August 25, 2006

Robert E. Hughes, Jr.
Designated Representative
East Kentucky Power Cooperative
4775 Lexington Road
Winchester, KY 40391

Re: Petition for Alternative SO_2 Missing Data Substitution Prior to Initial Certification for East Kentucky Power Cooperative, Dale Units 1 and 2 (Facility ID (ORISPL) 1385)

Dear Mr. Hughes:

The U.S. Environmental Protection Agency (EPA) has reviewed your March 1, 2006 petition (as amended on March 22, 2006) under §75.66, in which East Kentucky Power Cooperative (EKPC) requested to use an alternative method of missing data substitution for SO_2 emissions prior to completion of the initial continuous emission monitoring system certification tests for Units 1 and 2 at the Dale Power Station. EPA approves the petition, in part, as discussed below.

Background

EKPC operates two coal-fired boilers, Units 1 and 2, at the Dale Power Station (Dale) in Ford, Kentucky. The units discharge to the atmosphere through common stack CS1. For purposes of this petition, EKPC is assuming that these units became subject to Phase II of the Acid Rain Program and that starting on January 1, 2000, EKPC was required to hold allowances covering the units' sulfur dioxide (SO_2) emissions and was required to continuously monitor and report the units' SO_2, nitrogen oxides (NO_x), carbon dioxide (CO_2) emissions and heat input, in accordance with 40 CFR Part 75.[1]

EKPC did not meet the continuous emission monitoring and reporting requirements in 40 CFR Part 75 for Dale Units 1 and 2.[2] For example, EKPC did not install and certify the SO_2 and flow rate continuous emissions monitoring systems (CEMS) required by Part 75 to quantify SO_2 mass emissions. In such a case, §75.31(b)(2) and (c)(3) require conservatively high substitute

[1] In submitting this petition, EKPC stated that it was not waiving any claims concerning the Notice of Violation issued on January 17, 2006 for these units, e.g., any claims concerning the applicability of the Acid Rain Program to the units or the units' compliance with Acid Rain Program requirements.

[2] This petition does not address, and EPA's approval discussed below does not affect or supersede, any requirements under the Acid Rain Program other than the missing data substitution method required to be used for SO_2 for these units starting January 1, 2000.

data values (i.e., the maximum potential values of SO_2 concentration and stack gas volumetric flow rate) to be reported for each unit operating hour until the CEMS has been certified. In the March 1, 2006 petition, EKPC requested to use an alternative substitute data methodology to determine the SO_2 mass emissions from Dale Units 1 and 2 in the period extending from January 1, 2000 until the date and hour which certification testing of the SO_2 and flow rate monitoring systems is successfully completed. EKPC stated that it is currently in the process of installing and certifying all of the CEMS required by the Acid Rain Program.

Specifically, EKPC requested to use alternative substitute data based on: (1) hourly SO_2 emission rates (lb/mmBtu) measured by an SO_2_diluent CEMS on the common stack for Dale Units 1 and 2 (consisting of SO_2 and CO_2 monitors certified under 40 CFR Part 60); and (2) heat input rates derived using a mass balance engineering method, i.e., from coal feed rates and weekly analyses of the gross calorific value (GCV) of the coal combusted in Dale Units 1 and 2. Substitute data would be calculated for each hour as follows:

SO_2 mass (lb/hr) = SO_2 emission rate (lb/mmBtu) x Heat input rate (mmBtu/hr)

Where:

SO_2 emission rate (lb/mmBtu)	=	Hourly SO_2 emission rates (lb/mmBtu) measured by an SO_2_diluent CEMS
Heat input rate (mmBtu/hr)	=	GCV (mmBtu/lb) x Coal feed rate (lb/hr)

Then total SO_2 annual emissions in tons would be calculated by converting each hourly SO_2 mass value to pounds (lb), adding up all the hourly values of SO_2 mass emissions for the year and converting the sum from pounds to tons:

Annual SO_2 mass emissions (tons) = э [SO_2 hourly mass values (lb)] / 2,000 (lb/ton)

