NORTH CAROLINA DIVISION OF AIR QUALITY

Application Review

Issue Date:

Region: Raleigh Regional Office
County: Chatham
NC Facility ID: 1900134
Inspector's Name: Dawn Reddix
Date of Last Inspection: 06/18/2021
Compliance Code: 3 / Compliance - inspection

Facility Data

Applicant (Facility's Name): Duke Energy Progress, LLC - Cape Fear STAR Facility

Facility Address:
Duke Energy Progress, LLC - Cape Fear STAR Facility
500 C P and L Road
Moncure, NC 27559

SIC: 4911 / Electric Services
NAICS: 221112 / Fossil Fuel Electric Power Generation

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 .0540, 02D .1100, 02D .1111, 02Q .0317, 02Q .0711
NSPS: NSPS IIII
NESHAP: GACT ZZZZ
PSD: N/A
PSD Avoidance: Yes
NC Toxics: Yes
112(r): N/A
Other: N/A

Contact Data

Facility Contact	Authorized Contact	Technical Contact
Leanne Wilson, Senior EHS Professional (336) 597-7324 500 C P & L Road Moncure, NC 27559	Issa Zarzar GM CCP Project Management (919) 546-7574 Duke Energy Progress, LLC Raleigh, NC 27601	Erin Wallace Manager, EHS (919) 546-5797 410 South Wilmington Street Raleigh, NC 27601

Application Data

Application Number: 1900134.21A
Date Received: 09/14/2021
Application Type: Modification
Application Schedule: TV-1st Time

Existing Permit Data

Existing Permit Number: 10583/R01
Existing Permit Issue Date: 05/13/2020
Existing Permit Expiration Date: 05/31/2027

Total Actual emissions in TONS/YEAR:

CY	SO2	NOX	VOC	CO	PM10	Total HAP	Largest HAP
2020	0.0200	12.46	4.52	11.28	12.04	0.0445	0.0148 [Formaldehyde]

Review Engineer: Betty Gatano

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

Comments / Recommendations:
Issue 10583/T02
Permit Issue Date:
Permit Expiration Date:

1. Purpose of Application

Duke Energy Progress LLC – Cape Fear STAR® Ash Beneficiation Process (aka Duke Energy or the Cape Fear STAR® facility) currently holds Air Permit No. 10583R01 with an expiration date of May 31, 2027 for a coal ash beneficiation near Faison in Moncure, Chatham County, North Carolina. Per 15A NCAC 02Q .0504, the facility is allowed to construct and operate under 15A NCAC 02Q .0300 when a Title V permit application is submitted within one year from the date of beginning of operation. The facility began operation on September 16, 2020, and the first time Title V permit application (8200152.17B) was received on September 14, 2021, which was within the time period allowed.

2. Permitting History and Application Chronology

Permit History

June 5, 2019	Air Permit No. 10538R00 was issued for a greenfield facility for a coal ash beneficiation facility in Chatham County. The proposed plant was designed to produce up to 400,000 tons per year of coal combustion fly ash with other ingredient materials to produce a high-quality class F fly ash for use in ready mix concrete. The facility is a minor source under Prevention of Significant Deterioration (PSD) and a minor source of Hazardous Air Pollutants (HAPs).
May 13, 2020	Air Permit No. 10538R01 was issued as a 15A NCAC 02Q .0300 modification for the following: • Added two vibrating screeners (ID Nos. I-19a and I-19b), each with a 225 horsepower (hp) engine (ID Nos. I-22a and I-22b), and six telestackers (ID Nos. I-26a through I-26f), each with a 74 hp engine (ID Nos. I-27a through I-27f), to the insignificant activities list; • Updated the $PM_{2.5}$ speciation profile for several emission sources; • Revised the wind erosion calculations based on updated methodology previously accepted by DAQ; • Increased the ash basin (ID No. ES-15) working area from 10 to 25 acres; and • Requested the use of a sulfur dioxide continuous emission systems (CEMS) diluent cap during periods of startup and shutdown.

Application Chronology

September 14, 2021	Permit Application No. 1900134.21A was received as a 1st time TV permit application.
September 15, 2021	E-payment was received.
September 15, 2021	Sent acknowledgment letter indicating the application was complete.
November 3, 2021	Betty Gatano requested a revised D1 form from Erin Wallace of Duke Energy. The revised form and the associated emission spreadsheet were submitted that same day.
November 4, 2021	Betty Gatano sent an e-mail to Erin Wallace in regard to the diesel fired engine for the crusher (ID No. ES-23). Emissions for this non-emergency engine were based on 1,000 hours per year, but no emission limitation was provided in the permit. On November 10, 2021, Erin Wallace responded to the e-mail and indicated 8,760 hours was appropriate for this engine.
November 10, 2021	Betty Gatano and Erin Wallace discussed the baghouses on the STAR® process On November 11, 2021, Erin Wallace provided a follow up e-mail that indicated the STAR® has two baghouses. The first baghouse is located prior to the flue gas desulfurization (FGD) scrubber and is integral to the process. This scrubber is used only to separate the product coming out of the reactor from the exhaust gas. The gas is then exhausted to FGD scrubber where the lime is introduced. Following the scrubber, a second baghouse (ID No. CD-5B) is considered a control device and removes residual lime and scrubber byproduct.

December 10, 2021	Betty Gatano discussed an additional issue with the emissions with Erin Wallace. Emissions from the diesel fired engines for the screeners (ID Nos. I22-A and I22-B), which are non-emergency engines, were based on 6,500 hours per year, but no emission limitation was provided in the permit. Betty Gatano requested that Erin Wallace review all emission associated with the STAR® facility and provide updated emissions.
January 2022	Through 2021, Betty Gatano and Erin Wallace touched base about the requested information. Ms. Wallace requested more time to respond due to end of year reporting requirements. Ms. Gatano agreed.
March 10, 2022	Erin Wallace provided the revised emission spreadsheet and updated forms as requested. The revised forms included a request to remove the crusher (ID No. I-20) powered by a 300 hp diesel-fired engine (ID No. ES-23) from the permit.
April 7, 2022	Erin Wallace requested a change in permitting language regarding scrubber inspection. DAQ agreed to this change.
June 30, 2022	Draft permit and permit reviewed forwarded internally for comments.
July 7, 2022	Comments received from Ed Martin of the Permitting Section and Dawn Reddix of the Raleigh Regional Office (RRO).
July 8, 2022	Comments received from Samir Parekh of the Stationary Source Compliance Branch.
July 11, 2022	Draft permit and permit review forwarded to Duke Energy for comments.
August 10, 2022	Comments received from Erin Wallace.
August 31, 2022	Duke Energy submitted a permit addendum with optimized air dispersion modeling.
November 18, 2022	Nancy Jones of the Air Quality Analysis Branch (AQAB) of the DAQ approved the air dispersion modeling.
November 18, 2022	Betty Gatano spoke with Erin Wallace and requested that Duke Energy revise the facility-wide air emissions to include the site-specific product (post STAR®) analysis that was used in the air dispersion modeling. The product analysis was not available when the permit application was submitted.
December 5, 2022	Revised facility-wide air emissions received.
December 14, 2022	Draft permit and permit review forwarded for final review.
December 20, 2022	Comments received from Ed Martin of the Permitting Section.
January 3, 2023	Comments received from Dawn Reddix of the RRO.
January 6, 2023	Comments received from Erin Wallace. Duke Energy requested to simplify or reduce the monitoring requirements in the PSD avoidance condition for

	particulate matter. After discussing this request with Duke Energy and internally, DAQ determined monthly emission calculations for PSD avoidance were appropriate.
February 2, 2023	Draft permit and permit review forwarded to public notice.

3. Permit Modifications/Changes and TVEE Discussion

The following table describes the changes to the current permit as part of this first time TV permit.

Pages	Section	Description of Changes
Cover letter and throughout permit	--	• Updated all dates and permit revision numbers. • Reformatted permit in accordance with the updated formatting for TV permits.
3	--	"List of Acronyms" has been moved to Page 3 of the permit.
4	Section 1	• Removed crusher diesel fired engine (ID No. ES-23) • Removed page numbers from table.
5 to 14	Section 2.1	Added noncompliance statements as required for TV permit throughout this section.
5	2.1 A – Regulations Table	• Removed reference to 15A NCAC 02D .0611 • Removed reference for submittal of Title V permit application within one year from the date of beginning operation in accordance with 15A NCAC 02Q .0504. This requirement was fulfilled with the submittal of application no. 1900134.21A. • Added reference to 15A NCAC 02Q .0317 for PSD avoidance for $PM/PM_{10}/PM_{2.5}$ and SO_2 emissions.
5	2.1 A.1.c	Added requirement for testing every five years for compliance with 15A NCAC 02D .0515.
6	2.1 A.1.g	Added semiannual reporting requirements for 15A NCAC 02D .0515.
7 – 8	2.1 A.3.c	Removed requirement to establish "normal" for visible emissions within 30 days of operation of the STAR®.
8	2.1 A.3.e	Added semiannual reporting requirements for 15A NCAC 02D .0521.
--	2.1 A.4 (old numbering)	Removed permit condition for 15A NCAC 02D .0611 for inspection and maintenance of the FGD scrubber (ID No. CD-5B). This requirement will be incorporated into the new PSD avoidance condition for SO_2 emissions.
8 – 9	2.1 A.4	Added permit condition for 15A NCAC 02Q .0317 for PSD avoidance for SO_2 emissions.
9	2.1 A.5	Updated permit condition to require testing to verify NOx emission factor once every five years.
10	2.1 B – Regulations Table	• Added reference to 15A NCAC 02Q .0317 for PSD avoidance for $PM/PM_{10}/PM_{2.5}$ emissions. • Removed reference for submittal of Title V permit application within one year from the date of beginning operation in accordance with 15A NCAC 02Q .0504. This requirement was fulfilled with the submittal of application no. 1900134.21A.
10	2.1 B.1.c	Added requirement for testing every five years for compliance with 15A NCAC 02D .0515.
11	2.1 B.1.g	Added semiannual reporting requirements for 15A NCAC 02D .0515.
11	2.1 B.2.c	Removed requirement to establish "normal" for visible emissions within 30 days of operation of the heat exchangers A and B (ID Nos. ES-8 and ES-9).
12	2.1 B.2.e	Added semiannual reporting requirements for 15A NCAC 02D .0521.

