# Initial Review of Corrected Application for Cliffside Unit 6: Potential to Emit and Hazardous Air Pollutant Source Status

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## Background

This review addresses the corrected application materials for the construction and operation of Cliffside Steam Station Unit 6 ("Unit 6"), which Duke Energy Carolinas, LLC ("Duke") submitted to the North Carolina Division of Air Quality ("DAQ") by cover letter dated October 23, 2008. Duke's original December 16, 2005 construction and operation permit application for Cliffside Unit 6 showed that Unit 6 would be a major source of hazardous air pollutant ("HAP") emissions (i.e., greater than 10 tons per year of any one HAP and/or greater than 25 tons/year of all HAPs, calculated based on the unit's "potential to emit"). All of the subsequent applications, revisions, and supporting documents that Duke submitted to DAQ until October 2008 have also confirmed that Unit 6 would be a major source of HAPs. Specifically, Duke's calculations showed that controlled emissions of hydrogen chloride ("HCl") would be 171.9 tons/year, controlled emissions of hydrogen fluoride ("HF") would be 22.4 tons/year, and combined HAP emissions would be in excess of 217 tons/year. Based on these calculations, on July 3, 2008, Duke responded to a request by DAQ to voluntarily engage in a process analogous to a case-by-case Maximum Achievable Control Technology ("MACT") determination under Clean Air Act section 112 by submitting what Duke identified as a "MACT-like assessment." In this MACT-like assessment, Duke continued to indicate that Unit 6 with controls would emit 171.9 tons/year of HCl, 22.4 tons/year of HF, and combined HAP emissions in excess of 217 tons/year. Then, on October 14, 2008, Duke submitted a letter to DAQ indicating Duke now believes that Unit 6 would be a minor source of HAPs and therefore not subject to any MACT requirements.

At the request of Southern Environmental Law Center and Natural Resources Defense Council, I have reviewed the following documents in order to evaluate Duke's assertion that Unit 6 is a minor source of HAPs:

(i) Original application for Units 6 and 7 dated December 16, 2005;

(ii) MACT-like Assessment for Unit 6 dated July 3, 2008 and supplemented August 22, 2008;

(iii) October 14, 2008 letter from James L. Turner to Keith Overcash;

(iv) Letter from R. Roper (Duke) to D. van der Vaart (DAQ), dated October 23, 2008 along with Corrected Application Materials;

(v) USGS Coal Quality Database, available at http://energy.er.usgs.gov/products/databases/CoalQual/index.htm.

**Conclusion**

Based on my review, Unit 6 is not a minor source of HAPs because, in light of its design and operational limits, Unit 6 has the potential to emit above the 10-tons-per-year HAP threshold at least one HAP (HCl) and possibly above the 25-tons-per-year HAP threshold for all HAPs. It is also my opinion that Duke would not be able to qualify Unit 6 as a "synthetic minor" source of HAPs by modifying its permit to include appropriate enforceable conditions. This is because Duke's emissions of HCl are so close to the threshold that it would not be able to show compliance, as a practical matter, with a 10 ton limit through monitoring, as required by the Clean Air Act. These opinions are based on the analysis shown below which indicates that Duke's claim of minor source status for Unit 6 status rests on incomplete, unverifiable, and flawed assumptions.

**Analysis**

Duke's October 23, 2008 letter request for a permit modification with attachments to Mr. van der Vaart claims that Unit 6 will not be a major source of HAPs because its emissions of all HAPs will be 16.58 tons/year and emissions of HCl (the highest emitted HAP) will be 8.88 tons/year. From a technical standpoint there are several flaws in Duke's emissions calculations for HAP metals, HAP non-metals, HCl and HF. For purposes of this initial review, however, I will focus my attention mainly on HCl, since it is the HAP that will be emitted in the highest amount.

As noted earlier, the MACT major source threshold is based on a source's potential to emit HAPs. "Potential to emit" refers to the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. In this case, I will examine how Duke has estimated its HCl emissions and whether or not Duke's approach properly reflects Unit 6's potential to emit HCl.

HCl emissions are due to chlorine contained in the coal that will be burned in Unit 6. Thus, HCl emissions are a direct function of how much coal (i.e., tons) will be burned and the chlorine content present in the coal. It also then depends on the degree and consistency of HCl control afforded by the air pollution control system proposed for Unit 6. Duke has made unverified and unreliable assumptions regarding all three of these factors: the amount of coal that will be consumed, the chlorine content of that coal, and the percentage of HCl that will be removed by pollution control devices.

