North Carolina Department of Environment and Natural Resources
Division of Air Quality

Beverly Eaves Perdue
Governor

Sheila C. Holman
Director

Dee Freeman
Secretary

September 14, 2012

Mr. Brian Barlia
Chief Operating Officer
Revolution Energy Solutions, LLC
1625 New Hampshire Avenue, NW
Washington, DC 20009

SUBJECT: Applicability Determination No. 2045 – Secondary Material Determination
Revolution Energy Solutions, LLC – Sites DM 4-3 and DM 2-1
Facility ID Nos.: 3100169 and 3100170
Magnolia, Duplin County

Dear Mr. Barlia:

The North Carolina Division of Air Quality (NC DAQ) received your letter dated May 23, 2012 summarizing your analysis of biogas from swine barns. The NC DAQ received additional information in an e-mail dated September 10, 2012. Revolution Energy Solutions, LLC (RES) – Sites DM 4-3 and DM 2-1 is proposing to convert swine manure to biogas in a bioreactor. The gas will be burned as a fuel in a new cogeneration module that includes "dual-fuel" internal combustion engines designed to burn biogas and natural gas, and a thermal energy distribution system. Heat from the exhaust will be used to maintain stable temperatures in the bioreactors through water-based supply and return lines. An optimized synchronous generator sends power to a transformer that exports electricity to the grid.

Swine biogas is a non-hazardous secondary material (NHSM) within the meaning of Title 40, Part 241 of the Code of Federal Regulations (40 CFR Part 241). The swine biogas described in the letter referenced above remains within the control of the generator, and meets the legitimacy criteria provided in 40 CFR 241.3(d)(1). NC DAQ has determined, therefore, that the material is not a solid waste when used as fuel in this combustion unit.

Control of the Generator – 40 CFR 241.3(b)(1)

The NHSM rule provides that "within control of the generator" means that the NHSM is generated and burned in combustion units at the generating facility; or that such material is generated and burned in combustion units at different facilities, provided that facility combusting the NHSM is controlled by the generator; or both the generating facility and the facility combusting the NHSM are under the control of the same person as defined in this section. Pursuant to 40 CFR 241.2, "generating facility" means all contiguous property owned, leased, or otherwise controlled by the NHSM generator.

Permitting Section
1641 Mail Service Center, Raleigh, North Carolina 27699-1641
217 West Jones St., Raleigh, North Carolina 27603
Phone: 919-707-8400 / FAX 919-715-0717 / Internet: www.ncair.org

"Control" means the power to direct the policies of the facility, whether by the ownership of stock, voting rights, or otherwise, except that contractors who operate facilities on behalf of a different person (defined as an individual, trust, firm, etc.) shall not be deemed to "control" such facilities.

RES proposes to burn swine biogas on the site where the biogas is being generated. The swine biogas will be generated from the manure of the swine barns on property owned by Murphy Family Ventures, LLC. While RES and Murphy Family Ventures, LLC are two different legal entities, the engine burning the swine gas is "at the generating facility" which is sufficient to satisfy EPA's definition of "within the control of the generator" requirement. [1] Therefore, NC DAQ concludes that the swine biogas is maintained within the control of RES.

Managed as a Valuable Commodity – 40 CFR 241.3(d)(1)(i)

RES will manage and store the swine biogas much like natural gas. Currently the gases from the swine manure at these sites are emitted into the atmosphere from the swine barns and open lagoons. RES proposes to capture those gases in bioreactors and transform them into electricity for sale to the grid. Also, the swine biogas will be adequately contained in the closed loop process to maximize collection. Therefore NC DAQ concludes that these management practices satisfy the requirement that the NHSM be managed as a valuable commodity, and if so managed, the swine biogas meets the legitimacy criterion pursuant to 40 CFR 241.3(d)(1)(i).

Meaningful Heating Value – 40 CFR 241.3(d)(1)(ii)

In the preamble to the final NHSM definitional rule, US EPA indicated that materials with a heat content of at least 5,000 British thermal units per pound (Btu/lb) presumptively satisfy this criterion.[2] Swine biogas normally contains a significant amount (approximately 60 percent) of methane. Pure methane typically has a heating value of 1,000 British thermal units per cubic foot (Btu/ft^3) or 20,000 Btu/lb. Also, natural gas primarily consists of methane and typically has a heating value of 1,050 Btu/ft^3 or 21,000 Btu/lb. RES reasonably assumes the swine biogas would have a heat input of 600 Btu/ft^3 that results in a heating value of approximately 12,000 Btu/lb. Therefore, NC DAQ has determined that the biogas has meaningful heating value and meets the legitimacy criterion under 40 CFR 241.3(d)(1)(ii).