Pages	Section	Description of Changes
--	2.1 C (old numbering)	• Removed permit condition for crusher diesel fired engine (ID No. ES-23). • Renumbered permit accordingly.
13	2.1 C – Regulations Table (new numbering)	• Removed reference to 15A NCAC 02D .0540 for fugitive dust. This requirement is contained in the General Conditions in Section 4. • Removed reference for submittal of Title V permit application within one year from the date of beginning operation in accordance with 15A NCAC 02Q .0504. This requirement was fulfilled with the submittal of application no. 1900134.21A. • Added reference to 15A NCAC 02Q .0317 for PSD avoidance for $PM/PM_{10}/PM_{2.5}$.
14	2.2 A – Regulations Table	• Removed reference to 15A NCAC 02D .0535 for excess emissions. This requirement is contained in the General Conditions in Section 4. • Removed reference to 15A NCAC 02D .0540 for fugitive dust. This requirement is contained in the General Conditions in Section 4. • Added reference to 15A NCAC 02Q .0317 for PSD avoidance for $PM/PM_{10}/PM_{2.5}$.
--	2.2 A.1 (old numbering)	Removed permit condition for 15A NCAC 02D .0535 for excess emissions. This requirement is contained in the General Conditions in Section 4.
--	2.2 A.2 (old numbering)	Removed permit condition for 15A NCAC 02D .0540 for fugitive dust. This requirement is contained in the General Conditions in Section 4
14	2.2 A.1 (new numbering)	• Added permit condition for 15A NCAC 02Q .0317 for PSD avoidance for $PM/PM_{10}/PM_{2.5}$. • Renumbered permit accordingly.
15 – 17	2.2 A.2 (new numbering)	Removed crusher (ID No. I-20) from NC Air Toxics Table.
17	2.2 A.3 (new numbering)	Updated permitting language for 15A NCAC 02Q .0711 to reflect current permitting language.
--	2.2 A.5 (old numbering)	Removed permit condition for 15A NCAC 02Q .0207, "Annual Emissions Reporting." This requirement is contained in the General Conditions in Section 4.
--	2.2 A.6 (old numbering)	Removed permit condition for 15A NCAC 02Q .0304, "Applications." The requirements to submit at TV renewal application is contained in the General Conditions in Section 4.
--	2.2 A.7 (old numbering)	Removed permit condition for submittal of Title V permit application within one year from the date of beginning operation in accordance with 15A NCAC 02Q .0504. This requirement was fulfilled with the submittal of application no. 1900134.21A.
19	Section 3	• Moved "List of Insignificant Activities" to Section 3 in accordance with the updated formatting for TV permits. • Removed the crusher (ID No. I-20).
20 – 28	Section 4	Updated General Permit Conditions with most current version (version 6.0, 01/07/2022).

The TVEE will be updated as part of this modification to remove the crusher (ID No. I-20) powered by a 300 hp diesel-fired engine (ID No. ES-23). The crusher was never constructed at this site and has not worked well at other Duke beneficiation facilities.

4. Facility Description

The fly ash beneficiation facility is located in Moncure, Chatham County. The facility is owned by Duke Energy Progress LLC but is operated by the SEFA Group Inc. Construction began at the Cape Fear site in 2019, and the facility began operation on September 16, 2020.

The Cape Fear STAR® facility is designed to process up to 400,000 tons per year of coal combustion fly ash with other ingredient materials to produce a high-quality class F fly ash for use in ready mix concrete or other commercial products. The facility uses a proprietary technology from the SEFA Group Inc. called Staged Turbulent Air Reactor (STAR®) to chemically and physically convert fly ash into a low-carbon material that meets the American Society for Testing and Materials (ASTM) Standard C618-08, "Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete." The low carbon class F fly ash must be no more than 6 percent by weight loss-on-ignition (LOI) content to be suitable for use in concrete.

The preparation of fly ash for beneficial use in the manner at the Cape Fear site is encouraged by the U.S. Environmental Protection Agency (EPA). EPA finds "this practice can produce positive environmental, economic, and product benefits such as reduced use of virgin resources, lower greenhouse gas emissions, reduced cost of coal ash disposal, and improved strength and durability of materials."[1]

STAR® Process

Fly ash is first excavated from the ash ponds on the site and staged for dewatering. Dewatered fly ash is then screened to remove contaminants and produce a consistent chemical composition and a finely divided free-flowing ash. Excavation and processing of materials from the ash ponds to meet the STAR® system fly ash (ingredient) specifications are under the control of the Cape Fear STAR® facility. All fly ash reclaimed from an ash pond delivered for use as an ingredient in the STAR® system must first undergo processing by the owner to be:

- Free of all but minimal contaminants (e. g., organic debris, slag);
- Finely-divided and free-flowing,
- Have consistent moisture content of less than or equal to 25 percent; and
- Have a consistent chemical composition, including organic content measured by loss on ignition.

Processed fly ash is then delivered to the beneficiation process via trucks. The wet fly ash can be unloaded from the trucks into the storage shed or unloaded from the trucks to a pile that is then transferred to a storage shed by a front-end loader. The wet fly ash in the shed is transferred via front-end loader to a hopper at up to 70 wet tons per hour (tph). The fly ash is conveyed from the hopper to a de-lumper unit to reduce the "overs" material. The material is gravity discharged from the de-lumper into a fluidized external heat exchanger (EHE) that uses both pre-heated air and hot water to dry the fly ash.

Dried fly ash is discharged from the EHE either through a fixed height overflow weir or underflow discharge screw or rotary valves. Exhaust air from the EHE is routed to a high-efficiency bagfilter for feedstock recovery and PM control. The fly ash is discharged to the EHE transfer silo prior to being sent to the feed silo. From the feed silo, the fly ash is introduced into the reactor where it is physically and chemically converted into a high-quality class F fly ash for beneficial use in ready mix concrete or other specialty products.

During startup of the reactor, the combustion air is pre-heated via propane-fired auxiliary burners with a rated heat input of 60 million Btu per hour. Fuel and fly ash are then co-fired until the fly ash auto-ignition temperature (approximately 1,400 °F) is reached. At this temperature, residual carbon in the fly ash becomes the heat input source in the reactor, which is rated at 140 million Btu per hour heat input capacity. However, auxiliary firing of propane may be needed to maintain proper operating temperature under certain conditions.

After exiting the reactor, the fly ash entrained in the flue gas passes through a hot cyclone where solids are returned to the reactor for temperature control. The fly ash and flue gas leaving the hot cyclone are

[1] U.S. EPA, Coal Ash Reuse, https://www.epa.gov/coalash/coal-ash-reuse; Accessed May 10, 2017

conveyed to the air preheater and then pass through a gas cooler. The cooled flue gas and ash pass through a fabric filter baghouse, which is an integral part of the process for product capture, and then exhaust to a dry flue gas desulfurization (FGD) system used for control sulfur dioxide (SO_2) emissions. The FGD exhaust is vented to the atmosphere through a stand-alone stack.

The FGD system consists of a circulating dry scrubbing system (CDS) and a fabric filter baghouse used for control. Flue gas, hydrated lime, and water are mixed in the CDS to absorb SO_2. Particulate from the process is collected in the baghouse. The byproduct solids are discharged from the baghouse into a byproduct storage silo. The system is comprised of a three-day storage silo with a bin vent filter, fluidizing air stones, and dry unloading spouts. Dry dust unloading spouts are telescoping spouts equipped with small ventilation fans that recirculate displaced air back to the top of the byproduct storage silo. Each spout also has a compact filter module.

Once the ash leaves the STAR®, it is collected in a product recovery baghouse (considered integral to the process) and pneumatically transferred to either the storage dome or the loadout silo, each equipped with a bin vent filter. The truck loadout station uses telescoping chutes and a negative pressure ventilation system to reduce fugitive emissions.

The Cape Fear STAR® facility includes the following components:

<u>Fugitive Emission Sources</u>

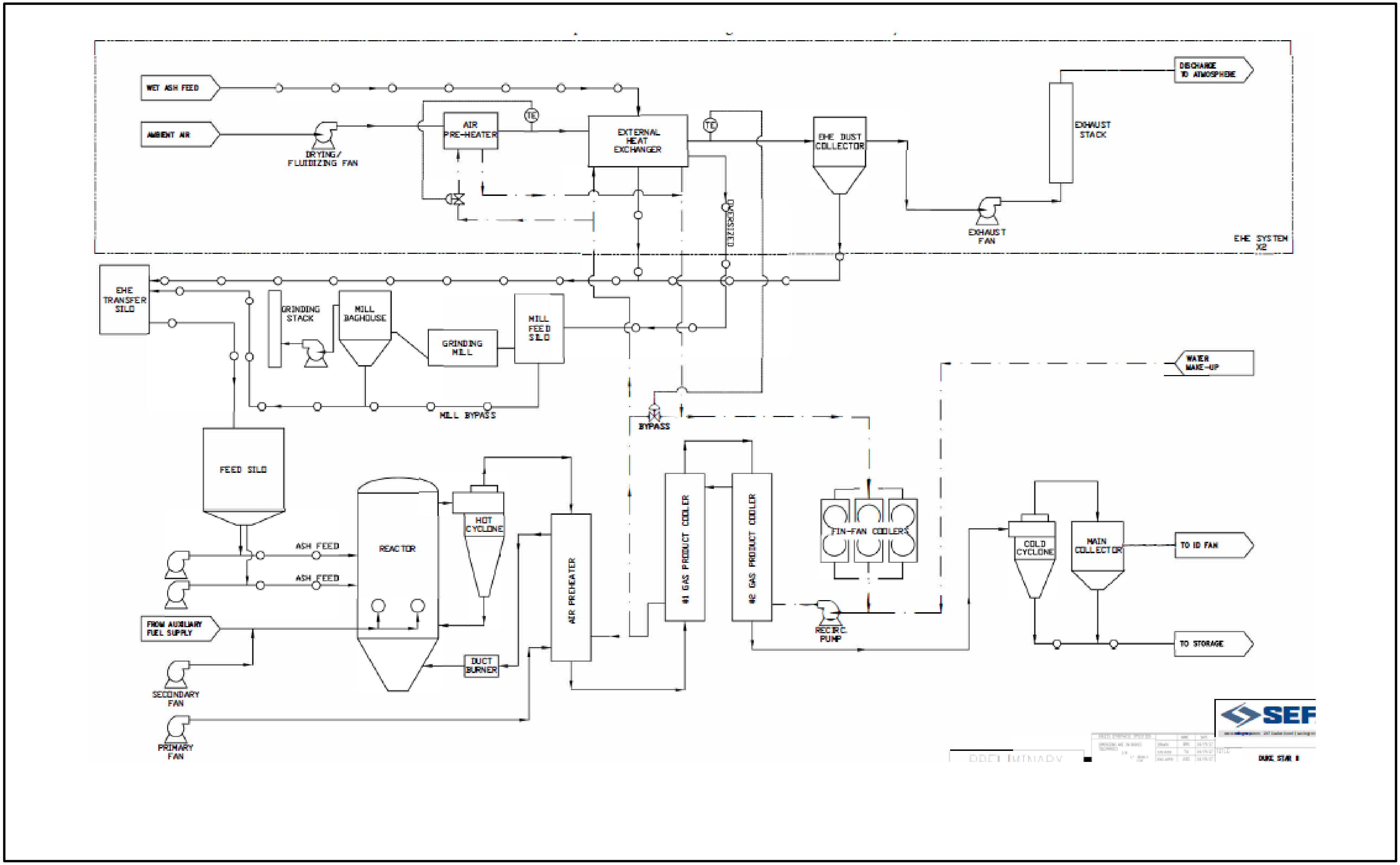
- Wet ash receiving (ID No. I-1) – Wet ash is transferred to storage shed at a rate up to 70 tph and then transferred to the feed hopper by a front-end loader.
- Unloading pile (ID No. I-3) – The unloading pile is 0.33 acres.
- Ash basin (ID No. ES-15) – The ash basin is 174-acre site, and dust from the ash basin is generated by wind erosion. The working area in the ash basin is established as 25 acres.
- Ash handling (ID No. I-16) - Ash handling consists of several activities. Ash is excavated from its respective basin and placed in windrows in that basin. The windrowed ash is loaded into a screener within its respective basin, and the screened ash is then placed in a stockpile within its respective basin.
- Haul roads (ID No. I-21).

<u>Point Source Emission Units</u>

- Two vibrating screeners (ID Nos. I-19a and I-19b), each with a 225 hp diesel-fired engine (ID Nos. I-22a and I-22b) – Each screener is designed to produce up to 200 tph of a finer free flowing feedstock suitable for the reactor.
- External heat exchangers A and B (ID No. ES-8 and 9) – The EHEs have a combined total operation not to exceed 8,760 hours per year drying a maximum of 70 tph of fly ash suspended in transport air. Each EHE is controlled by a felted filter baghouse (ID Nos. CD-8 and CD-9).
- EHE silo (ID No. I-10) – This silo with an associated bin vent filter is a transfer silo used to transfer material from the EHEs to the feed silo.
- Feed silo (ID No. I-4) – The ash feed silo with an associated bin vent filter is filled pneumatically at a rate of 125 tph and unloaded at the rate of 75 tph.
- STAR® system (ID No. ES-5) – The STAR® system has a 140 million Btu per hour total maximum firing rate for processing feedstock (fly ash and other ingredient materials) into a variety of commercial products. It is equipped with propane-fired, low-NO_X, auxiliary burners (60 million Btu per hour total capacity) for use during startup or when necessary to maintain the desired reactor temperature. The STAR® system is also equipped with an integral cyclone and baghouse for product recovery. A dry FGD scrubber (ID No. CD-5A) and baghouse (ID No. CD-5B) are used for SO_2 and PM control, respectively.

- FGD byproduct silo with bin vent filter (ID No. I-6) – Byproduct solids from the dry FGD system discharged from the fabric filter baghouse are stored in the silo. Material is unloaded from the silo via gravity into trucks. The silo is equipped with a bin vent filter for control of particulate matter emissions.
- FGD hydrated lime silo with bin vent filter (ID No. I-7) – The silo stores absorbent (hydrated lime) used in the dry FGD system. It is equipped with a bin vent filter for control of particulate matter emissions.
- Product storage dome with bin vent filter (ID No. I-11) – Product from the STAR® system is stored in the storage dome. It is equipped with a bin vent filter for control of particulate matter emissions.
- Loadout silo (ID No. I-12) and 2 loadout spouts (ID Nos. I-13 and I-14), – The silo stores product, which is loaded into trucks via loadout spouts, each with an associated bin vent filter.
- Six telestackers (ID Nos. I-26a through I-26f), each with a 74 hp diesel-fired engine (ID Nos. I-27a through I-27f). A telestacker is a telescopic conveyor for moving ash and product at the facility.
- Ball mill classifier (ID No. I-24) – Material from the ball mill feed silo is transferred to the conical ball mill. A baghouse inherent to the process filters any remaining particles from the air stream and then sends them to the EHE transfer silo.
- Ball mill feed silo (ID No. I-25) – Oversized material from EHE A and B are stored in the ball mill feed silo with an associated bin vent filter.

An overview of the ash beneficiation process is provided in the figures below.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EHE SYSTEM X2
EHE TRANSFER SILO
GRINDING STACK
MILL BAGHOUSE
GRINDING MILL
MILL FEED SILO
MILL BYPASS
BYPASS
WATER MAKE-UP
FEED SILO
ASH FEED
ASH FEED
REACTOR
HOT CYCLONE
AIR PREHEATER
#1 GAS PRODUCT COOLER
#2 GAS PRODUCT COOLER
FIN-FAN COOLERS
RECIRC. PUMP
COLD CYCLONE
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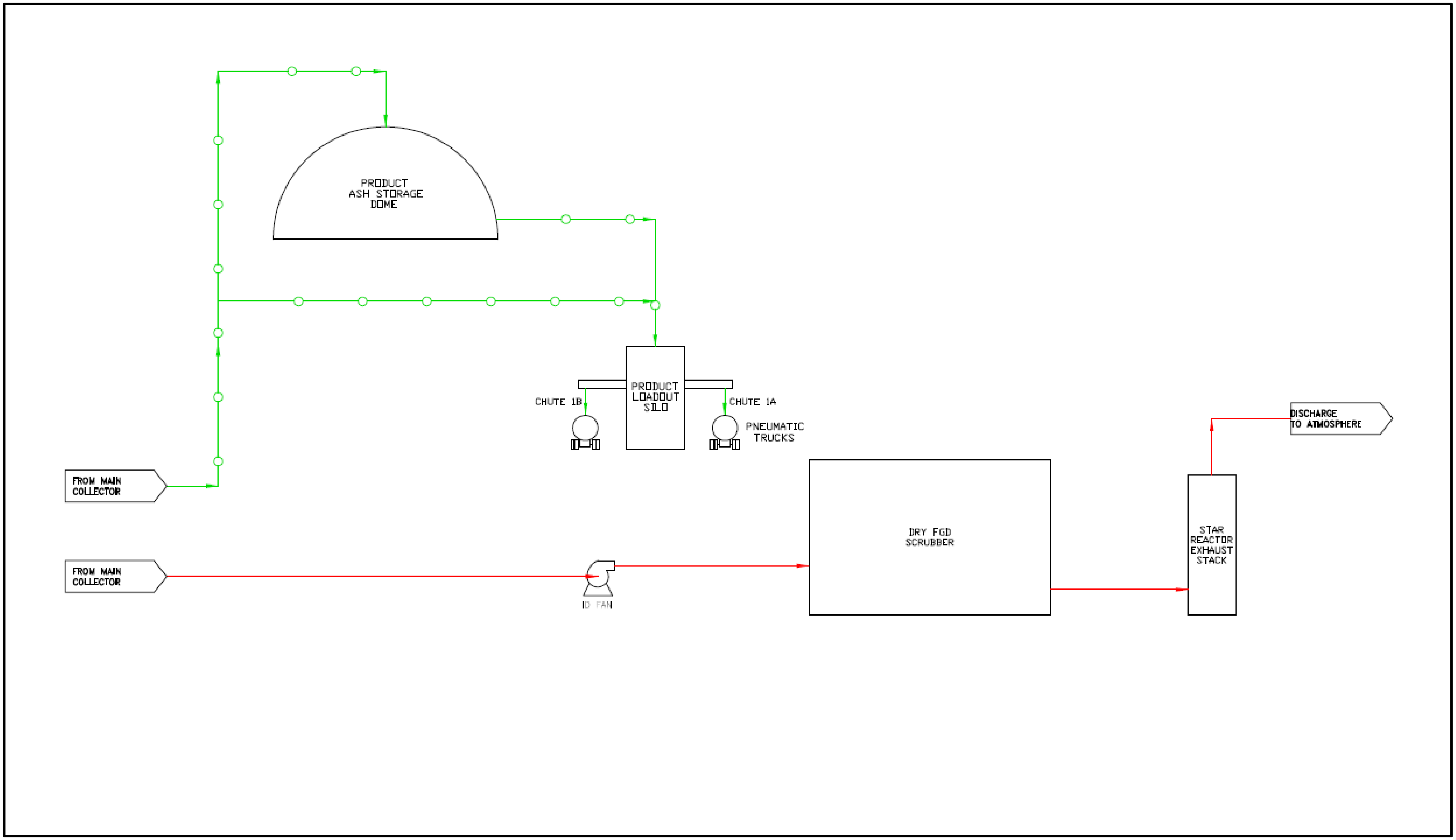
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ID FAN
DRY FGD
SCRUBBER
STAR
REACTOR
EXHAUST
STACK
DISCHARGE
TO ATMOSPHERE

5. Emissions

Emissions from the Cape Fear STAR® facility result from several sources as discussed in this section. The STAR® system is a source of nitrogen oxides (NO_X), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter ($PM/PM_{10}/PM_{2.5}$), sulfur dioxide (SO_2), hazardous air pollutants (HAPs), toxic air pollutants (TAPs) and greenhouse gases (GHGs). Emissions result from the burning of propane during startup and the oxidation of the residual carbon and other constituents in the fly ash. Emissions associated with fuel combustion are also expected from the diesel-fired engines. Additionally, the handling of the fly ash and fly ash product are considered a source of particulate matter and metals emissions.