**A. Quantity of Coal Needed To Fuel Unit 6**

In order to develop the annual potential to emit for HCl, one must use the maximum amount of coal that can be burned in Unit 6 in one year. Different coals have different "heat contents," meaning the amount of heat (Btu) that is generated when that coal is burned. The quantity of coal needed in order to achieve a desired heat input to a power plant thus depends on the heat content of the coal. The higher the heat content, the less coal is needed.

In its corrected application, Duke has maintained the Boiler Heat Input (7850 MMBtu/hr) and the Boiler Hours of Operation (8760 hours/year) at levels that are consistent with its previous submittals. However, Duke has made the following significant changes to the heat content which permits Duke to assume that less coal will be burned and, if all other things remain equal, that less pollution will be generated by Unit 6.

In its prior submittals, Duke assumed the Heat Content of Coal ("HHV") to be 9,376 Btu/lb ("design basis"), which is consistent with its stated desire to use a blend of Eastern Bituminous coals and sub-bituminous coals. In its October 23, 2008 submittal, however, Duke now proposes to use a Heat Content of 12,777 Btu/lb (dry). Although not clearly stated, this heat content value corresponds to a typical heating value for Eastern Bituminous coals only, and would not reflect a heating value based on a blend of Eastern Bituminous and sub-bituminous coals. By calculating HCl emissions using a higher Heating Value than previously represented, the number of tons of coal needed to obtain a desired heat input rate into the boiler is correspondingly reduced. By changing this assumption alone, Duke's estimated hourly maximum coal feed rate to Unit 6 dropped proportionally, from 418.6 tons/hr to 307.2 tons/hr, a decrease of roughly 26.6%. In order for Duke to use this heat content in its calculations of potential to emit, Duke would have to undertake an enforceable commitment to limit its coal supply for Unit 6 to Eastern Bituminous coals with a minimum Heat Content of 12,777 Btu/lb (dry).

Based on my review, however, I note that Duke has not provided any backup documentation (beyond a summary table) in support of the 12,777 Btu/lb Heat Content (dry) assumption. To properly perform potential-to-emit calculations, this value must reflect the lowest heat content for the coals that Duke is allowed to use at Unit 6. Duke indicates in its October 23 letter that it bases its assumptions on data from coal supplies in the last 5 years for its North Carolina and South Carolina plants. Yet, the relevance of the 5-year look-back time period, the lack of the data itself, the lack of discussion of the relevance of this historic data in relation to Unit 6's future coal supply and contracts, etc., is not clear. I also note that this assumption is also at odds with Duke's extensive statements regarding its fuel mix for Unit 6 as discussed in its August 22, 2008 submission to the NCDENR. In this submittal, Duke explicitly notes that the coal currently burned (much less for the last 5 years) at its Cliffside plant (much less in all of its NC and SC plants) is not representative of the coal that will be burned in Unit 6. Duke notes that the design of Unit 6 "…includes numerous features that assure the ability to burn a wide range of coal…" and that "…for the foreseeable operation of the plant, we can reasonably expect to burn significant quantities of Northern Appalachian coal from the Pennsylvania and Ohio mining regions, as well as Central Appalachian and Illinois Basin coals." Duke further notes that "…it is reasonable to conclude that these Northern Appalachian coals may be the dominant fuels during the course of any given 12-month period." Yet, the data provided in its October 23 corrected application materials do not seem to reflect these considerations. Nor do the corrected application materials show how its assumptions are conservative (i.e., designed to reflect potential to emit) by allowing for the lowest heating value (and therefore the highest number of coal tons that can be burned). If Duke intends to use a heat content assumption of 12,777 Btu/lb (dry) to compute potential HCl emissions from Unit 6, then the construction and operation permit must include an enforceable permit condition limiting the heat content of the coal Duke will burn at Unit 6 to a minimum of 12,777 Btu/lb (dry) at all times. As a corollary to this, Duke also must limit its coal supply to Eastern Bituminous coals only (excluding any sub-bituminous blends) and also must show continuous compliance with this minimum Heating Value.

