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Memorandum

To: Permit Engineers

From: Donald R. van der Vaart 

Subject: Waste Determination of Gas from Anaerobic Digestion of Swine Manure

Background

On March 21, 2011, the US EPA promulgated a rule, commonly referred to as the "Definitional Rule," that established procedures for identification of non-hazardous secondary materials (NHSM) that are solid wastes when used as fuels or ingredients in combustion. See 76 FR 15456. The Definitional Rule was necessary because combustion units that burn materials that are solid waste are subject to the emission standards for Commercial and Industrial Solid Waste Incineration (CISWI) pursuant to §129 of the Clean Air Act (CAA), while units burning materials that are not solid waste would typically be subject to the emission standard for commercial, or industrial boilers pursuant to §112 of the CAA.

Among other requirements for the determination, the NHSM rule established certain "legitimacy criteria" that must be met for a material to not be classified as a solid waste. 40 CFR 241.3. This memorandum explains the NCDAQ's application of the "legitimacy criteria" to gaseous material produced by the anaerobic digestion of swine manure (swine gas).

In the preamble to the final Definitional Rule, the EPA explained that manure from swine and poultry operations would not be considered a solid waste under any of the following three scenarios:

- 1) It is burned in a combustion unit that is within the control of the generator and the manure meets the legitimacy criteria. See 40 CFR 241.3(b)(1)
- 2) It is "processed" prior to combustion, and the processed fuel meets the legitimacy criteria. See 40 CFR 241.3(b)(4), or
- 3) EPA grants a non-waste determination for the material in accordance with 40 CFR 241(c).

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Additionally, the EPA stated that anaerobic digestion qualifies as a process under §241.3 (b)(4). 76 Fed. Reg. 15456 at 15479. As such, the gas produced from the anaerobic digestion of swine manure would not be classified as a solid waste provided the gas could satisfy the legitimacy criteria listed under §241.3(d)(1). One of the elements of the legitimacy criteria provides:

(iii) The non-hazardous secondary material *must contain contaminants at levels comparable in concentration to or lower than those in traditional fuels which the combustion unit is designed to burn*. Such comparison is to be based on a direct comparison of the contaminant levels in the non-hazardous secondary material to the traditional fuel itself.

(*emphasis added*). The concept of legitimacy is meant to prevent so-called “sham recycling” (76 FR at 15464) where materials are disposed of under the guise of recycling. A determination requires a comparison of the contaminant levels in the NHSM versus the contaminant levels in the traditional fuel (TF). The EPA defined contaminants “as any constituent in non-hazardous secondary materials that will result in emissions of the air pollutants identified in Clean Air Act section 112(b) or the nine pollutants listed under Clean Air Act section 129(a)(4)...” (40 CFR 241.2). Once the contaminant levels in the NHSM is determined, the question is whether those levels are “comparable in concentration to or lower than those in traditional fuels.

The EPA did consider gas produced from anaerobic digestion in the preamble to the rule. The EPA stated that it expected “a system could be designed to produce a clean gaseous fuel that would satisfy all of ...the legitimacy criteria.” (76 FR 154556 at 15481). The EPA stopped short of designating any gas so produced as meeting the legitimacy criteria. The NCDAQ is, therefore, faced with determining whether the contaminants found in the gas produced through the anaerobic digestion of manure meets the legitimacy criteria.

Gas produced from the anaerobic digestion of swine manure can be burned in a reciprocating combustion engine designed to burn natural gas. In this situation, the TF used for the comparison is natural gas and if the swine gas contains contaminants at concentrations comparable to or lower than those contained in natural gas, the swine gas would not be a solid waste.

Contaminant Analysis and Environmental Impact

When considering contaminant levels of a NHSM, the EPA made it clear in the preamble to the rule that the total environmental risk of the NHSM should not be compared with that of the TF:

EPA does not agree with those commenters who suggest that in evaluating the constituent concentrations in non-hazardous secondary materials, that the total environmental impact should be considered, rather than comparing each constituent to levels found in traditional fuels. Under such an approach, a non-hazardous secondary material may be judged not to present an environmental problem when assessing all contaminants together, although significantly higher levels for one or more contaminants may be present such that they are destroyed or discarded by means of combustion. This, we have determined, is inconsistent with the concept of discard under the statute, since it would allow a solid waste to be subject to the CAA section 112 standards, even though the non-hazardous secondary material has been discarded.

The essential point is to recognize that while the combustion of TF and NHSM may result in comparable ambient concentrations of contaminants that may adversely impact the health and the environment of the local community, the goal of the CISWI program is to minimize the increased risk from the handling of NHSM as compared with TF, as well as from its combustion. A NHSM may have lower levels of certain contaminants, as compared with a TF, but higher levels of other contaminants. While some might argue that “bubbling” the risk by considering the total environmental risk would be an appropriate basis for a comparison with TF, the EPA flatly rejected that approach. Similarly, attempts to show that burning a secondary material in a non-CISWI compliant combustion device presents an identical or even lower total environmental risk than alternative dispositions cannot justify labeling the material as non-waste and thereby avoid CISWI compliance.

However, unlike the position taken in the preamble to the Definitional Rule, in their Response to Comments (RTC) the EPA took a different position stating that a risk analysis focused on individual contaminants may be appropriate. In explaining why the agency changed the contaminant legitimacy criteria after their Advanced Notice of Proposed Rulemaking (ANPRM), the EPA said,

Finally, the proposed rule also revised the contaminant legitimacy criterion, stating that non-hazardous secondary materials used as fuels in combustion units must contain contaminants at levels “comparable to or less than” those in traditional fuels which the combustion unit is designed to burn, whereas the ANPRM had stated that non-hazardous secondary materials used as fuel could not contain contaminants that were “significantly higher” than traditional fuel products. In the proposed rule, EPA explained its rationale for making this change, stating that the requirement that non-hazardous secondary materials have contaminants at levels comparable to or less than traditional fuels would ensure that the burning of any secondary materials in combustion units will not result in discard of materials or their contaminants and thus, *will not result in increased releases to the environment that could adversely impact the health and environment of the local community.* [emphasis added]. Definitions Rule RTC at 252.