Emissions of CO and VOCs

Emissions of CO and VOCs are associated with the STAR® system due to the incomplete oxidation of carbon in the fly ash and propane from the auxiliary burners. Complete combustion depends upon oxygen availability (excess air), flame temperature, residence time at flame temperature, combustion zone design, and turbulence. Turbulence within the reactor ensures thorough mixing of air (oxygen) and fuel for the desired oxidation to proceed. The engines on the screeners and telestackers also emit CO and VOCs because of the incomplete combustion of diesel fuel.

Emissions of NO_X

NO_X is emitted from the STAR® system as the result of oxidation of nitrogen in the fly ash and auxiliary fuel. Thermal NO_X is not expected to contribute significantly to emissions because its formation begins at flame temperatures above 1,200 °C (~2,200 ºF) and the STAR® system operates at much lower temperatures. Low NO_X burners minimize NO_X emissions associated with the auxiliary fuel. Three permitted STAR® systems (two in South Carolina and one in Maryland) have NO_X limits ranging from 0.05 to 0.34 pounds per million Btu.[2] Based on these results, Duke Energy estimated emissions from the Cape Fear STAR® system at 0.34 pounds of NO_X per million Btu. Additionally, NO_X is emitted from the engines on the screeners and telestackers.

PM Emissions

PM emissions from the STAR® system consist of filterable and condensable PM resulting from ash, trace quantities of noncombustible metals and unburned carbon due to incomplete combustion, and the handling of fly ash and end product. A baghouse reduces PM emissions from the STAR® system to approximately 0.025 grain per actual cubic foot (gr/acf).

PM emissions are also expected from fly ash handling, wind erosion from the fly ash basin and unloading pile, and fly ash and end product transfer and loading operations. Baghouses on the heat exchangers reduce PM emissions to approximately 0.025 gr/acf.

Emissions of SO_2

SO_2 forms from the oxidation of the sulfur in the fly ash. The fly ash is expected to contain 0.05 percent sulfur on average, but potential emissions were based on an assumed 0.10 percent sulfur content as a worst-case estimate. SO_2 formed within the STAR® system is controlled by a dry scrubber that is designed to reduce SO_2 emissions by 95 percent.

SO_2 is also expected be emitted from the engines on the screeners and telestackers. The diesel fuel for these engines is limited to no more than 0.0015 percent sulfur in accordance with New Source Performance Standards for the engines.

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[2] Kevin Godwin (05/10/2018) Permit review for Duke Energy Carolinas, LLC - Buck Combined Cycle Facility, Air Permit No. 03786T35.

Emissions of CO_2

Carbon dioxide is the primary GHG. It is a product of the complete oxidation of carbon in the fly ash and propane in the STAR® system and diesel fuel in the engines on the screeners and telestackers. Emissions of GHG are expressed as carbon dioxide equivalents or CO_2e.

Emissions of TAPs and HAPs

TAP and HAP emissions result from combustion of fly ash (in the STAR®) and diesel (engines) and from fly ash handling. The largest TAP expected from the facility is sulfuric acid mist from the STAR® process. Emissions of sulfuric acid mist were based on a SEFA stack test performed in September 2016, the results of which were then doubled as an overconservative estimate. The largest HAP expected from the facility is formaldehyde from the diesel-fired engines. The largest TAP/HAP expected from fly ash handling is chromium. HAP and TAP emissions from metals associated with ash handling and the STAR® process were based on a site-specific ash analysis and EPRI PISCES Database (February 2003) Composition of Lime.

Emissions of hydrogen fluoride (HF) and hydrogen chloride (HCl) were specifically addressed in this review based on a recommendation from the Hearing Officer's report for the fly ash beneficiation project at Duke Energy Progress, LLC - H. F. Lee Steam Electric Plant.[3] Section 7 below provides more detail on emission of HF, HCl, and other TAPs from the Cape Fear STAR® facility.

Potential Emissions

The applicant has calculated the maximum emissions based on the STAR® system operating continuously (i.e., 8760 hours per year) at a design rate of 140 million Btu per hour and the auxiliary burners operating continuously at the design rate of 60 million Btu per hour. The higher of the two maximum emission rates was used as the annual potential emissions of each pollutant. Potential emissions from the STAR® system are provided below in Table 1. The emissions were revised in Application No. 1900134.20A to update the $PM_{2.5}$ speciation profile for the reactor (ID No. ES-5).

Table 1. Potential Emissions from Cape Fear STAR® Process

Pollutant	Auxiliary Fuel (propane)		Fly Ash – As Controlled		Potential as Controlled
	lb/hr	ton/yr	lb/hr	ton/yr	ton/yr
CO	4.97	21.8	22.4	98.1	98.1
NO_X	8.62	37.8	47.6	208.5	208.5
PM	0.464	2.03	16.1	70.4	70.4
PM_{10}	0.464	2.03	14.8	64.8	64.8
$PM_{2.5}$	0.464	2.03	3.7	16.2	16.2
SO_2	6.63E-03	2.90E-02	25.7	112.5	112.5
VOC	0.530	2.32	2.24	9.81	9.81
Lead	--	--	1.93E-06	8.45E-06	8.45E-06
Sulfuric Acid	--	--	0.10	0.438	0.438
Largest HAP (hydrogen chloride)	--	--	0.141	450 lb/yr	522 lb/yr
Total HAPs	--	--	0.148	474.9 lb/yr	474.9 lb/yr
GHGs as CO_2e	8,350	36,572	35,367	154,908	154,908

[3] The Hearing Officer's report was finalized on December 11, 2018 for the permit adding a fly ash beneficiation project to Duke Energy Progress, LLC - H. F. Lee Steam Electric Plant.

Table 1. Potential Emissions from Cape Fear STAR® Process					
Pollutant	**Auxiliary Fuel (propane)**		**Fly Ash – As Controlled**		**Potential as Controlled**
	lb/hr	**ton/yr**	**lb/hr**	**ton/yr**	**ton/yr**

Notes:
- Revised emissions submitted on December 5, 2022 and include product analysis.
- Emissions from auxiliary gas (propane) were calculated assuming 8,760 hours of operation per year. These emissions were compared with emissions from the STAR® reaction, and the largest emissions from these two scenarios were selected to represent worst-case emissions from Cape Fear STAR® process. The STAR® reaction resulted in the largest emissions for all pollutants.

Other emission sources at the Cape Fear STAR® facility include fly ash and product handling and the diesel engines. Potential facility-wide emissions for all sources including the STAR® system, the diesel engines, and the ash/product handling systems are provided below in Table 2 below. An overview of the emission factors used in emission calculations are provided in Attachment 1 of this review. HAP and TAP emissions from ash and product handling were based on a site-specific ash analysis and product analysis (post STAR®) conducted at the Cape Fear site. The results of the ash analysis and product analysis are provided in Attachment 2 to this permit review.

Table 2. Potential Facility-Wide Emissions				
Pollutant	**STAR® System (tpy)**	**Diesel Engines (tpy)**	**Ash/Product Handling and Fugitives (tpy)**	**Total (tpy)**
CO	98.1	4.34	--	102.5
NO_X	208.5	10.8	--	219.3
PM	70.4	9.68E-03	50.4	120.8
PM_{10}	64.8	9.68E-03	39.1	103.9
$PM_{2.5}$	16.2	9.68E-03	8.97	25.2
SO_2	112.5	4.15E-02	--	112.5
VOC	9.81	9.94	--	19.8
Lead		2.47E-4	3.36E-03	3.62E-03
Sulfuric acid mist	0.438	--	--	0.438
Largest HAP	450 lb/yr (hydrogen chloride)	64.7 lb/yr (formaldehyde)	8.53lb/yr (chromium)	450 lb/yr (hydrogen chloride)
Total HAPs	522.3 lb/yr	215.0 lb/yr	73.2 lb/yr	810.5 lb/yr
GHGs as CO_2e	154,908	4,485	--	159,393

Notes:
- Revised emissions submitted on December 5, 2022 and include product analysis.
- Engine emissions differ than those provided in the permit application. Revised emission based on 8,760 hours of operation per year and certified emission data from the engine manufacturers.

A major stationary source under Prevention of Significant Deterioration (PSD) rules is defined as any one of 28 named source categories in 40 CFR 51.166(b)(1)(i)(a) with the potential to emit 100 tons per year of any regulated pollutant or any other stationary source with the potential to emit 250 tons per year of any PSD regulated pollutant (other than GHG).

Because the beneficiation process is not one of the 100 named PSD sources, emissions from the Cape Fear STAR® facility must exceed the PSD major source level of 250 tons per year of a PSD pollutant for the facility to be major for PSD. As shown in Table 2 above, potential emissions of all pollutants are less than 250 tons per year. Therefore, the Cape Fear STAR® facility is a minor source under PSD, and no PSD review is required.

The potential emissions in Table 2 above account for controls of SO_2 and $PM/PM_{10}/PM_{2.5}$ emissions, and PSD avoidance conditions for these pollutants will be added to the first time TV permit under this modification. See discussion of 15A NCAC 02Q .0317 in Section 6 below for more detail regarding PSD avoidance.

6. Regulatory Review

The Cape Fear STAR® facility is subject to the following regulations.