## B. <u>Coal Chlorine Content</u>

In order to properly compute its potential to emit, Duke must use the maximum possible chlorine content of any coal it is permitted to burn. In its October 23, 2008 application, Duke used a coal chlorine content value of 3209 parts per million ("ppm") in its potential-to-emit calculations. However, it is not clear if the value Duke uses is an average value (as noted in the calculation sheet) or the maximum value (also noted in the calculation sheet). If the 3209 ppm figure represents the average chlorine content value, it is incorrect since the maximum chlorine content should have been used in its potential-to-emit calculations. On the other hand, if this figure is supposed to represent the maximum chlorine content, that assumption is not supported by any data (other than the unsupported summary sheet). Specifically, Duke has not provided any supporting data to show that a chlorine content of 3209 ppm is the maximum level in the "parent coals identified for . . . Unit 6 . . . ." The USGS Coal Quality database reports that Eastern Bituminous coals have chlorine contents ranging as high as 8800 ppm (with numerous such coals available from mines in Northern, Central, and Southern Appalachia). There are several reported coal chlorine contents between 3300 ppm and 8800 ppm. Based on these USGS data, calculating the potential chlorine emissions from Unit 6 based on the assumption that the maximum chlorine content of its input coal would not exceed 3209 ppm is inappropriate from a technical engineering standpoint unless backed up by a permit condition to that effect, with a requirement for continuous compliance.

Collectively, Duke's assumptions of coal heat content and chlorine content serve to limit the chlorine input to Unit 6 to a far smaller value than had been previously reported by Duke since December 2005. However, as discussed, these assumptions do not meet regulatory standards for calculation of potential to emit. Further, even if accurate and verifiable, these assumptions alone would not result in an output emissions level of HCl lower than the 10 tons/year MACT major source threshold. In addition, Duke had to rely on one more crucial assumption relating to the pollution control efficiency (i.e., efficiency of removal of HCl in its proposed control equipment train).

## C. <u>Projected Pollution Control Removal of HCl at Unit 6</u>

In its filings between December 2005 and July 3, 2008, Duke reported that the HCl removal efficiency for its suite of pollution controls would be 98%. In its October 23, 2008 corrected application materials, Duke states that the HCl removal efficiency should be revised upward to 99.9%. I will now examine this critical assumption as shown below.

Based on Duke's calculations (i.e., controlled HCl of 8.88 tons/year and control efficiency of 99.9%) the uncontrolled HCl emissions from Unit 6 are directly calculated to be 8,880 tons/year. Using this value of uncontrolled emissions, a constant control efficiency of 99.8874% would yield HCl emissions of 10 tons/year. In other words, if the assumed control efficiency of 99.9000% drops to 99.8874% (an absolute difference of only 0.000126%), then the potential to emit HCl for Unit 6 would equal the major source threshold of 10 tons/year, even if all of Duke's other assumptions held true. Under these circumstances Unit 6 would not qualify as a minor source of HAPs. Thus, Duke's claim that Unit 6 is a minor HAP source depends on being able to continuously maintain (and demonstrate that it is being so maintained) a control efficiency greater than 99.8874% for HCl across the Unit 6 control train.

In an effort to support its claimed ability to achieve a 99.9% HCl control efficiency Duke relies on the following: first, that such a level (i.e., 99.9%) has been achieved at the Marshall Unit 4; second, that the control system proposed at Unit 6 is better and therefore will be able to achieve 99.9% even more easily than at Marshall Unit 4; and third, a letter from its vendor, Alstom, although this letter does not actually support Duke's claims. I will examine each of these claims next.

(i) Relating to the Marshall Unit 4 test results:

(a) The test report Duke provided as Attachment 1 to its October 14, 2008 letter is not the complete report. The Attachment only includes a summary of the data and does not contain any of the actual details of the test such as process conditions, coal type and composition used during the test, the calibration information for the various instruments used, etc. It is also not clear if this test was conducted by DAQ pursuant to an approved test protocol or if DAQ staff witnessed the test. According to good engineering practices, it is not appropriate to rely on a summary of test results or testing that lacks quality assurance/quality control verification.