Comparable Contaminant Concentrations – 40 CFR 241.3(d)(1)(iii)

In order for a NHSM to be classified as a non-solid waste fuel, it must "contain contaminants *at levels comparable in concentration to or lower than* those in traditional fuels which the combustion unit is designed to burn."[3]

Contaminants

A contaminant is defined as "any constituent in a non-hazardous secondary material *that will result in emissions* of the air pollutants identified in the Clean Air Act section 112(b) or the nine pollutants listed under Clean Air Act section 129(a)(4) when such non-hazardous secondary material are

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[1] 76 Fed. Reg. 15,456 and 15,533 (March 21, 2011). EPA's definition of "within the control of the generator" is designed to allow two scenarios. The first scenario "that the NHSM is generated and burned in combustion units at the generating facility" limits the inquiry to the geographic location of the combustion units relevant to the generation of the NHSM. The second scenario allows geographic disparity only in instances where there is common control between the generator and facility burning the material.

[2] 76 Fed. Reg. 15,523 (March 21, 2011).

[3] 40 CFR 241.3(d)(1)(iii) (March 23, 2011) (*emphasis added*).

burned as fuel or used as an ingredient, including those constituents that could generate products of incomplete combustion."[4] This definition could be interpreted to include (1) chemical pollutants that are present within the NHSM that may be emitted as regulated air pollutants during the combustion process[5], (2) chemicals that are not regulated air pollutants, but which may form air pollutants during the combustion process[6], and (3) chemicals that are not regulated pollutants, but which may promote the formation of air pollutants during the combustion process.

Since the final NHSM rule was promulgated the US EPA has indicated that it did not intend for the definition of contaminants to be so broadly interpreted. On December 23, 2011, the US EPA proposed a revision to the contaminant definition "to clarify what will be considered contaminants for the purposes of the legitimacy criteria."[7] The US EPA proposed including a specific list of pollutants and precursors that fall within the definition of "contaminants" in place of the existing definition that includes constituents that would result in emissions of air pollutants.[8] In the preamble to the proposed rulemaking, US EPA repeatedly asserts that the revised language is only intended to clarify the intent of the March 2011 rule, and that the Agency does "not expect this change to affect any of the decisions previously made on whether NHSMs are solid wastes when burned as fuels."[9]

Based on these representations from the US EPA and the current rule's interpretation, the NC DAQ reviewed the concentrations of the following contaminants in the swine biogas:

- **Metals**[10]**:** Arsenic, Beryllium, Cadmium, Chromium, Lead, Manganese, Mercury, Nickel
- **Halogens:** Chlorine
- **Additional Precursors:** Nitrogen, Sulfur, Hydrogen Sulfide
- **Organics:** Benzene, Benzyl Chloride, 1,3-Butadiene[11], Carbon Disulfide, Chloroethane, Ethylenimine, Ethylbenzene, Toluene, Vinyl Acetate, m/p-Xylene, o-Xylene

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[4] 40 CFR 241.1 (March 23, 2011) (*emphasis added*).
[5] *Example*: Regulated toxic metals in the NHSM may be emitted in the form of particulate matter. Toxic metals include antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium.
[6] *Example*: Sulfur in the NHSM may be emitted as sulfur dioxide (SO_2), which is a pollutant listed under CAA § 129(a)(4).
[7] 76 Fed. Reg. 80470 (Dec. 23, 2011).
[8] The proposed definition is as follows: "*Contaminants* means all pollutants listed in Clean Air Act sections 112(b) and 129(a)(4), with modifications outlined in this definition to reflect constituents found in non-hazardous secondary materials prior to combustion. The definition includes the following elemental contaminants that commonly form Clean Air Act section 112(b) and 129(a)(4) pollutants: Antimony, arsenic, beryllium, cadmium, chlorine, chromium, cobalt, fluorine, lead, manganese, mercury, nickel, nitrogen, selenium, and sulfur. The definition does **not** include the following Clean Air Act section 112(b) and 129(a)(4) pollutants that are either unlikely to be found in non-hazardous secondary materials prior to combustion or are adequately measured by other parts of this definition: Hydrogen chloride (HCl), chlorine gas (Cl_2), hydrogen fluoride (HF), nitrogen oxides (NO_x), sulfur dioxide (SO_2), fine mineral fibers, particulate matter, coke oven emissions, diazomethane, white phosphorus, titanium tetrachloride, m-cresol, o-cresol, p-cresol, m-xylene, o-xylene, and p-xylene." See 76 Fed. Reg. 80529 (Dec. 23, 2011).
[9] 76 Fed. Reg. 80470 (Dec. 23, 2011).
[10] There was a dearth of information on concentrations of metals in as-fired natural gas. While EPA's Survey Results included concentration ranges for metals in natural gas, these values were based on AP-42 factors that were developed from testing of dual fuel boilers (e.g. oil and natural gas). The NC DAQ concluded that the metals measured were not from the combustion of natural gas but rather the result of residual metals in pipeline quality as-fired natural gas, and therefore, unless otherwise noted, it was assumed that there were no metals in as-fired natural gas. Similarly NC DAQ concluded that metals were not expected to be present in swine gas.
[11] 1,3-butadiene was detected in the swine gas sample. However, RTP Labs, Inc., the company that analyzed the sample, stated that based on their experience the detection of 1,3-butadiene was an anomaly because that organic

