STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION
17 STATE HOUSE STATION AUGUSTA, MAINE 04333-0017

DEPARTMENT ORDER

Standard Biocarbon Corporation **Penobscot County** **Enfield, Maine** **A-1158-71-E-A**	**Departmental** **Findings of Fact and Order** **Air Emission License** **Amendment #4**

FINDINGS OF FACT

After review of the air emission license amendment application, staff investigation reports, and other documents in the applicant's file in the Bureau of Air Quality, pursuant to 38 Maine Revised Statutes (M.R.S.) § 344 and § 590, the Maine Department of Environmental Protection (Department) finds the following facts:

I. REGISTRATION

A. Introduction

Standard Biocarbon Corporation (SBC) was issued Air Emission License A-1158-71-A-N on November 12, 2021, for the construction and operation of emission sources associated with their biocarbon (also called biochar) production and distribution facility to be located in East Millinocket. The license was subsequently amended as follows:

Amendment #	Date Issued	Brief Description
A-1158-71-B-A	10/13/2022	Construct and operate the proposed facility in Enfield, Maine rather than East Millinocket and reduce the number of PYREG units from four to two
A-1158-71-C-A	5/15/2024	Addition of Dryer #1 and update to visible emission standards
A-1158-71-D-M	3/14/2025	Extension to the deadline to conduct testing on Dryer #1

The equipment addressed in this license amendment is located at 542 Hammett Road in Enfield, Maine.

SBC has requested an amendment to their license in order to use cyclones to control particulate matter from the PYREG units instead of pressure membrane filter vessels.

I addition, SBC has interest in processing nut shells in the PYREG units. Materials such as crop residues, including nut shells, is included in the definition of "clean cellulosic biomass" in 40 C.F.R. § 241.2. The definition of biomass has been updated accordingly.

B. Emission Equipment

The following equipment is addressed in this air emission license amendment:

Fuel Burning Equipment

Equipment	Max. Capacity (MMBtu/hr)	Maximum Firing Rate	Fuel Type	Date of Manuf.	Date of Install.	Stack #
PYREG Unit #1	5.2	~1,370 lb/hr	Syngas	2022	2022	#1
	1.4 (Startup only)	15.3 gph	Propane			
PYREG Unit #2	5.2	~1,370 lb/hr	Syngas	2022	2022	#2
	1.4 (Startup only)	15.3 gph	Propane			

C. Definitions

Biomass means any biomass-based solid fuel that is not a solid waste. This includes, but is not limited to, wood residue and wood products (*e.g.,* trees, tree stumps, tree limbs, bark, lumber, sawdust, sander dust, chips, scraps, slabs, millings, and shavings) as well as crop residues (e.g., peanut shells, vines, orchard trees, hulls, seeds, spent grains, cotton byproducts, corn and peanut production residues, rice milling and grain elevator operation residues). This definition also includes wood chips and processed pellets made from wood or other forest residues. Inclusion in this definition does not constitute a determination that the material is not considered a solid waste. SBC should consult with the Department before adding any new biomass type to its fuel mix.

Records or *Logs* mean either hardcopy or electronic records.

D. Application Classification

All rules, regulations, or statutes referenced in this air emission license refer to the amended version in effect as of the date this license was issued.

The modification of a minor source is considered a major or minor modification based on whether or not expected emission increases exceed the "Significant Emissions" levels as defined in the Department's *Definitions Regulation*, 06-096 Code of Maine Rules (C.M.R.) ch. 100. The emission increases are determined by subtracting the current licensed annual emissions preceding the modification from the maximum future licensed annual emissions, as follows:

Pollutant	Current License (tpy)	Future License (tpy)	Net Change (tpy)	Significant Emissions Levels
PM	10.5	10.5	0	100
PM_{10}	10.8	10.8	0	100

Pollutant	Current License (tpy)	Future License (tpy)	Net Change (tpy)	Significant Emissions Levels
$PM_{2.5}$	10.8	10.8	0	100
SO_2	0.1	0.1	0	100
NO_x	10.0	10.0	0	100
CO	3.7	3.7	0	100
VOC	22.5	22.5	0	100

This modification is determined to be a minor modification and has been processed as such.

E. Facility Classification

The facility is licensed as follows:

- As a natural minor source of criteria pollutants, because no license restrictions are necessary to keep facility emissions below major source thresholds for criteria pollutants; and
- As an area source of hazardous air pollutants (HAP), because the licensed emissions are below the major source thresholds for HAP.

