GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

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NARRATIVE

TO: Jeng-Hon Su

FROM: Ginger Payment

DATE: June 1, 2022

Facility Name:	**Blue Goblin**
AIRS No.:	089-00404
Location:	Stone Mountain, GA (DeKalb County)
Application #:	28408
Date of Application:	May 13, 2022

Background Information

Blue Goblin (hereinafter "facility) operates a foam recycling plant which is located at 2534 Royal Place, Suite E in Tucker (DeKalb County). The facility densifies expanded polystyrene foam. Permit No. 5162-089-0404-B-01-0 was issued on April 2, 2018 for the construction and operation of the facility. Permit Amendment No. 5162-089-0404-B-01-1 was issued on December 17, 2020 for the replacement of the EPS foam compactor with a smaller model.

Densifiers compact expanded polystyrene (EPS, aka Styrofoam) and extruded polystyrene (XPS) into dense blocks for convenient storage or transportation before recycling. EPS/XPS can be compacted by different methods which use either heat (hot densification) or high pressure (cold densification). The facility uses a cold melt densifier. The Densifier is controlled by an Automatic Densification Control System (ADCS). Foam pieces are fed into the equipment through a bagged hopper and are then compacted by a horizontal ram which extends forward to crush the material. Then, the discharge restriction plate holds the material inside the unit until the preset ADCS ram pressure parameters are attained, and pressure is reduced to allow the densified EPS to be discharged. VOC emissions are emitted as part of the densification process because EPS contains a blowing agent that is released when it is condensed. It is assumed that the blowing agent consists mainly of isopentane.

Purpose of Application

Application No. 28408 was received on May 13, 2022 to request a relocation of the facility from 2534 Royal Place, Suite E in Tucker (DeKalb County) to 1475 Rock Mountain Blvd. in Stone Mountain (DeKalb County). The proposed location will include a Bright Technologies EPS D120 Densifier with a capacity of 1,200 lb/hr. Due to the capacity of the densifier, the facility will be subject to Georgia Rule (tt) – *VOC Emissions from Major Sources* and with a RACT determination for the application. A public advisory (PA0522-3) was issued on May 16, 2022 and will expire on June 17, 2022.

Updated Equipment List

Emission Units			Associated Control Devices	
Source Code	**Description**	**Installation Date**	**Source Code**	**Description**
D120*	EPS D120 Densifier (electric)	2022	--	--

*proposed within current application

Emissions Summary

Emissions were calculate using the capacity of the proposed cold melt densifier (1,200 lb/hour). When densification occurs, it releases a blowing agent that is in the EPS/XPS. It is expected that the EPS/XPS processed by Blue Goblin will have been manufactured in several different manufacturing plants and will have been produced over several years. Therefore, the actual blowing agent and the amount left in the EPS/XPS will vary. Because a similar facility assumed EPS/XPS contains 1.4 weight % isopentane, Blue Goblin assumed a conservative estimate of 1.5% isopentane contained in the EPS/XPS and that all the isopentane is emitted during densification.

Facility-Wide Emissions
(in tons per year)

Pollutant	Potential Emissions			Actual Emissions		
	Before Mod.	**After Mod.**	**Emissions Change**	**Before Mod.**	**After Mod.**	**Emissions Change**
$PM/PM_{10}/PM_{2.5}$	Negligible	Negligible	--	Negligible	Negligible	--
NOx	--	--	--	--	--	--
SO_2	--	--	--	--	--	--
CO	--	--	--	--	--	--
VOC	0	78.84	78.84	0	<78.84	<78.84
Max. Individual HAP	--	--	--	--	--	--
Total HAP	--	--	--	--	--	--
Total GHG (if applicable)	--	--	--	--	--	--

Regulatory Applicability

The facility’s manufacturing processes will continue to be subject to Georgia Rule (b) – *Visible Emissions* and Georgia Rule (e) – *Particulate Emissions from Manufacturing Processes*.

Because the VOC emissions will exceed 25 tpy, the facility will now be subject to Georgia Rule (tt) - *VOC Emissions from Major Sources* and a RACT (Reasonably Available Control Technology) analysis is required to be conducted. The following is the RACT analysis included in Application No. 28408.

RACT Review for VOC

The main source of emissions at Blue Goblin is the densifier which has the potential to emit VOC emissions. At the maximum operation of 8,760 hours, the densifier has potential VOC emissions of 78.84 tpy.

Identify Product Alternative

1. Densifier

   There are no alternative options for the densifier.

