Duke Power Cliffside Unit 6 & 7 Permit Application
PM_{10} Emission Limits for New Coal Boilers

Duke Power (Duke) proposes to install PM_{10} control technology on the proposed Cliffside Units 6 and 7 pulverized coal-fired boilers which represents the “top” control technology evaluated in its PSD top-down BACT evaluation. While not required for this permit, the technology chosen also represents the Lowest Achievable Emissions Rate (LAER) control technology. Duke has proposed to control emissions of PM_{10} using a combination of dry electro-static precipitator (ESP), followed by a wet scrubber, followed by a polishing Wet Electrostatic Precipitator (WESP). Duke is not aware of any operating utility-scale pulverized coal-fired boiler operating in the US with this combination of PM_{10} control devices, and considers its proposal to do so an innovative and advanced technology demonstration.

The North Carolina DAQ has requested additional justification for approval of the associated PM_{10} emission limits proposed as BACT in the Cliffside Units 6 and 7 PSD Application. This attachment provides additional detail and justification of the proposed limits.

1.0 First of a Kind Application of Technology

The addition of a polishing Wet ESP to improve PM_{10} capture downstream of a dry ESP and Wet Flue Gas Desulfurization (FGD) system, to ENSR’s knowledge, has yet to be demonstrated in practice on a 800 MW scale supercritical design PC boiler firing Eastern Bituminous coals. The closest application identified to date is WE Energies Elm Road Station permitted in 2004 with fabric filter and polishing WESP, however those units have not yet been operated or tested. WESP has been permitted for application to CFB boilers (a different emission source category), and we are not aware that any of those have actually been constructed or tested.

Duke’s vendors are certain that WESP technology can be applied to the saturated flue gas stream of a PC boiler downstream of an ESP and FGD system with good efficacy; what is presently still uncertain is the ultimate emission rate of condensable PM_{10} that will be achieved in practice. A dry ESP is designed to control filterable particulate, but does little or nothing to control aerosols that condense at flue gas temperatures below the operating range of the ESP. Although Duke has not yet received bids for air quality control equipment, the Company expects to obtain filterable PM_{10} emission guarantees to support a permit limit of 0.015 lb/MMBtu of filterable, or solid particulate. Field data shows that a portion of filterable PM_{10} will be captured within the FGD system. Since the FGD system will cool and saturate the flue gas, it will force condensation of some fraction of certain PM_{10} aerosols. Wet FGD system vendors do provide limited PM_{10} emission guarantees, but only when the specific inlet concentration, size distribution and aerosol condensation temperatures are defined. Therefore, with the combination of dry ESP and wet FGD upstream of the wet ESP, the inlet concentration of filterable or condensible PM10 will already be controlled to some degree. While high removal percentages are documented in WESP’s with no upstream control, much lower removal percentages are expected when the larger size distribution –

more easily condensed PM_{10} fractions have already been "skimmed" by two previous stages of collection. Finally, since the test method required to measure the condensable emission fraction condenses and counts all gaseous species that will condense down to 32° F, there are some PM_{10} aerosols that will never condense or be captured at all in the WESP due to actual stack exhaust temperatures greater than 120° F. No empirical data exists for this particular application to develop meaningful commercial performance condensable PM_{10} guarantees for a WESP when the inlet PM_{10} quantity, speciation and size distribution is not known. As a result, uncertainty exists as to what level of condensable PM_{10} will reach the WESP and what level of reduction can be commercially guaranteed. As an investor owned utility, Duke and its Investors can not accept the commercial risk of permit limits that are not supported by commercial guarantees from qualified suppliers. As a result, Duke has proposed to install the LAER technology for filterable and condensable PM_{10}, however without an associated condensable PM_{10} emission limit. Operation of the combination of this technology will assure actual emissions are as low as achievable.