II. BEST PRACTICAL TREATMENT (BPT)

A. Introduction

In order to receive a license, the applicant must control emissions from each unit to a level considered by the Department to represent Best Practical Treatment (BPT), as defined in *Definitions Regulation*, 06-096 C.M.R. ch. 100. Separate control requirement categories exist for new and existing equipment.

BPT for new sources and modifications requires a demonstration that emissions are receiving Best Available Control Technology (BACT), as defined in *Definitions Regulation*, 06-096 C.M.R. ch. 100. BACT is a top-down approach to selecting air emission controls considering economic, environmental, and energy impacts.

B. PYREG Units #1 and #2

PYREG Units #1 and #2 are carbonization units. Combined, they are capable of converting approximately 16.5 tons/day of woodchips to approximately 4.0 ton/day of biochar.

Woodchips are continuously fed via screw conveyor through the PYREG reactor where the biomass is slowly heated, degassed, and carbonized via pyrolysis at temperatures of 930 to 1,300 degrees Fahrenheit (°F). Pyrolysis, conducted in an oxygen-starved environment, produces a solid (biochar), vaporized organic compounds, water, and non-condensable gases.

As the temperature within the PYREG reactor increases, residual moisture within the biomass evaporates and the woodchips begin to soften, releasing chemically bound water, small amounts of carbon dioxide (CO_2), and volatile organic compounds (VOC). As the woodchips are further heated from 390 to 530 ^oF, the woodchips become torrefied as chemical bonds within the biomass begin to break, releasing emissions of methane (CH_4), VOC, CO_2, and carbon monoxide (CO) from the breakdown of cellulose and hemicellulose. As temperatures approach 570 ^oF, further thermal decomposition of the biomass occurs, releasing a combustible mixture of hydrogen, CO, CH_4, CO_2, and other hydrocarbons and tars.

At this point in the process, the biochar created contains appreciable amounts of VOC. The biochar is heated to 1,100 ^oF to increase the stable carbon content, surface area, and porosity of the char by decomposing more of the VOC. Once the temperature reaches 1,300 ^oF, more VOC are released, increasing the carbon concentration in the biochar to approximately 90%.

The synthesis gas, or syngas, is the collection of gases generated in the PYREG reactors containing primarily CO, CO_2, H_2, and nitrogen (N_2). These gases are produced from small amounts of air that enter the PYREG reactor with the woodchips and water vapor. The syngas contains less than 10% by volume of short-chained hydrocarbons (such as methane, ethane, propane, and butane) that add calorific value. The higher heating value of the syngas is approximately 3,800 Btu/lb.

Upon exiting the PYREG reactor at approximately 1,000 to 1,200 ^oF, the syngas is filtered in a pressure membrane filter vessel designed to withstand the high temperature of the syngas. Membrane filters are different from traditional fabric filters in that filterable particulate matter (PM) is collected on the membrane surface and there is no reliance on a filter cake to drive efficiency. Instead, the membrane acts as the primary filter cake which inhibits the migration of smaller particles into the filter material. The pressure vessel filter utilizes a pulse jet backflow cleaning system which removes particulate matter from the surface of the membrane filters with bursts of compressed nitrogen.

Once filtered, the syngas enters the combustion chamber which utilizes a 5.2 MMBtu/hr FLOX (flameless oxidation) burner. In FLOX burners, the fuel gases/syngas and combustion air are vigorously mixed prior to the onset of flame reactions. This leads to a homogenous temperature distribution within the chamber and reduced peak temperature zones, minimizing the formation of thermal NO_x. The combustion chamber also includes a separate 1.4 MMBtu/hr propane burner that will be utilized upon startup of the unit until the process can operate auto-thermally.

1. Proposed Amendment

In Air Emission License A-1158-71-B-A (issued 10/13/2022), BACT for emissions of particulate matter was determined to be use of a pressure membrane filter vessel and the following emission limits:

Emission Unit	Pollutant	lb/MMBtu	lb/hr
PYREG Unit #1	PM	0.12	0.62
	PM_{10}	–	0.62
PYREG Unit #2	PM	0.12	0.62
	PM_{10}	–	0.62

Performance testing conducted in fall 2024 demonstrated that the pressure membrane filter vessel could achieve this level of emissions control with a PM result of 0.011 lb/hr (0.006 lb/MMBtu) and a PM_{10} result of 0.014 lb/hr (0.008 lb/MMBtu). However, after 2-3 months of intermittent operation, SBC determined that the pressure membrane filter vessel was fouling quickly, requiring frequent downtime for maintenance, and limiting PYREG unit operation. SBC has proposed reevaluating BACT for control of particulate matter emissions from PYREG Units #1 and #2.