Identify Technological Alternatives

Blue Goblin evaluated RACT for the densifier by determining what process changes and add-on emission controls are technically feasible for the specific type of equipment. Potential emission reduction options were determined from EPA's RACT/BACT/LAER (RBLC) Clearinghouse and other research. The following control technologies are considered to be technologically feasible:

1. Recuperative/Regenerative Thermal Oxidizer
2. Adsorption
3. Biofiltration
4. Refrigerated Condensers
5. Good Management Practices

Eliminate Technically Infeasible Options

1. Biofiltration

   In biofiltration, off-gases containing biodegradable organic compounds are vented, under controlled temperature and humidity, through a biologically active material. The process uses a biofilm containing a population of microorganisms immobilized on a porous substrate such as peat, soil, sand, wood, compost, or numerous synthetic media. As an air stream passes through the biofilter, the contaminants in the air stream partition from the gaseous phase to the liquid phase of the biofilm. Once contaminants pass into the liquid phase, they become available for the complex oxidative process by the microorganisms inhabiting the biofilm.

   Based on RBLC research on VOC control technology for all processes, biofiltration has not been placed in operation aside from very limited applications. Therefore, biofiltration was not considered technically feasible.

2. Refrigerated Condensers

   Condensers operate by lowering the temperature of the exhaust gas streams containing condensable VOC to a temperature at which the target VOC's vapor pressure is lower than its entering partial pressure (saturation point). Before the VOC can condense, any sensible heat present in the exhaust gas above the saturation point must be removed. Cooling the exhaust stream to a temperature below the saturation point removes the latent heat from the exhaust and allows the VOC to condense on the surface of the condenser tubes for collection and recycle to the process or disposal to an appropriate location. The tubes located within the condenser contain re-circulating cooling liquid that provides a heat sink for rejecting both sensible and latent heat from the hot exhaust gas stream. Available cooling fluids (depending on the necessary outlet temperature of the exhaust stream to achieve high levels of recovery for the condensable VOC) include chilled water, brine, or refrigerants. Once the cooling liquid is passed through the condenser, it is chilled to the required condenser inlet temperature and recycled back to the cooling liquid inlet of the condenser.

   The VOC efficiency achieved by a condenser, as a sole add-on control device, is a function of: 1) the heat capacity and temperature of the inlet exhaust stream, 2) the heat transfer characteristics of the condenser (including the heat transfer area and the heat transfer coefficient), and 3) the outlet temperature of the exhaust gas exiting the condenser. Condensers are most effective in single component systems involving emission streams with a high percentage of a condensable VOC, because less heat must be removed from the exhaust gas to reduce the sensible heat of non-condensable gases and the required condenser temperature to achieve high levels of recovery. Unlike other VOC control devices for which quantifying control efficiency can require emissions testing, only the outlet exhaust gas temperature is required to estimate the VOC control efficiency of a condenser if the temperature, VOC concentration, and flow rate of the non-condensable in the inlet exhaust stream are all known. Since the control efficiency of a condenser is dynamic based on the outlet temperature and inlet concentration of VOC in the exhaust stream, condensers exhibit a wide range of VOC control efficiency from as low as 50% to as high as 99%.

   Refrigerated condensers were determined to be infeasible in these cases because the concentrations by volume of VOC in the exhausts are well below 5,000 ppmv. According to the US EPA Air Pollution Control Cost Manual, refrigerated condensers are used as air pollution control devices for treating emission streams with high VOC concentrations (usually > 5,000 ppmv) in applications for example involving gasoline bulk terminals, storage, etc. The concentration of VOC by volume in the waste gas streams is 47 ppmv. Due to the low concentration, condensation of the waste gas streams was not considered technically feasible.

Technical Feasibility Determination

3. Adsorption

   Regenerative adsorption systems are typically a batch operation involving two or more fixed adsorption beds. One or more of the beds operates in adsorption mode while the others operate in regeneration mode. Several adsorbent materials with substantial surface area per unit volume can be used in adsorbers including activated carbon, organic resin polymers, and inorganic materials such as zeolite. An induced draft fan is typically used to force the VOC-laden gas through the adsorption bed where the VOC molecules are physically bound to the pore space in the adsorbent by Van der Waals forces. There are many types of carbon, polymer, and zeolite adsorbents available with different affinities for adsorbing various VOC. A key selection criterion for determining the appropriate adsorbent is the range of pore sizes relative to the largest molecular size of the VOC to be adsorbed.

The batch nature of the adsorption process concludes when the adsorbent bed becomes saturated with VOC and must be replaced or regenerated. The gas-solid interface within the bed at which adsorption is occurring is referred to as the mass transfer zone (MTZ), and the location of this MTZ within the bed determines its level of bed saturation and the time at which it must be replaced or regenerated. When the MTZ nears the end of the bed, the VOC concentration of the exhaust gas will increase producing a phenomenon referred to as “breakthrough.”