2.0 The Composition of PM10

The composition and amount of particulate matter emitted from coal-fired boilers are a function of firing configuration, boiler operation, coal properties and emission controls. Particulate matter will be emitted from the pulverized coal-fired boilers as a result of entrainment of incombustible inert matter (ash) and condensable substances such as condensable organics and acid gases. Particulate matter (PM) and particulate matter smaller than 10 microns (PM_{10}) has historically been regulated from coal-fired boilers as the filterable, or front half catch only. Many permits contain filterable only limits, and/or require stack testing for filterable particulate only for demonstration of compliance. US EPA has clarified that when considering the air quality impacts under the PSD review process, both filterable and condensable fractions of PM_{10} must be addressed. However, for purposes of establishing continuous compliance limits, North Carolina DENR recognizes the inherent difficulties of monitoring condensable PM_{10} as well as the fact that air pollution control equipment is not designed for capture of condensable PM_{10}. Therefore, NC has historically set PM_{10} permit limits based on filterable PM_{10}. ENSR has included an estimate of condensable PM_{10} of 0.009 lb/MMBtu (total PM_{10} of 0.024 lb/MMBtu) in dispersion modeling to support the Cliffside Units 6 and 7 PSD Application. This is a reasonable estimate for purposes of modeling air quality impacts, but it is not a good measure of control technology performance.

Control technologies in practical and demonstrated use for PM_{10} control are primarily designed to capture solid or filterable materials only, and any capture of condensable emissions is secondary. This is also true of wet ESPs. While a wet ESP will capture aerosol emissions that have condensed, the technology is not capable of condensing and capturing a large fraction of pollutants in the flue gas that have not condensed (A small fraction of the condensable pollutants may condense and be captured, but the temperature differential through the wet ESP is too small to condense a substantial fraction). Thus, in setting a BACT standard, an emission standard based on the filterable-only fraction may be appropriate once the facility has addressed the air quality analysis required by the PSD review. The constituents of condensable PM_{10} are primarily made of pollutants which are regulated separately and typically addressed through use of other control technologies than those used for solid particles. These include sulfuric acid mist, VOC, HCL and HF. Since these species are regulated separately, and have their own BACT emission limits, their BACT emission rates should be summed to calculate the estimated emission rate of condensable aerosols (condensable PM_{10}). For the Cliffside Units 6 and 7, this results in a total allowable condensable PM_{10} emission rate of .0198 lb/MMBtu.

3.0 Benchmarking

Previously permitted PM_{10} emission limits are difficult to assess as many permits do not specify test methods and some emission limits only reflect filterable PM_{10} while some others include condensable PM_{10}. The permit for AES-Puerto Rico (a CFB) addressed this issue in detail. AES's permit limited filterable PM_{10} to 0.015 lb/MMBtu and allowed stack testing to determine an achievable total PM_{10} emission limit. Stack tests showed that filterable PM_{10} emissions were below 0.015 lb/MMBtu; however, based on stack test results, AES received an administrative change to their permit to set the total PM_{10} emission limit at 0.03 lb/MMBtu a value that accounts for the additional contribution of measured condensable PM_{10} at that facility. Several recent coal-fired boiler projects are listed with emission rates in the range of 0.010 lb/MMBtu to 0.015 lb/MMBtu based on front half (filterable) PM only, and this level is representative of BACT for PM.

Several facilities are listed in USEPA's BACT/LAER Clearinghouse with low levels of PM_{10}, and several of these purport to be for both filterable and condensable PM_{10}. ENSR is aware of only one other PC boiler permitted with a polishing WESP (WE Energies ELM Road Generating, WI (2004), PM_{10} limit of 0.018 filterable plus condensable). That facility is fundamentally different than the Cliffside Units in that it will burn low sulfur western coal (and therefore will not approach the condensable H_2SO_4 formation levels that will be experienced at Cliffside). Finally, Elm Road has not been operated or tested, nor has its application of WESP been demonstrated in practice as capable of meeting that total PM_{10} emission limit.