- 15A NCAC 02D .0515, Particulates from Miscellaneous Industrial Processes – Numerous emission sources at the Cape Fear STAR® facility are subject to 02D .0515. This regulation limits particulate emissions from any stack, vent, or outlet, resulting from any industrial process, for which no other emission control standard is applicable. Allowable emissions of PM are calculated from the following equation:

  $E = 4.10(P)^{0.67}$ For process weight rates less than or equal to 30 tph
  $E = 55.0(P)^{0.11} - 40$ For process weight rates greater than 30 tph

  For both equations:
  E = allowable emission limit for particulate matter in lb/hr; and
  P = process weight rate in tph.

  Table 3 below shows the process rate, allowable PM emission rate and post-control filterable PM emissions rates. Based on PM emission calculations provided in the permit application for the sources listed in the table, the control devices are sufficient to ensure compliance.

Table 3. Allowable PM Emissions under 15A NCAC 02D .0515					
Emission Source	**Process Rate (tph)**	**Allowable PM Emissions (lb/hr)**	**Potential PM Emissions (lb/hr)**	**Compliance Expected?**	**Comments**
STAR® (ID No. ES-5)	75	48.4	16.1	YES	Throughput based on 400,000 ton/yr of fly ash. (Gas fuel is not considered part of the throughput.) PM emissions based on an outlet loading of 0.025 gr/scf and a flow rate of 75,000 scfm.
EHE Unit A / B (ID No. ES8 / ES9)	70	47.8	6.86	YES	PM emissions based on an outlet loading of 0.025 gr/scf and a flow rate of 32,000 scfm. Each unit is rated at 70 tph.

Duke Energy is required to conduct monthly external inspections of the control devices and ductwork and annual internal inspections of the control devices to ensure compliance with 02D .0515.

Duke Energy was also required to conduct and complete testing on the STAR® (ID No. ES-5) and one of the two external heat exchangers (ID Nos. ES-8 and 9) within 90 days of the initial startup of these units to demonstrate compliance with 02D .0515. Duke Energy conducted emission source testing on January 27, 2021. The results of the source test are provided in Table 4 below and indicated compliance with 02D .0515.

Table 4. Test Results Demonstrating Compliance with 15A NCAC 02D .0515

Pollutant	Test Result	Emissions Limit	Standard/Requirement	Compliance
STAR® (ID No. ES-5)				
Filterable PM	0.16 lb/hr	---	---	---
Condensible PM	10.60 lb/hr	---	---	---
Total PM	10.76 lb/hr	42.16 lb/hr	15A NCAC 02D .0515	Yes
Process Rate	38.4 tph	---	---	---
EHE B (ID No. ES-9)				
Filterable PM	0.53 lb/hr	---	---	---
Condensible PM	0.92 lb/hr	---	---	---
Total PM	1.45 lb/hr	42.16 lb/hr	15A NCAC 02D .0515	Yes
Process Rate	38.4 tph	---	---	---

Notes:
- Shannon Vogel of the Stationary Source Compliance Branch (SSCB) reviewed and approved the testing results for the STAR® in a memorandum dated July 22, 2021.
- Shannon Vogel of the SSCB reviewed and approved the testing results for EHE B in a memorandum dated April 25, 2022.

The permit will be modified as part of this modification to require PM emission testing once every five years (i.e., once per permit cycle) to ensure continued compliance with 02D .0515.

- NCAC 02D .0516, Sulfur Dioxide Emissions from Combustion Sources – The STAR® process (ID No. ES-5) at the Cape Fear STAR® facility is subject to 02D .0516 and must not exceed 2.3 pounds of SO_2 per million Btu heat input. The STAR® system is initially fueled by propane and then becomes self-sustained by burning fly ash. Sulfur dioxide forms when the sulfur contained in the fuel and fly ash is oxidized during combustion. When only propane is fired in the STAR®, compliance is achieved without emissions control. When the STAR® is fueled by fly ash, the dry FGD scrubber can achieve compliance with a 60 percent reduction in SO_2 emissions. As designed, the scrubber is expected to reduce the amount of SO_2 in the flue gas by 95 percent.

  Duke Energy has installed a CEMS for SO_2 on the STAR®. Compliance with the SO_2 emission standard is demonstrated based on a three-hour rolling average of SO_2 measured by the CEM systems. To date, no emission exceedance of SO_2 have been reported in the facility's quarterly reporting. Continued compliance with 02D .0516 is anticipated.

  The permit also requires semiannual reporting of monthly and 12-month rolling average emissions of SO_2 based on CEMS data to ensure the PSD threshold of 250 tons per year is not exceeded.[4] The most recent semiannual report was submitted on January 24, 2022, and the highest 12-month total was

[4] This requirement was recommended in the Hearing Officer's Report, dated June 4, 2019, for Air Permit No. 10583R00.

204.5 tons. Continued compliance is anticipated. This requirement will be moved to the permit PSD avoidance condition as part of this modification.

- 15A NCAC 02D .0521, Control of Visible Emission – The emission sources cited below are subject to 02D .0521. The 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).
  - STAR® ash beneficiation process equipped with propane low-NO_X startup burners controlled by a FGD scrubber (ID No. CD-5A) and a baghouse (ID No. CD-5B)
  - Two external heat exchangers A and B (ID Nos. ES-8 and ES-9) with baghouses (ID Nos. CD-8 and CD-9)
  - Storage dome (ID No. ES-11) with bin vent filter (ID No. CD-11).

  Duke Energy ensures compliance by operating the emission sources with the appropriate control devices and conducting monthly visible emission observations and associated recordkeeping and reporting. Compliance is anticipated.

- 15A NCAC 02D .1100, Control of Toxic Air Pollutants – Duke Energy has demonstrated compliance with the acceptable ambient levels (AALs) for arsenic, benzene, beryllium, and sulfuric acid via air dispersion modeling. A detailed discussion of the NC Air Toxics is found in Section 7.

- 15A NCAC 02Q .0317, Avoidance Conditions – The potential emissions in Table 1 above account for controls SO_2 and $PM/PM_{10}/PM_{2.5}$. As defined under 40 CFR 51.166(b)(4), "Potential-to-emit means the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable."

  Permit avoidance conditions for SO_2 and $PM/PM_{10}/PM_{2.5}$ are required so that the potential emissions (aka controlled emissions) are federally enforceable, and avoidance conditions for these pollutants will be added to the first time TV permit as part of this modification. Requirements for the avoidance conditions are discussed below:
  - SO_2 emissions – The only emission sources of SO_2 at the Cape Fear site are the STAR® (ID No. ES-5) and the engines (ID Nos. I-22a and I-22b and I-27a through I-27f). Because the potential emissions of SO_2 from these engines are less than 0.1 tons per year (see Table 2 above), compliance with the avoidance condition can be demonstrated using only CEMS data from the STAR®. To ensure compliance, Duke Energy will be required to operate the FGD scrubber (ID No. CD-5A) at all times except during periods of startup, shutdown, and malfunction. The facility must also conduct inspection and maintenance of the FGD scrubber and conduct associated recordkeeping and reporting. Compliance is anticipated.

  - $PM/PM_{10}/PM_{2.5}$ – Numerous emission sources emit $PM/PM_{10}/PM_{2.5}$, but the largest emitters of these pollutants at Cape Fear are the STAR®, the heat exchangers A and B (ID Nos. ES-8 and ES-9), and the ash basin (ID No. ES-15). To ensure compliance, Cape Fear will be required to operate the baghouse (ID No. CD-5B) on the STAR® and the baghouses (ID Nos. CD-8 and CD-9) on the heat exchangers. The facility must also conduct inspection and maintenance of these baghouses and conduct associated recordkeeping and reporting. Compliance is anticipated.

Potential emissions in Table 1 above also account for control of HAP emissions. However, HAP emissions remain below major source levels prior to control, indicating controls are not required for the Cape Fear STAR® facility to be classified as a minor source of HAPs. For example, the largest HAP emitted from the facility is HCl at 0.225 tpy after control and 4.5 tpy before control, assuming a 95 percent control efficiency in the FGD scrubber. A similar calculation for all HAPs can be made to demonstrate that before control emissions total to less than 25 tpy. Therefore, an avoidance condition is not required for HAP emissions.

- 15A NCAC 02Q .0711, Emission Rates Requiring a Permit – The facility is subject for specific TAPs as discussed below in Section 8.

7. NSPS, NESHAP/MACT, NSR/PSD, 112(r), CAM

NSPS

The Cape Fear STAR® facility is subject to the following New Source Performance Standards (NSPS) as discussed below.

NSPS Subpart IIII

The screener diesel-fired engines (ID No. I-22a and I-22b) and the telestacker diesel fired-engines (ID Nos. I-26a through I-26b) are 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 these engines, Duke Energy must purchase engines 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. The facility is expected to be in compliance with NSPS Subpart IIII for these engines.

Furthermore, Duke Energy must operate the engines per the manufacturer's instructions and burn only low-sulfur fuel with no more than 0.0015 percent sulfur. Compliance with all applicable emission limitations, monitoring, recordkeeping and reporting is anticipated for the engines.

NSPS Subpart CCCC

This rule establishes standards of performance for commercial and industrial solid waste incineration units (CISWI). In June 2015, DAQ determined Staged Turbulent Air Reactors, such as the one at Cape Fear, are not subject to CISWI. The fly ash from a coal-fired power plant’s particulate collection infrastructure, as well as fly ash received from coal ash landfills or ponds, when used as an ingredient product in the reactor in accordance with 40 CFR 241.3(b)(4), is considered a non-hazardous secondary material (NHSM) and not a solid waste.[5]

NESHAPS/MACT

The Cape Fear STAR® facility is a minor source of HAPs, with potential emissions less than 10 tons per year for the largest HAP and less than 25 tons per year for total HAPs. The facility is subject to the following Generally Available Control Technology (GACT) standard as discussed below.

[5] Letter from DAQ to the SEFA Group (June 10, 2015) Retrieved from https://files.nc.gov/ncdeq/Air%20Quality/permits/memos/NHSM_Determination_for_The_SEFA_Group-2015-06-10.pdf

GACT Subpart ZZZZ

The screener diesel-fired engines (ID No. I-22a and I-22b) and the telestacker diesel fired-engines (ID Nos. I-26a through I-26b) are subject to the "NESHAP for Stationary Reciprocating Internal Combustion Engines, 40 CFR Part 63," GACT Subpart ZZZZ. They are considered new sources under GACT Subpart ZZZZ because they will be constructed 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 applicable requirements of NSPS Subpart IIII. Continued compliance is anticipated.