The italicized statement above gives the basis for the comparison that the EPA is allowing for cases when the containment level is higher in the NHSM than in the TF. In particular, a NHSM should be classified as a solid waste only if increased contaminant releases resulting from the handling and combustion of the NHSM *lead to an adverse impact*. The EPA is recognizing that: (1) A NHSM that contains a contaminant that TF does not contain at all may still be allowed provided the emission of that contaminant would not adversely impact the health or environment of the local community, and (2) If the level of contaminant in the TF is high, but the marginal increase of the contaminant in the NHSM is de minimis either on a risk basis or on a simple concentration basis the NHSM would satisfy the legitimacy criteria. The EPA provided numerous examples in their Response to Comments.

A non-hazardous secondary material contains 500 parts per million (ppm) of lead, while the traditional fuel that would or could be burned in the combustion unit contains 475 ppm of lead. These levels would be considered comparable (since it falls within a small acceptable range) and thus, would meet this factor. If, on the other hand, the level of lead in the non-hazardous secondary material was 1,000 ppm, these levels would not be comparable and it may indicate

that the non-hazardous secondary material was being burned to dispose of the material and that the activity is sham recycling.

A traditional fuel contains no detectable amounts of barium, while the non-hazardous secondary material contains a minimal amount of barium (e.g., 1 ppm). In this situation, the levels would be considered comparable since it falls within a small acceptable range. If, however, the barium were at much higher levels in the non-hazardous secondary material (such as 50 ppm), the levels would not be comparable and it may indicate discard of the barium and sham recycling.

RTC at 148. In both examples the EPA appears to limit its analysis to absolute concentrations devoid of any risk consideration. However, on closer examination, the change in risk between burning a TF and a NSHM plays an important part in EPA's conclusion. In the first example EPA concludes that a 5 percent increase, from 475 ppm to 500 ppm, is comparable. In the second example, EPA concludes that a similar absolute increase (50 ppm) is not comparable. These two examples can be reconciled when considering the inherent risks the two examples describe. In the first example, both the TF and the NHSM have high concentrations of lead, but the change in ambient concentrations resulting from a 5 percent increase would be considered de minimis.¹ Similarly, in the second example, a change from 0 to 1 ppm would have a de minimis change in existing ambient concentrations. However, a change from 0 to 50 ppm, despite being similar on an absolute scale with the first example, could significantly increase the ambient risk.

Swine Gas Analysis

To apply these principles to gas produced from the anaerobic digestion of swine gas NCDAQ first considered the device proposed to burn the gas. Sources considered to date, utilize a reciprocating internal combustion engine capable of burning gas only.² The query was then whether the digester gas contained contaminants of a comparable or lower concentration as natural gas.

Swine gas leaving the anaerobic digester contains elevated levels of hydrogen sulfide as well as lesser quantities of carbonyl sulfide (COS) and carbon disulfide (CS₂).³ To protect the engine, the gas is scrubbed to remove hydrogen sulfide. Some of the COS and CS₂ may also be removed by the scrubber. Nevertheless, some COS and CS₂ remain in the swine gas. Specifically, a total of <1 ppm of CS₂ and 2.5 ppm COS has been measured in swine gas while natural gas appears to contain less of both although no quantifiable results have been found. By modeling a reciprocating combustion engine firing this material the maximum impact was shown to be far less than the acute thresholds (both 1-hour and 8-hour) given by the EPA. That threshold value corresponds to one that would "adversely impact the health and environment of the local community" as defined by the CAA under §112(f)(2).

¹ For example, coal is a traditional fuel that can have an adverse lead impact. Coal typically contains less than 100 ppm of lead, and would seldom contain levels greater than 340 ppm. A TF with 475 ppm could very reasonably be expected to adversely impact the environment. In this context, a NHSM with 5% more lead could be considered comparable simply based in relation to a TF with 475 ppm since the TF already adversely impacts the environment.

² If the engine had dual fuel capability, both gaseous and liquid fuels would have been used as TF for comparison.

³ Hydrogen sulfide, while regulated under various other CAA programs, is not a "contaminant" under the NHSM rule.

In addition to the §112(b) HAPs, the definition of contaminants includes the post combustion §129(a)(4) pollutants: particulate matter (total and fine), opacity (as appropriate), sulfur dioxide, hydrogen chloride, oxides of nitrogen, carbon monoxide, lead, cadmium, mercury, dioxins and dibenzofurans. There is no information that indicates swine gas contains any more chlorine than natural gas. Chlorine is a required precursor for hydrogen chloride, and dioxins and furans.⁴ In addition, the marginal increase in sulfur dioxide from the oxidation of COS and CS₂ would lead to trivial increases in environmental risk as compared with natural gas. The formation of nitrogen oxides, particulate matter, carbon monoxide and opacity are functions of the combustion device as well as the fuel. For sources subject to the state-BACT process under North Carolina's renewable energy portfolio standard the emission rates of these pollutants are lower than the federal standards for natural gas fired reciprocating engines.

Based on these data, swine gas produced from the anaerobic digestion of swine manure is comparable to natural gas and would meet the legitimacy criteria under 40 CFR 241.3(d)(1).

⁴ <http://www.epa.gov/apti/bces/module6/dioxins/formation/formation.htm>