(b) Based on the limited information provided, the relevant data for Duke's claim of HCl control efficiency are the test data summarized in Tables 2-13 through 2-20. I have re-analyzed these data as shown in attached Table 1. Duke estimates its removal efficiency, as noted under each table starting with Table 2-15, "based on ppmv @ 3% O2 . . . ." This is an incorrect method to determine mass removal efficiency, which is at issue here. Concentrations alone do not indicate mass in and mass out, which are needed for mass removal efficiency calculations. According to standard engineering practice, I have used the lb/MMBtu values provided in the same tables to calculate mass removal efficiency. Since Duke has not provided flow rate data, I could not independently verify the lb/MMBtu data and simply accepted Duke's represented values to perform the necessary calculations. I do note, however, that Duke relies on the F-factors (either oxygen-based or CO2-based), leading me to believe that perhaps no flow data were directly collected. If so, this would be a further major problem with these data, rendering them inaccurate and unusable for Duke's calculations.

All of this notwithstanding, Table 1 is instructive. I have calculated the control efficiency for each of the 16 runs conducted by Duke, using both the F-factors. I note that in at least 6 of the 16 runs, the calculated efficiency equals or is lower than the 99.8874% control efficiency required for Duke to avoid major source status, even assuming the validity of Duke's other assumptions regarding coal Heating Value and chlorine content. In fact, using Duke's estimated uncontrolled HCl emission value of 8880 tons/year, the calculated outlet emissions using the control efficiencies of each of the test runs is shown in Table 1. As shown in the blue highlights, there are numerous instances where the outlet HCl level would exceed 10 tons/year. In a few additional cases, highlighted in green, the value is very close to 10 tons/year.

I note that the stack test of the type Duke relies on is typically conducted under the very best operational and maintenance conditions for the control equipment, particularly where, as here, the report was prepared for Alstom, the FGD vendor, and is labeled "Report on FGD Feedback Test Program." Nevertheless, even under these optimal conditions, the control efficiency that was obtained was not consistently above (and certainly not robustly above, with some margin for variability) the 99.8874% control efficiency threshold for major source status. Under more reasonably expected normal operating parameters, it is extremely unlikely that the control efficiency would be maintained at greater than this level for all other hours of unit operation. Therefore, to infer that the Unit 6 control system can achieve 99.9% efficiency consistently based on the Marshall Unit 4 data, with all of the flaws noted above, is technically incorrect and practically infeasible at best.

(ii) Next Duke suggests that since Unit 6 will have additional control enhancements (such as a "…more advanced Alstom WFGD system…" as well as the separate dry FGD and the baghouse), the efficiency obtained at Unit 6 will be greater. From an engineering standpoint, this is merely speculation. Control efficiencies are a function of equipment design and equipment operation. As I have noted, for Unit 6 to qualify as a minor HAP source, Duke must demonstrate with a reasonable degree of assurance that the minimum value of 99.8874% control of HCl will be maintained at all times. Duke has provided no data on the design elements of its various control system components to assist in making this demonstration, and statements contained in its October 14, 2008 and October 23, 2008 submissions do not support Duke's claims. For instance, Duke suggests that its suite of controls, including baghouses with fabric filters, will achieve a high level of HCl control. But baghouses are not designed for effective or consistent removal of acid gases such as HCl. Even if there were some incidental absorption of HCl on the filter cake, it is not quantifiable and it would vary unpredictably with the baghouse cleaning cycle.

(iii) Probably the better sense of the impact of the "more advanced Alstom system" comes from statements in Alstom's October 14, 2008 letter to Duke. First, the table in this letter shows the Marshall Unit 4 HCl efficiency range of 99.7 – 99.9 (average of 99.87%). Plainly, neither the lower end of the range nor the average value will be adequate to keep Unit 6 in minor source status. The required 99.8874% is greater than the average (99.87%), per Alstom's analysis. For example, using the low end of the Alstom efficiency range, 99.7%, and using Duke's estimated uncontrolled HCl emissions of 8,880 tons/year, the HCl emitted would be 26.64 tons/year. Using the average of the Alstom range, 99.87%, the emissions would be 11.544 tons/year. Clearly, these are values greater than the 10 tons/year major source threshold for HCl. As an aside, I note that the Alstom summary is inconsistent with the source test data provided by Duke, which did not include any 99.7% efficiency results or test runs. Based on Alstom's reported test summary, it is not clear whether Duke has shared all of the stack test data available to it or if Alstom is using additional data and different calculation methods than those presented by Duke.

In the Alstom summary, the average efficiency of 99.87% was obtained including Alstom's more recent design including dual orifice plates and wall rings. The effect of these enhancements is modest. As

Alstom itself notes and shows, the average control efficiency of 99.75% (at a different, unspecified unit), which is marginally smaller than Marshall Unit 4, was obtained without wall rings and with partially retrofitted dual orifice plates.