NSR/PSD

A major stationary source under PSD rules is defined as any one of 28 named source categories in 40 CFR 51.166(b)(1)(i)(a) that has the potential to emit 100 tons per year of any regulated pollutant or any other stationary source that has the potential to emit 250 tons per year of any PSD regulated pollutant (other than GHG).

Fly ash beneficiation is not one of the 28 named source categories. Therefore, potential emissions of PSD regulated pollutants must exceed 250 tons per year for the Cape Fear STAR® facility to be considered a major PSD source. As shown above in Table 2, emissions of all PSD regulated pollutants (other than GHG) are below the new major source threshold. Although GHG emissions exceed the PSD threshold of 100,000 tons per year, the June 23, 2014 Supreme Court Decision in "Utility Air Regulatory Group v. EPA" indicates that EPA may not treat GHGs as an air pollutant for the specific purpose of determining whether a source is required to obtain a PSD permit. Therefore, the Cape Fear STAR® facility is a minor source under PSD.

NO_X emissions from the facility are estimated at 219.3 tons per year or 87.7 percent of the PSD threshold of 250 tons per year. Most of these emissions (208.5 tons per year) are expected from the STAR®. Because NO_X emissions are within 15 percent of the PSD threshold, Duke Energy was required to conduct initial emission testing of NO_X from the STAR® to verify compliance with PSD within 90 days of beginning operation. Duke Energy conducted emission source testing on January 27, 2021. Shannon Vogel of the SSCB reviewed and approved the testing results in a memorandum dated July 22, 2021. The results indicate that the NO_X emissions remain below the PSD threshold as calculated with the emission factor measured during testing.

Pollutant	Test Result	Previous Emissions Factor
NO_X	0.085 lb/MMBtu	0.34 lb/MMBtu
Maximum Capacity of reactor	140 MMBtu/hr	
Estimated NO_X emissions from STAR®	52.1 ton/yr	208.5 ton/yr
Notes: MMBtu = million Btu		

The permit will be modified to require NO_X testing of the STAR® every five years to ensure continued compliance.

As noted in Section 6 above, PSD avoidance conditions for SO_2 and $PM/PM_{10}/PM_{2.5}$ will be added to the permit as part of this modification. Compliance is anticipated.

112(r)
The facility is not subject to Section 112(r) of the Clean Air Act because it does not store any of the regulated substances in quantities greater than the thresholds in 112(r).

CAM
The CAM rule (40 CFR 64; 15A NCAC 02D .0614) applies to each pollutant specific emissions unit (PSEU) at major TV facilities that meets all three following criteria:
- the unit is subject to any (non-exempt: e.g. before 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.
- The unit has potential pre-control device emissions of the applicable regulated air pollutant that are equal to or greater than 100 percent of the amount, in tons per year, required for a source to be classified as a major source (i.e., 100 tpy for criteria pollutants or 10/25 tpy for HAPs).

SO_2 and PM are the only pollutants controlled with add-on control devices at the facility. Applicability to CAM for these pollutants are discussed below:

SO_2 Emissions
The STAR® system is subject to 02D .0516, is vented to a dry FGD scrubber to comply with this rule, and its potential pre-control SO_2 emissions are 2,249 tons per year, with an assumed 95 percent control efficiency. This emission source meets the applicability for CAM. However, the permit requires a CEMS for SO_2 on the STAR® system to ensure compliance with 15A NCAC 02D .0516. In accordance with 40 CFR 64.2(b), CAM is not required for an emission standard for which a permit specifies a continuous compliance determination method, such as CEMS. The CEMS is considered sufficient monitoring such that a CAM plan is not required for this pollutant.

PM Emissions
The STAR® system and other emission sources subject to 15A NCAC 02D .0515 and using PM controls for compliance were also evaluated for CAM. As shown in Table 5 below, the STAR® system and the EHE Units A and B have pre-controlled emissions of PM above 100 tons per year, making these units subject to CAM for PM. In accordance with 40 CFR 64.5(b), Duke Energy must submit CAM plans for these emission sources with the application for first renewal of the Title V operating permit.

Table 5. Evaluation of PM Emission Sources for Applicability to CAM

Emission Source	PM Emissions before Control		PM Emissions after Control		
	lb/hr	ton/yr	lb/hr	ton/yr	Comments
STAR® (ID No. ES-5)	16,100	70,518	16.1	70.5	PM emissions based on an outlet loading of 0.025 gr/scf and a flow rate of 75,000 scfm. Control efficiency of baghouse is 99.9%.
EHE Unit A (ID No. ES8)	13,720	60,094	6.86	30.0	PM emissions based on an outlet loading of 0.025 gr/scf and a flow rate of 32,000 scfm. Control efficiency is 99.95%.
EHE Unit B (ID No. ES9)	13,720	60,094	6.86	30.0	PM emissions based on an outlet loading of 0.025 gr/scf and a flow rate of 32,000 scfm. Control efficiency is 99.95%.

Notes:
Other PM emission sources do not require controls to meet the allowable PM emission limit under 15A NCAC 02D .0515.

8. Facility Wide Air Toxics

Duke Energy conducted a revised analysis to demonstrate compliance with NC Air Toxics in support of Air Permit No. 10583R01. Potential facility-wide TAP emissions and their associated (TPERs) are provided in Table 6 below. As noted in the table, several TAPs exceeded their TPER, and air dispersion modeling was required for these TAPs as discussed in more detail below.

Table 6. Potential TAP Emissions and Associated TPER

TAPs	**Potential Emissions**			**TPER**			**Modeling Required?**
	lb/hr	**lb/day**	**lb/yr**	**lb/hr**	**lb/day**	**lb/yr**	
Acetaldehyde	4.80E-03	1.15E-01	4.20E+01	6.8			N
Acrolein	5.79E-04	1.39E-02	5.07E+00	0.02			N
Arsenic	1.05E-02	2.53E-01	**9.24E+01**			0.053	**Y**
Benzene	5.84E-03	1.40E-01	**5.11E+01**			8.1	**Y**
Benzo(a)Pyrene	1.18E-06	2.82E-05	1.03E-02			2.2	N
Beryllium	2.16E-03	5.17E-02	**1.89E+01**			0.28	**Y**
1,3-Butadiene	2.45E-04	5.87E-03	2.14E+00			11	N
Cadmium	6.90E-04	1.66E-02	**6.04E+00**			0.37	**Y**
Soluble chromate compounds	2.08E-03	5.00E-02	1.83E+01		0.013		**Y**
Formaldehyde	7.38E-03	1.77E-01	6.47E+01	0.04			N
Hydrogen chloride	1.41E-01	3.37E+00	1.23E+03	0.18			N
Hydrogen fluoride	7.55E-03	1.81E-01	6.61E+01	0.064	0.63		N
Manganese	1.92E-02	4.61E-01	1.68E+02		0.63		N
Mercury	7.01E-05	1.68E-03	6.14E-01		0.013		N
Nickel	1.74E-02	**4.19E-01**	1.53E+02		0.13		**Y**
Sulfuric Acid	**1.00E-01**	**2.40E+00**	8.76E+02	0.025	0.25		**Y**
Toluene	2.56E-03	6.14E-02	2.24E+01	14.4	98		N
Xylene (Mixed Isomers)	1.78E-03	4.28E-02	1.56E+01	16.4	57		N

<u>HCl and HF Emissions</u>
Although emissions of HCl and HF emissions did not exceed their TPERS, these TAPs were of concern during permitting actions at other coal ash beneficiation facilities. Therefore, emission calculations for these pollutants are discussed in detail in this section.

Coal combustion typically results in emissions of HCl and HF from chlorine and fluorine in the coal, and a portion of the HCl and HF could be absorbed in the fly ash. Although the fly ash analysis from the Cape Fear site did not indicate the presence of chlorides or fluorides (See Attachment 2), emissions of HCl and HF from the beneficiation process were estimated. The methodology used to calculate HCl and HF emissions is provided below:

Methodology for Estimating HCl Emissions

Parameter	Value	Reference
Cl concentration	10.933 mg/kg	Chloride concentration in fly ash at H.F. Lee site. Although no chloride was present in the fly ash at the Cape Fear site, this concentration is being used as a conservative estimate.
Cl molecular weight	35.45 g/mol	
HCl molecular weight	36.46 g/mol	
HCl Emission Factor	EF = (10.933 mg Cl /kg ash) * (1 kg/1E6 g) * (36.46 g HCl /mol)/(35.45 g Cl/ mol) EF = 1.12E-5 g HCl / g ash = 1.12E-5 lb HCl/ lb ash	
Throughput	125 ton/hr	This value is overly conservative. The designed process feedstock is 75 tph, and the permitted process reactor rate is 400,000 ton per year of fly ash (45.6 tph).
Control efficiency	95 %	The control efficiency of the FGD is estimated at 95%, based on control efficiency for SO_2. The reactivity of calcium hydroxide (lime) is much greater for HCl than SO_2, so this percentage is a conservative estimate.
Emissions	E_{HCl} = (1.12E-5 lb HCl/lb ash) * (125 ton/hr) * (2000 lb/1ton) * (1-0.95) E_{HCL} = 0.14 lb/hr	

Methodology for Estimating HF Emissions

Parameter	Value	Reference
Cl concentration in fly ash	10.933 mg/kg	Chloride concentration in fly ash at H.F. Lee site. Although no chloride was present in the fly ash at the Cape Fear site, this concentration is being used as a conservative estimate.
Cl concentration in coal	1468 mg/kg	Chloride concentration in coal based on historical data from EPA's 1999 Mercury ICR
% Cl retained in fly ash	% = 10.933 mg/kg/ 1468 mg/kg = 0.74%	
F concentration in coal	77 mg/kg	Fluoride concentration in coal (EPRI)
F concentration in fly ash	Assuming fluoride is retained in fly ash in the same ratio as chloride: F_{Conc} = 77 mg/kg * 0.74/100 F_{Conc} = 0.57 mg/kg	
F molecular weight	18.998 g/mol	
HF molecular weight	20.0 g/mol	
HF Emission Factor	EF = (0.57 mg F /kg ash) * (1 kg/1E6 g) * (20.0 g HF /mol)/(18.998 g F/ mol) EF = 6.04E-7 g HF / g ash = 6.04E-7 lb HF /lb ash	
Throughput	125 ton/hr	This value is overly conservative. The designed process feedstock is 75 tph, and the permitted process reactor rate is 400,000 ton per year of fly ash (45.6 tph).
Control efficiency	95 %	The control efficiency of the FGD is estimated at 95%, based on control efficiency for SO_2. The reactivity of calcium hydroxide (lime) is much greater for HF than SO_2, so this percentage is a conservative estimate.