Duke is also aware of the PSD Permit issued to Santee Cooper for the Cross facility in NC, with a total PM_{10} limit of 0.018 lb/MMBtu. It is unknown if Santee Cooper will be able to demonstrate compliance with that limit, especially since that facility has not even proposed a polishing WESP. Again, Santee Cooper has not been operated or tested, nor has it been proven capable of meeting a very low permit limit for total PM_{10} in practice. The permit includes an initial demonstration to verify expected total PM_{10} emissions but does not set an ongoing control technology performance standard. After initial startup testing, the Cross facility will only be subject to periodic testing using filterable PM test methods (Method 5 or 17).

The existence of very low emission limits in new permits that have yet to be demonstrated in practice does not imply that new achievable emission levels have been proven or are achievable. The proponents of those projects have accepted risk for any number of reasons; however, Duke has proposed to install a greater level of control technology than Santee Cooper as a first of a kind demonstration, while capping PM_{10} emission rates at levels that are achievable in practice. Because the technology has not been proven in commercial application for the proposed configuration, it would not be appropriate to set a BACT limit based on expected (but not proven) emission rates. However, upon successful operation of the Cliffside project (and other potential coal-fired projects if they are actually constructed), measured performance of this technology may be useful in assessing future BACT limits for other sources.

4.0 Uncertainty in Measurement of Total PM_{10} from a Super-saturated WESP Stack

In setting permit limits for total PM_{10}, consideration should be given to the difficulty of measuring the very low concentrations of particulate emissions and the super saturated wet stack conditions after a WESP where the measurements would have to be conducted. The EPA reference methods require manual manipulations of test equipment and laboratory analysis which can introduce significant error, and little or no experience exists with actually testing condensable PM_{10} after a polishing WESP on a utility-scale boiler. Measurement of condensables also presents the problem of collection of secondary particulates (sulfates and nitrates) which are technically not part of PM_{10} because they form artificially in Method 202 and would not form in the air pollution control train or stack. In proposing very low limits, such as the Santee Cooper limit, consideration should also be given to potential testing artifacts that my be present for a WESP-equipped stack such as the proposed Cliffside Units vs. a hotter and dryer stack as proposed for Santee Cooper. With no field test experience in measuring condensable PM_{10} from a new utility coal unit with polishing WESP, as yet undiscovered variations and potential inaccuracies resulting from the test methods themselves create additional compliance risks for the proposed Cliffside Units.

5.0 Proposed BACT Limit for Total PM_{10}

- Duke proposes a total PM_{10} limit of 0.024 lb/MMBtu for the Cliffside Units, which is consistent with the value used in PSD dispersion modeling (which indicated compliance with National Ambient Air Quality Standards and PSD increment requirements). This value is based on the proposed limit of 0.015 lb/MMBtu for filterable PM_{10}, and adding 0.009 lb/MMbtu of non-otherwise regulated condensable PM_{10} (i.e. excluding H_2SO_4, HF, HCL, VOC). While Duke expects that emissions testing will easily demonstrate compliance at this level, Duke will accept permit conditions and a Continuous Assurance Monitoring (CAM) Plan that will require each PM_{10} control device to be operated at all times per good pollution control practice. Those conditions will ensure that the primary ESP, FGD and polishing WESP will operate to reduce total PM_{10} to the minimum levels that can be achieved in practice using the state-of-the-art or LAER particulate control technology for clean coal supercritical PC boilers. Duke proposes that compliance will be demonstrated by performing periodic (annual) testing at the stack to verify performance of the installed control technology (dry ESP, wet FGD, and wet ESP). Because these technologies have limited ability to control the condensation and capture of condensable aerosols, the performance testing will be limited to filterable PM emissions. In summary, Duke is proposing the following permit conditions for PM_{10}: Total PM_{10} emissions for BACT analysis: 0.024 lb/MMBtu

- Filterable PM_{10} Performance Standard: 0.015 lb/MMBtu
- Compliance demonstrated by:
  - Initial and Annual Filterable Emissions: Emissions below 0.015 lb/MMBtu based on Method 5 or 17
  - Best practice for continuous operation of all pollution control devices
  - Initial total PM_{10} test to demonstrate actual emissions (based on Method 202 or other approved test method).