Designed, not Permitted to Burn

To determine whether a NHSM satisfies the legitimacy criteria, the current rule requires that the contaminant levels in the NHSM be compared against the levels in "traditional fuels which the combustion unit is designed to burn."[12] The current rule is silent as to whether the traditional fuels used in the comparison should include all fuels that the combustion unit is capable of burning, or whether it is limited to those fuels that the combustion unit is legally allowed to burn. However, US EPA has subsequently made it clear both through communications with the NC DAQ and in subsequent proposed rulemaking, that the contaminant comparison should be based on what the combustion unit is simply capable of burning.[13] In this instance, the proposed engines are designed to burn both traditional fuel (natural gas) and NHSM (swine biogas). The units are MWM Model BG 600 dual-fuel, 4-stroke, lean burn, internal combustion engines capable of burning natural gas and swine biogas. Therefore, the swine biogas can be compared with natural gas for purposes of meeting the legitimacy criteria.

Further, following the publication of the final NHSM rule in the Federal Register, the US EPA issued a Guidance Concept Paper indicating its intent to "address questions raised by industry, assist them in making determinations under the rule, and ensure their use of the flexibility embodied in the rule."[14] The Agency forecasted that the guidance would include a compilation of data it had collected on contaminant levels in traditional fuels which could be used by industry and other interested parties in the contaminant level comparison.

RES is proposing to burn the swine biogas in a new biogas cogeneration system. RES stated that the cogeneration system will be capable of burning traditional fuel (natural gas) and swine biogas. In accordance with US EPA's interpretation of "capable of burning," the NC DAQ compared the concentrations of contaminants in the swine biogas to the contaminant levels in natural gas as provided in the February 7, 2011 guidance document[15] and literature values.

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compound is usually found in synthetic rubber manufacturing processes. See attached Letter dated September 7, 2012 from RTP Labs, Inc. to RES. As discussed in this determination the NCDAQ will require RES to sample swine gas from this site prior to operation in order to verify that 1,3-butadiene is not present in their gas stream.

[12] 40 CFR 241.3(d)(1)(iii) (March 23, 2011).

[13] E-mail from George Faison (US EPA) to Donald van der Vaart (NC DAQ), dated May 2, 2012 (indicating that the contaminant levels in the NHSM "should be compared to what traditional fuel the unit is [burning] or CAN burn, not what it is permitted for."; 76 Fed. Reg. 80530 (Dec. 23, 2011) (proposing to revise 40 CFR 241.3(d)(1)(ii) to indicate that, "In determining which traditional fuel(s) a unit is designed to burn, persons can choose a traditional fuel that can be or is burned in the particular type of boiler, whether or not the combustion unit is permitted to burn that traditional fuel."

[14] US EPA, "Non-Hazardous Secondary Materials (NHSM) Rule: Comparable Contaminant Guidance Concept Paper" (July 11, 2011. http://www.epa.gov/osw/nonhaz/define/pdfs/nhsm-concept.pdf

[15] Materials Characterization Paper *in support of the* Final Rulemaking:
Identification of Nonhazardous Secondary Materials That Are Solid Waste - Traditional Fuels and Key Derivatives dated February 7, 2011.