Parameter	Value	Reference
Emissions	E_{HF} = (6.04E-7 lb HF/lb ash) * (125 ton/hr) * (2000 lb/1ton) * (1-0.95) E_{HF} = 0.0076 lb /hr	

Emissions of HCl and HF are below their respective TPERs as noted above in Table 6, and no additional evaluation is required for these TAPs.

Air Dispersion Modeling
As shown in Table 6 above, facility-wide emissions of several TAPs exceed their TPERs as listed in 15A NCAC 02Q .0711, and air dispersion modeling was required for these TAPs. Facility-wide air dispersion modeling was conducted for arsenic, benzene, beryllium, cadmium, chromium IV, nickel, and sulfuric acid. Although 15A NCAC 02Q .0702(a)(27) specifically exempts emission sources subject to 40 CFR Part 63, Duke Energy elected to include these emission sources in its facility-wide air dispersion modeling.

Revised air dispersion modeling was reviewed and approved by Nancy Jones of the AQAB in a memorandum dated November 18, 2022. As indicated in the memorandum, the modeling demonstrates compliance, on a source-by-source basis, for all TAPs. The maximum impacts and the optimized impacts as a percentage of the acceptable ambient levels (AAL) are provided in Table 7 below. The revised optimized emission rates on a source-by-source basis are provided in Table 8 and are included as emission limits under 15A NCAC 02Q .1100 in the air permit.

Table 7. Modeled Concentration and Optimized Modeled Impacts						
Pollutant	Averaging Period	AAL ($\mu g/m^3$)	Maximum Impacts		Optimized Maximum Impacts	
			Max. Conc. ($\mu g/m^3$)	% of AAL	Max. Conc. ($\mu g/m^3$)	% of AAL
Arsenic	Annual	2.1E-3	1.7E-04	8.32	2.06E-03	98
Benzene	Annual	0.12	2.0E-03	1.63	0.118	98
Beryllium	Annual	4.1E-3	4.1E-05	0.989	4.0E-03	98
Cadmium	Annual	5.50E-03	1.5E-05	0.27	5.4E-03	98
Chromium IV	24-hour	6.20E-01	1.1E-03	0.18	6.1E-01	98
Nickel	24-hour	6	9.0E-03	0.15	5.9	98
Sulfuric Acid	1-hour	100	7.7E-02	0.077	98	98
	24-hour	12	3.8E-02	0.315	11.8	98

Table 8. Permitted Limits of TAPs		
Emission Source	Toxic Air Pollutant	Emission Limit
Feed silo (ID No. I-4)	Arsenic	3.03E-02 lb/yr
	Beryllium	5.48E-02 lb/yr
	Cadmium	5.39E-02 lb/yr
	Chromium VI	1.41E-03 lb/day
	Nickel	1.38E-02 lb/day

Table 8. Permitted Limits of TAPs		
Emission Source	**Toxic Air Pollutant**	**Emission Limit**
STAR® process (ID No. ES-5)	Arsenic	65.8 lb/yr
	Beryllium	38.5 lb/yr
	Cadmium	211 lb/yr
	Nickel	0.889 lb/day
	Sulfuric Acid Mist	31.8 lb/hr
		763 lb/day
FGD Byproduct Silo (ID No. I-6)	Arsenic	1.35E-02 lb/yr
	Beryllium	1.92E-02 lb/yr
	Cadmium	6.63E-02 lb/yr
	Chromium VI	2.69E-03 lb/day
	Nickel	2.83E-03 lb/day
FGD hydrated lime silo (ID No. I-7)	Arsenic	8.76E-03 lb/yr
	Beryllium	1.06E-02 lb/yr
	Cadmium	5.55E-02 lb/yr
	Nickel	3.39E-03 lb/day
EHE A (ID No. ES-8)	Arsenic	13.2 lb/yr
	Beryllium	23.9 lb/yr
	Cadmium	23.5 lb/yr
	Chromium VI	0.350 lb/day
	Nickel	3.44 lb/day
EHE B (ID No. ES-9)	Arsenic	13.2 lb/yr
	Beryllium	23.9 lb/yr
	Cadmium	23.5 lb/yr
	Chromium VI	0.350 lb/day
	Nickel	3.44 lb/day
EHE Silo (ID No. I-10)	Arsenic	303E-02 lb/yr
	Beryllium	5.48E-02 lb/yr
	Cadmium	5.39E-02 lb/yr
	Chromium VI	1.41E-03 lb/day
	Nickel	1.38E-02 lb/day

Table 8. Permitted Limits of TAPs		
Emission Source	**Toxic Air Pollutant**	**Emission Limit**
Product Storage Dome (ID No. I-11)	Arsenic	2.51E-02 lb/yr
	Beryllium	1.47E-02 lb/yr
	Cadmium	8.05E-02 lb/yr
	Chromium VI	1.04E-03 lb/day
	Nickel	1.28E-02 lb/day
Loadout Silo (ID No. I-12)	Arsenic	2.51E-2 lb/yr
	Beryllium	1.47E-02 lb/yr
	Cadmium	8.05E-02 lb/yr
	Chromium VI	8.18E-04 lb/day
	Nickel	1.00E-02 lb/day
Loadout silo spouts (ID No. ES-13 and ES-14, combined)	Arsenic	1.26E-02 lb/yr
	Beryllium	7.35E-03 lb/yr
	Cadmium	4.00E-02 lb/yr
	Chromium VI	5.94E-04 lb/day
	Nickel	7.30E-03 lb/day
Wet Ash Transfer (ID No. I-1)	Arsenic	1.07E-01 lb/yr
	Beryllium	1.93E-01 lb/yr
	Cadmium	1.90E-01 lb/yr
	Chromium VI	3.15E-03 lb/day
	Nickel	3.10E-02 lb/day
Unloading Pile (ID No. I-3)	Arsenic	7.84 lb/yr
	Beryllium	14.2 lb/yr
	Cadmium	13.9 lb/yr
	Chromium VI	0.208 lb/day
	Nickel	2.04 lb/day

Table 8. Permitted Limits of TAPs		
Emission Source	**Toxic Air Pollutant**	**Emission Limit**
Ash Basin (ID No. ES-15)	Arsenic	948 lb/yr
	Beryllium	1,713 lb/yr
	Cadmium	1,683 lb/yr
	Chromium VI	25.1 lb/day
	Nickel	247 lb/day
Ash handling (ID No. I-16)	Arsenic	2.14E-01 lb/yr
	Beryllium	3.86E-01 lb/yr
	Cadmium	3.79E-01 lb/yr
	Chromium VI	5.65E-03 lb/day
	Nickel	5.56E-03 b/day
Screeners (ID No. I-19a and I-19b)	Arsenic	7.6E-01 lb/yr
	Beryllium	1.37 lb/yr
	Cadmium	1.36 lb/yr
	Chromium VI	1.28E-01 lb/day
	Nickel	1.26 lb/day
Ball mall classifier (ID No. I-24)	Arsenic	4.38 lb/yr
	Beryllium	7.90 lb/yr
	Cadmium	7.77 lb/yr
	Chromium VI	1.16E-01 lb/day
	Nickel	1.14 lb/day
Ball mall feed silo (ID No. I-25)	Arsenic	5.40E-03 lb/yr
	Beryllium	9.75E-03 lb/yr
	Cadmium	9.59E-03 lb/yr
	Chromium VI	2.11E-04 lb/day
	Nickel	2.08E-03 lb/day
Telestackers (ID Nos. I-26a through I-26b)	Arsenic	8.73E-02 lb/yr
	Beryllium	8.58E-02lb/yr
	Cadmium	5.58E-02 lb/yr
	Chromium VI	2.44E-02 lb/day
	Nickel	2.40E-01 lb/day

As noted above, Duke Energy elected to include engines (ID Nos. I-22a, I-22b, and I-27a through I-27b), which are exempted from NC Air Toxics per 15A NCAC 02Q .0702(a)(27), in its facility-wide air dispersion modeling. However, these emission sources are not included in the permit condition for 15A NCAC 02Q .1100 because of this exemption.

For TAPs other than arsenic, benzene, beryllium, cadmium, chromium IV, nickel, and sulfuric acid, Duke Energy has made a demonstration that facility-wide actual emissions do not exceed the TPERs listed in 15A NCAC 02Q .0711(a). A condition is included in the permit requiring Duke Energy to operate and maintain the Cape Fear STAR® facility in such a manner that emissions of these TAPs, including fugitive emissions, will not exceed TPERs listed in 15A NCAC 02Q .0711.

9. Facility Emissions Review

Potential emissions are provided in Table 10 below and actual emissions for 2020 are provided in the header of this document.

Table 10. Potential Emissions from the Cape Fear STAR® Facility

Pollutant	Potential Emissions (tpy)
CO	102.5
NO_X	219.3
PM	120.8
PM_{10}	103.9
$PM_{2.5}$	25.2
SO_2	112.5
VOC	19.8
Lead	3.62E-03
Sulfuric acid mist	0.438
Largest HAP	450 lb/yr (hydrogen chloride)
Total HAPs	810.5 lb/yr
GHGs as CO_2e	159,393

Notes:
Revised D1 form received on 03/09/2022.

10. Compliance Status

During the most recent inspection, conducted on April 8, 2022, by Dawn Reddix of the RRO, 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.