2. BACT Findings

SBC submitted a BACT analysis for control of particulate matter emissions from PYREG Units #1 and #2. Potentially applicable control technologies were identified by researching technical literature, control equipment vendor information, the US EPA's RACT/BACT/LAER Clearinghouse, and air emission licenses recently issued by the Department. The following is a summary of that analysis.

a. Identify Potential Control Options

Potential post-combustion control technologies for particulate matter considered include pressure membrane filters, baghouses, electrostatic precipitators (ESPs), wet scrubbers, and cyclones.

<u>Pressure Membrane Filters</u>
As described previously, pressure membrane filters are different from traditional fabric filters in that filterable particulate matter is collected on the membrane surface and there is no reliance on a filter cake to drive efficiency. Instead, the membrane acts as the primary filter cake which inhibits the migration of smaller particles into the filter material.

<u>Baghouses</u>
Baghouses consist of a number of fabric bags placed in parallel that collect particulate matter on the surface of the filter bags as the exhaust stream passes through the fabric membrane. The collected particulate is periodically dislodged

from the bags' surface to collection hoppers via short blasts of high-pressure air, physical agitation of the bags, or by reversing the gas flow.

ESPs/WESPs

ESPs work by charging particles in the exhaust stream with a high voltage, oppositely charging a collection surface or surfaces where the particles accumulate, removing the collected particles by a rapping process, and collecting the particles in hoppers. In wet ESPs (WESPs), the collectors are either intermittently or continuously washed by a spray of liquid, usually water. Instead of collection hoppers, a drainage system is used.

Cyclones

Mechanical separators include cyclonic and inertial separators. In a cyclone, centrifugal force separates larger particulate matter from the gas stream. The exhaust gas enters a cylindrical chamber on a tangential path at a high velocity causing the PM to impact the outer wall of the unit and fall into a hopper for collection.

Wet Scrubbers

Wet scrubbers remove PM from gas streams primarily through impaction and, to a lesser extent, other mechanisms such as interception and diffusion. A scrubbing liquid (typically water) is sprayed countercurrent to the exhaust gas stream. Contact between the larger scrubbing liquid droplets and the suspended particulates removes PM from the gas stream. Entrained liquid droplets then pass through a mist eliminator (coalescing filter) which causes the droplets to become heavier and fall out of the exhaust stream.

b. Eliminate Infeasible Control Options

Pressure Membrane Filters

A pressure membrane filter vessel was originally selected as BACT when the PYREG units were initially licensed; however, they have proved problematic with frequent plugging and fouling resulting in significant downtime. SBC cannot operate the PYREG units as intended due to pressure membrane filter plugging issues, and despite working with PYREG to troubleshoot these issues, SBC finds the use of this control technology to be technically infeasible for their operation.

Baghouses

Due to the high moisture content of the exhaust stream, a baghouse would have the tendency to blind quickly in the emissions stream from the PYREG units resulting in frequent downtime for cleaning and replacement. Therefore, baghouses are considered technologically infeasible for this application.

ESPs/WESPs

Dry ESPs are not technically feasible for moist particles, such as particles in the exhaust stream from the PYREG units, as they are likely to adhere to the collection surfaces.

WESPs are a technically feasible control option. However, SBC does not currently have the infrastructure to properly manage the wastewater generated, and the installation of such a system would require significant capital investment. WESPs would also create a new pollution stream, i.e., wastewater. Therefore, WESPs are considered infeasible for economic and environmental reasons.

Wet Scrubbers

Similar to WESPs, wet scrubbers generate wastewater, and SBC does not have the infrastructure to properly manage the wastewater generated, and the installation of such a system would require significant capital investment. Therefore, wet scrubbers are considered infeasible for economic and environmental reasons

c. Ranking of Control Options

The use of a cyclone is determined to be the only control option that is technically, economically, and environmentally feasible for control of particulate matter from PYREG Units #1 and #2. SBC has proposed the use of a high efficiency Hurricane MK model cyclone designed by Advanced Cyclone Control Systems. The cyclone has an estimated control efficiency of 95 – 99.5% for PM_{10}. As such, SBC proposes to the use of a cyclone to continue to meet the currently licensed emission limits for PM and PM_{10}.

d. Determination

The Department finds the use of a Hurricane MK model cyclone and the following emission limits to represent BACT for particulate matter emissions from the PYREG units.