Results of the Contaminant Comparison

The US EPA has stated that a variety of comparisons could be made. For example, the highest contaminant levels in the NHSM could be compared against the highest contaminant levels in the relevant traditional fuels. Alternatively, the average values of the NHSM could be compared with the average values of the traditional fuels. "Anything less could result in 'traditional fuel' samples being considered solid waste if burned in the very combustion units designed to burn them – not the Agency's intent in either the 2011 NHSM final rule or today's proposed rule."[16] However, using different bases for comparison could lead to different results. The US EPA warned that "[i]t would not be appropriate to compare an average NHSM contaminant value to the high end of a traditional fuel range, as the existence of an average implies multiple data points from which a more suitable statistic (*e.g.,* range or standard deviation) could have been calculated." Finally, the EPA warned that "in the context of an inspection or enforcement action, the Agency will evaluate the appropriateness of alternative methodologies and data sources on a case-by-case basis when determining whether the legitimacy criteria have been met."[17]

RES analyzed the contaminant levels in a composite sample of swine biogas collected from an NC swine farm. A summary of the measured contaminant levels and the contaminant levels in natural gas provided in Attachment 1 to this letter. For many contaminants the results show that the measured contaminant levels in the swine biogas are within the range of contaminant concentrations in natural gas (both using maximum values and averages).

However, the "comparison" test is not limited to the ultimate analysis of the as-fired material. Rather EPA has acknowledged that emission rates can be considered as one factor of the comparison test, and therefore, NC DAQ employed a de minimis emission rate approach for comparability of the organic compounds. The de minimis approach consists of estimating the potential emission rate of each contaminant and comparing that rate to the federal de minimis emission rates that were developed by the EPA under the CAA Section 112(g) rulemaking process.[18] These de minimis rates were based on air dispersion modeling and ambient health data and represent rates that the EPA considers trivial for regulatory purposes. All the potential organic compound emission rates from swine biogas were lower than EPA's de minimis emission rates except for 1,3-butadiene. The expected emission rate (0.24 tons per year) of 1,3-butadiene from the combustion of this swine biogas is greater than the EPA de minimis emission rate for 1,3-butadiene (0.07 tons per year). However, RTP Labs, Inc., the company that analyzed the sample, stated that based on their experience the detection of 1,3-butadiene was an anomaly because that organic compound is usually found in synthetic rubber manufacturing processes. See attached Letter dated September 7, 2012 from RTP Labs, Inc. to RES. The NC DAQ confirmed that 1,3-butadiene is a contaminant that traditionally is limited to manufacturing processes. Therefore, the NC DAQ will accept the claim that the presence of 1,3-butadiene in the sample was an anomaly. However, in order to verify this assumption the NC DAQ will require RES to sample swine gas from this site prior to operation. If this compound is found in the biogas in concentrations that would result in emissions exceeding the EPA's de minimis value, RES will, prior to operation, be required to obtain a revised solid waste determination from the NC DAQ. Given the comparability of all relevant contaminants between natural gas and swine biogas as characterized by your submittal, the NC DAQ has determined that the swine biogas does meet the legitimacy criteria under 40 CFR 241.3(d)(1)(iii).

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[16] 76 Fed. Reg. 80841 (Dec. 23, 2011).

[17] 76 Fed. Reg. 80482-3. (Dec. 23, 2011).

[18] The emission rates from the process are conservative as they assume the entire concentration present in the biogas is emitted (i.e. no control or destruction of the organic in the combustion process is assumed).

Conclusion

As described in the letters received from you or on your behalf on May 23, 2012 and September 10, 2012, the swine biogas remains within control of the generator and meets the legitimacy criteria provided in 40 CFR 241.3(d)(1). Therefore, the NC DAQ has determined that it is not a solid waste when used as fuel in this combustion unit. As a result of this determination, the burning of biogas in this cogeneration system will not be subject to the emission standards promulgated pursuant to Section 129 of the Clean Air Act. If you have any questions regarding this NHSM determination, please contact me at (919) 707-8475.

Sincerely,

Donald R. van der Vaart, Ph.D., J.D., P.E.
Chief

Attachments

c: Wilmington Regional Office
John Evans
Jeff Twisdale
Central Files

ATTACHMENT 1: RES – Contaminant Comparison Table for Swine Gas

Contaminant	ppmv (unless otherwise noted)	Source	ppmv (unless otherwise noted)	Source	MW	CFM	lb/hr	tpy	EPA de minimis (tpy unless otherwise noted)	Notes
	Natural Gas		**Swine Gas**							
Nitrogen	3,100 – 25,000	Perry's Handbook	Less than 10,000	Site test						Within range of traditional fuel
Sulfur	0.34 ppmw									See sulfur compounds below
Hydrogen Sulfide (H_2S)	1,800	Ohio Raw Gas Sample	200	Site test						Lower than traditional fuel
Metals[19]										
Arsenic (As)	NA	NA	NA	NA						Not expected to be in swine gas
Beryllium (Be)	NA	NA	NA	NA						Not expected to be in swine gas
Cadmium (Cd)	NA	NA	NA	NA						Not expected to be in swine gas
Chlorine (Cl)	NA	NA	NA	NA						Not expected to be in swine gas
Chromium (Cr)	NA	NA	NA	NA						Not expected to be in swine gas
Lead (Pb)	NA	NA	NA	NA						Not expected to be in swine gas
Manganese (Mn)	NA	NA	NA	NA						Not expected to be in swine gas
Mercury (Hg)	NA	NA	NA	NA						Not expected to be in swine gas
Nickel (Ni)	NA	NA	NA	NA						Not expected to be in swine gas