Finally, it is important to note that Alstom declined to provide any "specific performance guarantee or warranty . . . for HCl or HF removal" based on the Marshall Unit 4 stack test results.

Based on my initial review of the documents Duke submitted on October 14 and 23, 2008, it is my professional engineering opinion that Duke has not demonstrated with reasonable assurance that the pollution controls planned for Unit 6 will reliably and consistently maintain a 99.9% HCl control efficiency. Duke has not provided sufficiently robust data or support to demonstrate that it will be able to achieve this level of efficiency accurately and consistently. Consequently, from an engineering perspective based on available data, Unit 6 has a potential to emit 10 tons/year or more of HCl, thus meeting or exceeding the major HAP source threshold for this pollutant.

**D. <u>Additional Comments</u>**

Separate from the discussion above, I have the following additional initial comments.

(i) Separate from the HCl discussion above, Duke has changed the basis of its HAP metal calculations in its October 2008 submittals. Duke has now based its metal emission factors on the methodology provided in AP-42 Section 1.1, Table 1.1-16, which requires the metal content (in ppm), the ash fraction, and other data. While Duke has noted metal content values, there is no underlying support other than that these are based on the "last five year average actual coal constituents." Similarly, the ash content is based on the "last 5-year average . . . ." These are both inappropriate bases for conducting potential-to-emit calculations. As noted previously, determining a source's potential to emit should be based on the maximum metal HAP content in the coal (and, in this case, the minimum ash fraction in coal, given the calculation approach).

It is also not clear if the metal content and ash content are on a dry or as-received basis. Since the lb/ton emission factors are ultimately used in conjunction with a tons/year coal use that is developed on a dry basis, the ash and metal content values should also be calculated on this basis.

I note that there can be significant differences between average and maximum metal content values. Just for Eastern Bituminous coals with sulfur contents that exceed 3300 ppm, I have determined (using the USGS coal quality database) that these differences are pronounced. For example, Duke uses an average arsenic content of 7.83 ppm while the USGS maximum is 340 ppm. Similarly the average and maximum values for several other metals are as follows: for antimony, 0.65 versus 4.8 ppm; for beryllium, 2.17 versus 9.0 ppm; for cobalt, 7.61 versus 18.0 ppm; for lead, 8.8 versus 25.0 ppm; for manganese, 26.09 versus 39 ppm, and for nickel, 14.9 versus 39.0 ppm.

For selenium, Duke assumes that 12% of the incoming selenium in the coal is released. However, the only support for this is a document noted as an "EPRI referenced document." No actual document title is provided, nor is any actual backup documentation provided to support this assumption. Since selenium accounts for the vast majority of the metal HAPs Unit 6 will emit according to Duke's calculations, this is a significant omission.

Thus, Duke's potential to emit calculations for metal HAPs is significantly underestimated.

(ii) Similarly, Duke has also significantly revised its calculation bases for non-metal HAPs. Instead of using AP-42 factors exclusively, as was done earlier, it has now used a combination of AP-42 factors as well as EPRI factors. However, the backup documentation for the EPRI data is not provided and to my knowledge is not part of the public record. The EPRI report in question is only available to EPRI members and to non-members at a cost of $75,000. This precludes the ability of the public to verify any of this data.

(iii) Duke's calculations do not consider the emissions of HAPs from startup, shutdown, and other similar conditions, wherein boiler operations and air pollution control operations are, by definition, less than optimal. While different HAPs will be affected differently during such conditions, Duke provided no analysis of such situations at all.

In summary, Duke's most recent analysis relies on untested, unsupported assumptions that differ in material respects from its earlier (including very recent) submissions in an effort to demonstrate that Unit 6 will qualify as a minor HAP source. However, according to standard engineering practices, these assumptions have not been adequately demonstrated or verified to support the conclusion for which they are offered. Absent specific and enforceable operating limitations and monitoring requirements, Unit 6 has a potential to emit above the Clean Air Act section 112 HAP threshold and therefore cannot qualify as a minor source of HAPs. I also note that at least for HCl, because its potential-to-emit estimate is so very sensitive to the control efficiency assumption of the pollution control suite, it is my opinion that it will not be possible to create a monitoring system that would make a minor source emission level practically enforceable for this pollutant.