchloranthrene	0.0000	0.00	0.00	-				No							
Methylnaphthalene	0.0000	0.00	0.05	-				No							
Naphthalene	0.0002	0.00	1.37	-				No							
Phenanathrene	0.0000	0.00	0.04	-				No							
Pyrene	0.0000	0.00	0.01	-				No							
Toluene	0.0096	0.23	84.44		197.96			No							
Xylene	0.0060	0.14	52.74		113.7			No							
Acetaldehyde	0.0008	0.02	6.89				28.43	No							
Acrolein	0.0002	0.01	2.15				0.08	No							
Total PAH	0.0066	0.16	57.93	-				No							
Ammonia Slip	7.9549	190.92	69685.11				2.84	Yes				Yes			2.7

Attachment 1

Emission Calculations for Modification (Application No. .4900261.21A)

Process	Thruput	Thruput	PM/PM10/PM2.5		SO2		NOx		CO		VOC		Pb		H2SO4		CO2e		CAA HAP	
		Units	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)
P01 - Glass Furnace	700	tpd glass	27.7	121.4	50.7	222.0	53.4	233.8	55.4	242.7	2.9	12.8	0.050	0.2	5.0	21.9	34154.2	149,595	0.8	3.4
P02 - Cullet Handling	29	tph cullet	2.6	11.3																
P03 - Batch Plant - Elevator Bottom	300	tph	0.1	0.6																
P04 - Batch Plant - Elevator Top	300	tph	0.1	0.3																
P05 - Batch Plant - Mixers	150	tph	0.1	0.5																
P06 - Emergency Generator	15.6	mmbtu/hr	1.1	0.3	0.8	0.2	48.4	12.1	12.6	3.2	1.4	0.4							0.0	0.0
IP09 - Emergency Generator	10.2	mmbtu/hr	0.6	0.2	0.5	0.1	16.2	4.0	4.3	1.1	0.1	0.0							0.0	0.0
P07 - Annealing Lehr	6.3	lbs/hr SO2			6.3	27.6														
P08 - Glass Cutting	9.1	lbs/hr VOC									9.1	39.9								
Total Emissions			**32.3**	**134.4**	**58.3**	**249.9**	**117.9**	**249.9**	**72.3**	**247.0**	**13.5**	**53.0**	**0.05**	**0.2**	**5.0**	**21.9**	**34154.2**	**149,595**	**0.8**	**3.4**
Process	Thruput	Thruput	PM/PM10/PM2.5		SO2		NOx		CO		VOC		Pb		H2SO4		CO2e		CAA HAP	
		Units	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)	(lbs/hr)	(tpy)
P01 - Glass Furnace	750	tpd glass	29.7	130.0	51.5	225.7	56.9	249.1	57.0	249.7	3.1	13.7	0.053	0.2	4.6	20.3	36593.8	160,281	0.8	3.5
P02 - Cullet Handling	31.25	tph cullet	2.6	11.3																
P03 - Batch Plant - Elevator Bottom	300	tph	0.1	0.6																
P04 - Batch Plant - Elevator Top	300	tph	0.1	0.3																
P05 - Batch Plant - Mixers	150	tph	0.1	0.5																
P06 - Emergency Generator	15.6	mmbtu/hr	1.1	0.0	0.016	0.0002	48.4	0.6	12.6	0.2	1.4	0.0							0.0	0.0
IP09 - Emergency Generator	10.2	mmbtu/hr	0.6	0.0	0.010	0.0001	16.2	0.2	4.3	0.1	0.1	0.0							0.0	0.0
P07 - Annealing Lehr	6.3	lbs/hr SO2			6.3	24.3														
P08 - Glass Cutting	9.1	lbs/hr VOC									9.1	39.9								
Total Emissions			**34.3**	**142.7**	**57.8**	**249.9**	**121.4**	**249.9**	**73.9**	**249.9**	**13.7**	**53.6**	**0.05**	**0.2**	**4.6**	**20.3**	**36593.8**	**160,281**	**0.8**	**3.5**
Change in Emissions			**2.0**	**8.3**	**-0.5**	**0.0**	**3.5**	**0.0**	**1.6**	**2.9**	**0.2**	**0.6**	**0.004**	**0.02**	**-0.4**	**-1.6**	**2439.6**	**10,685**	**0.0**	**0.1**