[19] There was a dearth of information on concentrations of metals in as-fired natural gas. While EPA's Survey Results included concentration ranges for metals in natural gas, these values were based on AP-42 factors that were developed from testing of dual fuel boilers (e.g. oil and natural gas). The NC DAQ concluded that the metals measured were not from the combustion of natural gas but rather the result of residual metals in pipeline quality as-fired natural gas, and therefore, unless otherwise noted, it was assumed that there were no metals in as-fired natural gas. Similarly NC DAQ concluded that metals were not expected to be present in swine gas.

Contaminant	ppmv (unless otherwise noted)	Source	ppmv (unless otherwise noted)	Source	MW	CFM	lb/hr	tpy	EPA de minimis (tpy unless otherwise noted)	Notes
Organics										
	Natural Gas		**Swine Gas**							
Benzene (C_6H_6)	3.1 – 8.3	Boiler Fuel Sample	0.040	Site test	78.11	2193	0.001	0.004	2	Lower than EPA de minimis
Benzyl Chloride	No Data Available		0.017	Site test	126.58	2193	0.0007	0.003	0.1	Lower than EPA de minimis
1,3 Butadiene (C_4H_6)	No Data Available		2.96	Site test	54.09	2193	0.056	0.24	0.07	Greater than EPA de minimis[20]
Carbon Disulfide	No Data Available		1.0	Site test	76	2193	0.026	0.12	1	Lower than EPA de minimis
Chloroethane	No Data Available		0.206	Site test	64.5	2193	0.005	0.02	10	Lower than EPA de minimis
Chloromethane	No Data Available		0.047	Site test	50	2193	0.0008	0.004	10	Lower than EPA de minimis
Ethylenimine	No Data Available		0.026	Site test	43.07	2193	0.00039	0.002	0.003	Lower than EPA de minimis
Ethylbenzene	No Data Available		0.006	Site test	106.1	2193	0.0002	0.001	10	Lower than EPA de minimis
Toluene	4.0 – 11.2	Boiler Fuel Sample	0.046	Site test	92	2193	0.001	0.006	10	Lower than EPA de minimis
Vinyl acetate	No Data Available		0.031	Site test	86.09	2193	0.0009	0.004	1	Lower than EPA de minimis
m/p-xylene	No Data Available		0.003	Site test	106.16	2193	0.0001	0.0005	10	Lower than EPA de minimis
o-xylene	No Data Available		0.032	Site test	106.16	2193	0.001	0.005	10	Lower than EPA de minimis

[20] 1,3-butadiene was detected in the swine gas sample. However, RTP Labs, Inc., the company that analyzed the sample, stated that based on their experience the detection of 1,3-butadiene was an anomaly because that organic compound is usually found in synthetic rubber manufacturing processes. See attached Letter dated September 7, 2012 from RTP Labs, Inc. to RES. As discussed in this determination the NC DAQ will require RES to sample swine gas from this site prior to operation in order to verify that 1,3-butadiene is not present in their gas stream.
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Research Triangle Park Laboratories, Inc.
7201 ACC Blvd., Suite 104
Raleigh, NC 27617

919 510-0228 Telephone
919 510-0141 Fax *Web Site: www.rtp-labs.com*

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September 7, 2012

Revolution Energy Solutions, LLC
1615 New Hampshire Ave. NW
Washington, DC 20009

Attn: Al Tank, CEO

PROJECT: "PO# CRP-60202012 Gas Sample Collected 6/11/12"
RTP Labs ID: 12-0305

This letter is in response to questions concerning the chemical analysis of the gas sample received on June 11, 2012. One of the analyses performed was by EPA Method TO-14A/15 GC/MS and the chemical 1,3-butadiene was found in the sample at 2,951 ppbv. 1,3-butadiene is not typically found in biogas or landfill gases and we have not detected this compound in these type of samples that we have tested over many years. We expect this is an anomaly because 1,3-butadiene is usually found in synthetic rubber manufacturing processes.

If you have any questions, please give me a call at (919) 510-0228.

Sincerely,

Alston Sykes

Alston Sykes, Principal Chemist