Emission Unit	Pollutant	lb/MMBtu	lb/hr
PYREG Unit #1	PM	0.12	0.62
	PM_{10}	–	0.62
	$PM_{2.5}$	–	0.62
PYREG Unit #2	PM	0.12	0.62
	PM_{10}	–	0.62
	$PM_{2.5}$	–	0.62

These standards apply at all times. Compliance with the particulate matter limits shall be demonstrated through performance testing within 180 days of installation of the cyclone.

If any of the tested pollutant emissions are greater than 75% of the emission limit, SBC shall test both units for each pollutant with emissions greater than 75% of the emission limit within two years of the initial testing date.

When firing propane, visible emissions from PYREG Units #1 and #2 each shall not exceed 10% opacity on a six-minute block average basis.

When firing syngas, visible emissions from PYREG Units #1 and #2 each shall not exceed 20% opacity on a six-minute block average basis.

C. Performance Test Protocol

For any performance testing required by this license, SBC shall submit to the Department for approval a performance test protocol, as outlined in the Department's Performance Testing Guidance, at least 30 days prior to the scheduled date of the performance test. [06-096 C.M.R. ch. 115, BPT]

The Department's Performance Testing Guidance is available online at: https://www.maine.gov/dep/air/emissions/testing.html

D. Annual Emissions

The table below provides an estimate of facility-wide annual emissions for the purposes of calculating the facility's annual air license fee and establishing the facility's potential to emit (PTE). Only licensed equipment is included, i.e., emissions from insignificant activities are excluded. Similarly, unquantifiable fugitive particulate matter emissions are not included except when required by state or federal regulations. Maximum potential emissions were calculated based on the following assumptions:

- Operating each PYREG unit for 8,760 hr/year;
- Propane emissions are not included because the normal hourly emissions from combusting syngas are higher;
- Operating Dryer #1 for 8,760 hr/year;
- Processing no more than 4,200 ton/year of green pine (assumed 50% moisture) in Dryer #1; and
- Processing no more than 21,000 ton/year (assumed 50% moisture) of all species combined in Dryer #1.

This information does not represent a comprehensive list of license restrictions or permissions. That information is provided in the Order section of this license.

Total Licensed Annual Emissions for the Facility
Tons/year
(used to calculate the annual license fee)

	PM	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO	VOC
PYREG Units #1 - #2	5.5	5.5	5.5	0.1	10.0	3.7	0.3
Dryer #1	5.0	5.3	5.3	–	–	–	22.2
Total TPY	**10.5**	**10.8**	**10.8**	**0.1**	**10.0**	**3.7**	**22.5**

Pollutant	Tons/year
Single HAP	7.9
Total HAP	19.9

ORDER

Based on the above Findings and subject to conditions listed below, the Department concludes that the emissions from this source:
- will receive Best Practical Treatment,
- will not violate applicable emission standards, and
- will not violate applicable ambient air quality standards in conjunction with emissions from other sources.

The Department hereby grants Air Emission License Amendment A-1158-71-E-A subject to the conditions found in Air Emission License A-1158-71-A-N; in amendments A-1158-71-B-A, A-1158-71-C-A, and A-1158-71-D-M; and the following conditions.

Severability. The invalidity or unenforceability of any provision of this License Amendment or part thereof shall not affect the remainder of the provision or any other provisions. This License Amendment shall be construed and enforced in all respects as if such invalid or unenforceable provision or part thereof had been omitted.

SPECIFIC CONDITIONS

The following shall replace Condition (17) of Air Emission License A-1158-71-B-A as amended in A-1158-71-C-A:

(17) **PYREG UNITS #1-#2**

A. Fuel

1. SBC is licensed to combust syngas derived from biomass in the FLOX combustion chamber. Propane shall be used solely as a startup fuel.

2. SBC shall use FLOX burners utilizing Flue Gas Recirculation (FGR) for control of NO_x in the PYREG carbonization units whenever the units are operating.

[06-096 C.M.R. ch. 115, BACT]

B. Control Equipment

1. SBC shall continuously use a Hurricane MK cyclone to control emissions of particulate matter from PYREG Units #1 and #2 during all operating times, including periods of startup and shutdown.

2. SBC shall keep a log of all maintenance (planned or unplanned) conducted on the Hurricane MK cyclone including a description of the maintenance and the date, time, and reason for the maintenance.