After breakthrough has occurred in an adsorbent bed, it must be replaced with a new bed or regenerated using a thermal swing or vacuum process. For this analysis, it was assumed bed replacements would be selected over bed regeneration since the collected VOC would need to undergo thermal treatment for final destruction.

The typical VOC inlet concentration required for effective adsorption falls in the range of 400 to 2,000 ppm, and adsorbers and their associated follow-up control devices (i.e., condenser or decanter) are typically capable of achieving VOC control efficiencies greater than 95%. The concentration of exhaust stream is 47 ppm which is slightly below the concentration range for effective adsorption. Adsorption system was considered to be technically feasible.

4. Recuperative Thermal Oxidizer

Oxidizers with heat recovery are either considered recuperative or regenerative depending on the design of the incoming process gas to exhaust gas heat exchange system. Recuperative oxidizers (labeled herein as a TO) use plate-to-plate or shell-and-tube gas heat exchangers to recover up to 70% of the sensible heat present in the hot exhaust to transfer it to the incoming process gas. U.S. EPA expects that a TO can achieve a destruction/removal efficiency (DRE) of greater than 98% depending on the system requirements of the air contaminant stream. Typical gas flow for TOs are 500 to 50,000 scfm. While the concentration and exit temperature of the exhaust stream is comparatively low for this option to be feasible, a recuperative oxidizer was considered to be technically feasible.

5. Regenerative Thermal Oxidizer

A regenerative thermal oxidizer (RTO) uses a high-density packed heat transfer media, typically ceramic random saddle packing or honeycomb monolith structures, to preheat incoming waste gas streams and to achieve 85 to 95% heat recovery. The RTO consists of at least two modules that are cycled between inlet and outlet service to maintain appropriate operating temperatures and to conserve as much thermal energy as possible. The high level of heat integration offered by RTOs is particularly suited for high flow rate and low VOC concentration waste gas streams that do not vary in composition or flow rate over time. When necessary, the feed gas stream in an RTO can also be further heated to the oxidizer’s operating temperatures (1,400 to 2,000 °F) through supplemental fuel combustion. RTOs have been used effectively in applications where the inlet VOC concentration is as low as 100 ppmv, and, therefore, they are the preferred oxidizer design for low VOC concentration exhaust stream U.S. EPA expects that an RTO can achieve a destruction/removal efficiency of greater than 95% depending on the system’s requirements and the characteristics of the contaminated stream.

Typical gas flow for regenerative incinerators are 5,000 to 500,000 scfm. While the concentration and exit temperature of the exhaust stream is comparatively low for this option to be feasible, a regenerative thermal oxidizer (RTO) was considered to be technically feasible.

6. Good Management Practices

The use of good management practices at the facility for recordkeeping and reporting to Georgia EPD if VOC emissions from the baking lines exceeds 80 tons/rolling 12-month period.

Rank Remaining Control Technologies

Control Ranking	Control Technology	Destruction / Control Efficiency
1	Recuperative Thermal Oxidizer	99%
2	Regenerative Thermal Oxidizer	95-99%
3	Adsorption	98%
4	Catalytic Thermal Oxidizer	95%
5	Good Management Practices	N/A

Energy, Environmental and Economic Impacts

The energy consumption of each control technology and emission unit pairing was calculated using the procedures specified in the EPA Air Pollution Control Cost Manual and calculation spreadsheet provided by EPA (dated in 2018). These impacts are important because the nation's energy supply and distribution capacity is limited. The securing, production, and distribution of energy has impacts on the availability and cost of energy, the nation's balance of trade, and national security. While estimating the cost of these externalities is beyond the scope of this analysis, it is important that the magnitude of these impacts is considered when evaluating potential pollution control technologies. As such, the estimated annual consumption of electricity and natural gas for each such control technology is listed below.

Secondary environmental impacts of proposed control technologies were also considered, as they may create emissions of one type while controlling emissions of another. Based on the estimated annual energy consumption of each control technology, the estimated nitrogen oxides (NOx), carbon monoxide (CO), and greenhouse gas (GHG) emissions of each pairing are summarized below.