11. Facility Comments on Draft Permit

Duke Energy submitted comments on draft permit on August 10, 2022 and January 6, 2023. Responses to these comments are provided in this section. The comments in this section do not represent all of the comments from Duke Energy but those considered most substantive.

1. Removing PSD Avoidance Limit – Duke Energy requested to remove the PSD Avoidance condition for PM/PM_{10}/$PM_{2.5}$. Duke Energy indicated an avoidance condition for PM is not needed to ensure emissions of PM/PM_{10}/$PM_{2.5}$ remain below PSD thresholds. Emissions of SO_2 can be variable based on several factors, while the PM/PM_{10}/$PM_{2.5}$ emissions outside of the fugitive sources are exhausted through baghouses and have little variability.

Response
DAQ disagrees with this request. As noted in Section 6 above, precontrolled emissions of $PM/PM_{10}/PM_{2.5}$ exceed 250 tons per year. Permit avoidance conditions for $PM/PM_{10}/PM_{2.5}$ are required so that the potential emissions (aka controlled emissions) are federally enforceable, and avoidance conditions for these pollutants will be added to the first time TV permit as part of this modification.

2. Reducing MRR in PSD Avoidance Limit – In their January 6, 2023, Duke Energy requested to reduce or simplify the MRR in the $PM/PM_{10}/PM_{2.5}$ avoidance condition. They suggested quarterly emission calculations rather than monthly or reporting the amount of flyash processed, among other suggestions.

   Response
   DAQ disagrees with this request. For mass based 12-months rolling limit such as PSD avoidance, per EPA guidance, emissions calculations (monitoring) should be on monthly basis.

3. Remove testing requirements – The draft permit includes testing of NO_X emissions from the STAR® and testing of PM emissions from the STAR and the EHE. Testing is to be conducted once per permit cycle (i.e., every five years). Duke Energy requested to eliminate these testing requirements.

   Response
   DAQ disagrees with this request. Although the initial testing of these sources demonstrated a large margin of compliance with emission limits, additional testing is warranted to demonstrate consistent emission data from these sources.

12. 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. There are no affected entities within 50 miles of the facility.

13. Other Regulatory Considerations

- A P.E. seal is not required for this permit application.
- A zoning consistency determination is not required for this application.
- A permit fee of $1,002 is required and was paid via e-payment on September 15, 2021.

14. Recommendations

The 1st time TV permit application for Duke Energy Progress LLC – Cape Fear STAR® Ash Beneficiation Process in Moncure, Chatham County, NC has been reviewed by DAQ to determine compliance with all procedures and requirements. DAQ has determined this facility is complying or will achieve compliance, as specified in the permit, with all requirements that are applicable to the affected sources. The DAQ recommends the issuance of Air Permit No. 10583T02.

ATTACHMENT 1

Overview of Emission Factors used in Determining Emissions from Cape Fear STAR® Facility

Emission Source		Emission Factors/References	
STAR®			
ID No.	**Emission Source Description**	**Pollutant**	**Emission Factors/References**
ES-5	STAR® (140 million Btu/hour firing rate)	PM, PM_{10}, $PM_{2.5}$	Gas flow of 75,000 acfm and loading rate of 0.025 gr/acf PM_{10} = 92% of Total PM (AP-42 Table 1.1-6, Bituminous and Subbituminous Coal Combustion) $PM_{2.5}$ = 23% of Total PM (Vendor dated based on field testing of beneficiation units.)
		SO_2	SO_2 emission rate is based on 3.76% LOI, 0.10% fly ash sulfur content, 14,500 Btu/lb carbon heat value, and 95% scrubber control efficiency.
		NO_X	Based on SEFA operation experience
		CO	Based on SEFA operation experience
		VOC	Based on SEFA operation experience
		GHG CO_2e	CO_2e emission rate is based on 14,500 Btu/lb carbon heat value and an emission factor of CO of 0.16 lb/mm Btu as provided by the SEFA group.
		H_2SO4	Based on SEFA stack test performed September 2016. Sulfuric Acid Mist was 0.05 lb/hr for contingency was doubled to 0.1 lb/hr.
		Pb and Metal HAPs/TAPs	Concentration in the ash product based on site-specific product analysis.
	Propane low-NO_X startup burner (60 million Btu/hour)	All	Emissions from worst case startup fuel: propane: AP-42, Table 1.5-1

Emission Source		Emission Factors/References	
Engine Emissions			
ID No.	**Emission Source Description**	**Pollutant**	**Emission Factors/References**
I-22a and I-22b I-27a – I-27f	Two diesel-fired screener engines (225 HP, each) Six diesel-fired telestacker engines (74 HP, each)	NOx, SO2, CO, PM/PM10/PM2.5, and VOC	Certified emissions data from engine manufacturer.
		HAPs/TAPs	AP-42 Table 3.4-1 (10/96) AP-42 Table 1.3-10 (5/10) AP-42, Table 3.3-1 (10/96) AP-42, Table 3.3-2 (10/96)
		GHG CO_2e	Emission factors derived from Tables C-1 and C-2 in 40 CFR Part 98, Subpart C, converted to lb/mmBtu basis using 2.20462 pounds per kilogram Global Warming Potential (GWP) values from Table A-1 to 40 CFR Part 98, Subpart A
Material Handling Emissions (PM, PM_{10}, $PM_{2.5}$, Pb, HAPs/TAPs)			
I-4	Feed Silo	AP-42, Section 13.2.4 and 99% bin vent filter control Duke site-specific average ash analysis	
I-6	FGD Byproduct Silo	PM emissions based on an outlet loading of 0.005 gr/acf and a flow rate of 1,050 acfm. PM_{10} = 92% of Total PM and $PM_{2.5}$ = 53% of Total PM (AP-42 Table 1.1-6**,** Bituminous and Subbituminous Coal Combustion) Byproduct composition based on 10% inerts from fresh lime. Most metal emissions from the FGD Byproduct Silo are from hydrated lime introduced in the FGD system.	
I-7	FGD hydrated lime silo	PM emissions based on an outlet loading of 0.005 gr/acf and a flow rate of 1,050 acfm. Lime composition from EPRI PISCES Database (February 2003) Composition of Lime, Median Value	
ES-8 and ES-9	EHE A and B	PM emissions based on an outlet loading of 0.025 gr/scf and a flow rate of 32,000 dscfm PM_{10} = 92% of Total PM and $PM_{2.5}$ = 53% of Total PM (AP-42 HAP/TAP emissions based on concentration in the ash product based on site-specific product analysis.	
I-10	EHE Silo	AP-42, Section 13.2.4 and 99% bin vent filter control HAP/TAP emissions based on concentration in the ash product based on site-specific product analysis.	
I-11	Product storage dome		
I-12	Load silo and loadout spouts		
I-19	Screener	AP-42, Table 11.19.2-2 Duke site-specific average ash analysis	

<table>
<tr><th colspan="2">Emission Source</th><th>Emission Factors/References</th></tr>
<tr><th colspan="3">Fugitive Emissions (PM, PM_{10}, $PM_{2.5}$, Pb, HAPs/TAPs)</th></tr>
<tr><td>I-1</td><td>Wet ash receiving transfer to shed</td><td>AP-42 Section 13.2-4 (Aggregate Handling and Storage Piles)
Duke Energy Average Ash Analysis</td></tr>
<tr><td>I-3</td><td>Unloading pile</td><td rowspan="2">Methodology in “Air/Superfund National Technical Guidance Study Series – Volume III – Estimate of Air Emissions From Cleanup Activities at Superfund Sites – Interim Final,” by U.S. EPA Office of Air Quality Planning and Standards (EPA-450/1-89-003) and in the “Western Regional Air Partnership (WRAP) Fugitive Dust Handbook” dated 09/07/2006.
Speciation of PM emissions from AP-42 Section 13.2.5 (Industrial Wind Erosion)
Duke Energy Average Ash Analysis</td></tr>
<tr><td>ES-15</td><td>Ash basin</td></tr>
<tr><td>I-16</td><td>Ash handling</td><td>AP-42 Section 13.2.4 (Aggregate Handling and Storage Piles)
Duke Energy Average Ash Analysis</td></tr>
<tr><td>I-21</td><td>Haul roads</td><td>AP-42 Section 13.2.2 (Unpaved Roads)
No Pb emissions</td></tr>
</table>

ATTACHMENT 2

Site-Specific Ash-Analysis for the Cape Fear STAR® Facility

The site-specific ash analysis submitted with the permit application received on July 24, 2018 was conducted incorrectly for all pollutants, with the exception of mercury. Duke Energy submitted a revised site-specific ash analysis with the permit addendum received on November 9, 2018. The values in the table below reflect the revised ash analysis for all pollutants, except for mercury. Mercury was originally analyzed by a separate and correct method, and an updated analysis was not required. The results from the original analysis were used for mercury.

Compound	HAP	TAP	Updated 3052 Analysis (ppm)	Concentration Used in Revised Analysis (ppm)
Antimony	Y		5.44	5.44
Arsenic	Y		53.67	53.67
Barium			NRA	NRA
Beryllium	Y	Y	11.43	11.43
Cadmium	Y	Y	3.25	3.25
Chromium	Y		99.98	99.98
Chromium VI	Y	Y	NRA	11.00
Cobalt	Y		41.48	41.48
Copper			NRA	NRA
Lead	Y		43.48	43.48
Manganese	Y	Y	98.98	98.98
Mercury	Y	Y	NRA	0.25
Molybdenum			NRA	NRA
Nickel	Y	Y	91.11	91.11
Selenium	Y		12.82	12.82
Silver			NRA	NRA
Thallium			NRA	NRA
Vanadium			NRA	NRA
Zinc			NRA	NRA

Notes:
- NRA means "No Result Available."
- Duke used results of 3052 for all compounds except Hg and Cr VI.
- CrVI was assumed to be 11% of total chromium. EPA-453/R-98-004a states 11% of Total Cr from coal is Cr VI.
- Mercury was originally analyzed by separate method, and the results from the original analysis were used for mercury.