[06-096 C.M.R. ch. 115, BACT]

C. Stack Height

Each PYREG unit shall exhaust through its own stack having a height of at least 48 feet above ground level. [06-096 C.M.R. ch. 115, BACT]

D. Emissions while firing syngas shall not exceed the following:

Emission Unit	Pollutant	lb/MMBtu	Origin and Authority
PYREG Unit #1	PM	0.12	06-096 C.M.R. ch. 115, BACT
PYREG Unit #2	PM	0.12	06-096 C.M.R. ch. 115, BACT

E. Emissions when firing syngas shall not exceed the following:
[06-096 C.M.R. ch. 115, BACT]

Emission Unit	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr	SO_2 (lb/hr)	NO_x (lb/hr)	CO (lb/hr)	VOC (lb/hr)
PYREG Unit #1	0.62	0.62	0.62	0.01	1.14	0.42	0.03
PYREG Unit #2	0.62	0.62	0.62	0.01	1.14	0.42	0.03

F. Emissions when firing propane shall not exceed the following:
[06-096 C.M.R. ch. 115, BACT]:

Emission Unit	PM (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	NO_x (lb/hr)	CO (lb/hr)	VOC (lb/hr)
PYREG Unit #1	0.07	0.07	0.07	0.01	0.2	0.11	0.02
PYREG Unit #2	0.07	0.07	0.07	0.01	0.2	0.11	0.02

G. Visible Emissions

1. Visible emissions from each PYREG unit firing propane shall not exceed 10% opacity on a six-minute block average basis. [06-096 C.M.R. ch. 101, § 4(A)(3)]

2. Visible emissions from each PYREG unit when firing syngas shall not exceed 20% opacity on a six-minute block average basis. [06-096 C.M.R. ch. 115, BACT]

H. Performance Testing

1. SBC shall conduct performance testing under conditions representative of normal operation to demonstrate compliance with the PM, PM_{10}, and $PM_{2.5}$ lb/hr emission limits within 180 days of installation of the cyclone.

2. If any of the tested pollutant emissions are greater than 75% of the emission limit, SBC shall test both units for each pollutant with emissions greater than 75% of the emission limit within two years of the initial testing date.

3. For any performance testing required by this license, SBC shall submit to the Department for approval a performance test protocol, as outlined in the Department's Performance Testing Guidance, at least 30 days prior to the scheduled date of the performance test.

4. Performance tests for PM shall be conducted in accordance with EPA Test Method 5 or other methods as approved by the Department.

5. SBC may elect to conduct PM_{10} and $PM_{2.5}$ testing either in accordance with EPA Test Methods 201/201A and 202 or in accordance with EPA Test Methods 5 and 202 (or other methods as approved by the Department). If SBC elects to demonstrate compliance using EPA Test Method 5, emissions of filterable particulate matter shall be assumed to be 100% $PM_{2.5}$.

I. Periodic Monitoring and Recordkeeping

1. Periodic monitoring for the PYREG units shall include recordkeeping to document the amount of biomass and propane used both on a monthly and calendar year total basis. SBC shall record the amount of biomass received based on information provided by the supplier or shall weigh, measure, and calculate the tons of biomass conveyed into the system. [06-096 C.M.R. ch. 115, BACT]

2. The following parameters and operational values shall be monitored and recorded.

Parameter	Units of Measure	Monitoring Tool/Method	Frequency of Monitor	Frequency of Recordkeeping
Pressure drop across cyclone	Pressure difference	Differential pressure gauge	Continuously	Once per shift
FLOX combustion temperature	^{o}F	Thermometer	Continuously	Continuously, with Maximum and Minimum values recorded daily
Biomass moisture content	%	Lab test	Monthly	Monthly

[06-096 C.M.R. ch. 115, BACT]

DONE AND DATED IN AUGUSTA, MAINE THIS 4th DAY OF AUGUST, 2025.

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BY:_____ for _____
MELANIE LOYZIM, COMMISSIONER

The term of this license amendment shall be ten (10) years from the issuance of Air Emission License A-1158-71-A-N (issued 11/12/2021).

[Note: If a renewal application, determined as complete by the Department, is submitted prior to expiration of this license, then pursuant to Title 5 M.R.S. § 10002, all terms and conditions of the license shall remain in effect until the Department takes final action on the license renewal application.]

PLEASE NOTE ATTACHED SHEET FOR GUIDANCE ON APPEAL PROCEDURES

Date of initial receipt of application: 7/1/2025
Date of application acceptance: 7/3/2025

This Order prepared by Lynn Muzzey, Bureau of Air Quality.