Control Technology	Natural Gas Consumption (scf/yr)	Electricity Consumption (kWh/yr)	NO_x Emissions (tpy)	CO Emissions (tpy)	GHGs (CO_2e) Emissions (tpy)
Recuperative Thermal Oxidizer	331,004,708	1,844,319	16.55	13.90	2104.0
Carbon Adsorption	--	--	--	--	--
Regenerative Thermal Oxidizer	48,953,657	1,844,319	2.45	2.06	311.18
Catalytic Oxidizer	170,970,442	1,523,568	8.55	7.18	1086.8

Cost Effectiveness

Economic analyses were performed to compare total costs (capital and annual) per ton of pollutant removed for control technologies that have been deemed technically feasible. Capital costs include the initial cost of the components intrinsic to the complete control system. Annual operating costs include the financial requirements to operate the control system on an annual basis including overhead, maintenance, outages, raw materials, and utilities.

Cost analysis is based on EPA Air Pollution Control Cost Manual and calculation spreadsheet provided by EPA (dated in 2018). Note that capture cost is not included in EPA's calculation template. Therefore, additional duct work costs were calculated separately based on EPA Air Pollution Control Cost Manual - Sixth Edition (EPA 452/B-02-001), Section 2, Chapter 1 - Hoods, Ductwork, and Stacks.

Note that this evaluation assumed that the capture efficiencies of process VOC emissions from densifier are 100% for Blue Goblin with the creation of a capture system built around the unit and reroute to a stack. The cost of adding vacuum pickup points and routing gas to stacks were not estimated as part of the evaluation. In addition, improving the capture efficiencies will increase the flow rate and decrease the VOC concentration of the waste stream, which will increase the cost as well.

Blue Goblin evaluated the cost effectiveness of each control strategy by developing annualized cost estimates used to determine the unit cost of reducing one (1) ton of VOC emissions. The following table indicates the cost effectiveness of the technically feasible control options for reducing VOC emissions from the two production lines combined. See Appendix D of the application for detailed calculations regarding cost effectiveness of the technically feasible control options.

Control Technology	Control Technology (%)	Potential Emissions (tpy)	Pollutant Removed (tpy)	Cost Effectiveness ($/ton removed)
Recuperative Thermal Oxidizer	99	79	78.1	$28,575
Carbon Adsorption	98	79	77.3	$89,329
Regenerative Thermal Oxidizer	97	79	76.5	$11,767
Catalytic Thermal Oxidizer	95	79	74.9	$23,242

<u>Selection of VOC RACT</u>

The cost of all add-on VOC control technologies would exceed the benefit of VOC reduction. The per ton VOC removal costs in the table above are all excessive and the control technologies are all determined to be economically infeasible. Therefore, RACT for the densifier at Blue Goblin is determined to be:

- Good Management Practices, where possible
- Recordkeeping and reporting to Georgia EPD if VOC emissions from the entire facility exceeds 80 tons/rolling 12-month period.

The Division agrees with the proposed VOC RACT of good management practices and recordkeeping and reporting of the VOC emission limit of 80 tpy. Due to the high cost effectiveness, add-on VOC control technologies are not reasonable.

Permit Conditions

- Condition 2.1 identifies the approved RACT determination is Good Management Practice. Since all the VOC inside the foam will be released and become airborne emissions, the facility is limited to emit up to 80 tpy VOC.
- Condition 2.2 subjects the facility to Georgia Rule (b).

- Condition 2.3 subjects the facility to Georgia Rule (e).
- Condition 7.1 requires the facility to notify the Division for the startup date of the facility.
- Condition 7.2 requires monthly records of the amount of foam processed by the densifier.
- Conditions 7.3 and 7.4 require the facility to calculate monthly and 12-month rolling totals of VOC emissions. The facility is required to notify the Division if any one month exceeds 6.66 tons or if any 12 month total exceeds 80 tpy.
- Condition 8.2 revokes the permit for the previous location upon startup of the facility at the new location.

Toxic Impact Assessment

The potential emission rate for isopentane (the only HAP/TAP) was evaluated to determine if a toxic impact assessment was necessary. The emission rate was evaluated to the MER (minimum emission rate) located in Appendix A for the Georgia Air Toxics Guidelines. Because there is not a MER for isopentane, pentane was used. A summary of the MER for the pollutant is shown in the table below. The emission rate was below the MER; therefore, a toxic impact assessment was not necessary.

Pollutant	CAS	Emission Rate (lb/yr)	MER (lb/yr)	Modeling Required?
Pentane	109660	1.58E+05	3.42E+05	No

Summary & Recommendations

I recommend issuance of Permit No. 5162-089-0404-B-02-0 to Blue Goblin for the construction and operation of a foam recycling plant which will be constructed at 1475 Rock Mountain Blvd. in Stone Mountain (DeKalb County). A public advisory was issued and will expire on June 17, 2022. The Mountain District – Atlanta office will continue to be responsible for compliance and inspection of this facility.