Note that EKPC's proposed calculation methodology for the hourly SO_2 mass emission rates (lb/hr) differs from the standard way in which SO_2 mass emission rates are calculated under Part 75. The standard Part 75 method for calculating hourly SO_2 mass emission rates for coal_fired units (<u>see</u> Section 2 in Appendix F of Part 75) uses hourly SO_2 concentrations and stack gas volumetric flow rates and the following equation:

SO_2 mass (lb/hr) = 1.660×10^{-7} x SO_2 concentration x Stack gas flow rate

Where:

1.660×10^{-7} =	Constant for units conversion (lb/scf_ppm)
SO_2 concentration =	Hourly average SO_2 concentration during unit operation measured by an SO_2 monitor (ppm)
Stack gas flow rate =	Hourly average volumetric flow rate during unit operation measured by a flow monitor (scfh)

In proposing substitute data, EKPC could not use the standard Part 75 approach because there was no flow monitor installed on the common stack serving Dale Units 1 and 2.

To support the use of the proposed alternative SO_2 substitute data methodology for Units 1 and 2, EKPC used the same method to estimate SO_2 emissions from Dale Units 3 and 4, which already monitor and report emissions under Part 75 under the Acid Rain Program. Units 3 and 4 share common stack CS2. EKPC continuously monitors the SO_2 mass emissions from Units 3 and 4, using certified Part 75 CEMS installed at CS2. For the years 2000 through 2005, Table 1 below compares the annual SO_2 mass emissions measured at common stack CS2 to EKPC's emissions estimates for Units 3 and 4, derived from the proposed alternative substitute data methodology.

Table 1. Comparison of Part 75 CEMS Data and EKPC's Proposed Approach for Estimating SO_2 Mass Emissions (Dale Units 3 and 4)

Year	**SO_2 Mass Emissions from Dale Units 3 and 4, as Determined by:**	
	EKPC's Proposed Estimation Method (tons)	**The Certified Part 75 CEMS (tons)**
2000	6,316	6,286
2001	7,035	6,846
2002	7,217	7,404
2003	7,607	7,759
2004	8,098	7,758
2005	8,275	8,210
Total	44,548	44,263

Table 1 shows that for calendar years 2000 through 2005, the differences between the annual SO2 mass emissions estimated by EKPC's proposed methodology and the corresponding emissions measured by the Part 75 CEMS range from -187 to + 340 tons. The corresponding percentage differences range from -2.5 percent to + 4.4 percent, averaging + 0.7 percent. According to EKPC, these results indicate that the proposed alternative method of calculating SO_2 emissions is capable of producing emissions estimates that compare reasonably well to actual emissions measurements made with certified Part 75 CEMS.

EKPC prepared and submitted to EPA all supporting data used in the development of the proposed alternative SO_2 substitute data methodology for Dale Units 1 and 2.

EPA's Determination

Based on a careful review of EKPC's proposed substitute data calculation method, EPA concluded that inherent uncertainties in the method could result in underestimation of the annual SO_2 emissions from Dale Units 1 and 2. Therefore, EPA sought to quantify the uncertainty of the method by comparing it directly against the standard way in which SO_2 emissions are calculated for coal-fired Part 75 units, i.e., as the product of SO_2 concentration times stack gas flow rate. The Agency believes that this is the most meaningful way to evaluate EKPC's request and to derive reasonable, yet conservative emissions estimates that are consistent with the purposes of Part 75 and Section 412 of the Clean Air Act.

The necessary hourly SO_2 concentration data for EPA's uncertainty assessment were provided by EKPC, as an attachment to the March 1, 2006 petition (i.e., the hourly data from the Part 60 SO_2 monitor installed on CS1). However, these SO_2 concentration data alone were insufficient for the uncertainty evaluation because (as previously noted) SO_2 mass emissions for coal-fired Acid Rain Program units are derived from measurements of both SO_2 concentration and stack gas volumetric flow rate. Since there was no flow rate monitor installed on common stack CS1, a mathematical relationship would have to be established between stack gas volumetric flow rate and the mass balance method used by EKPC to estimate unit heat input rate, in order to make the desired uncertainty assessment.

The necessary relationship between stack gas flow rate and EKPC's mass balance method was provided by an EPA flow study[3,4] in which the stack gas volumetric flow rate from a coal-fired boiler was estimated by four mass balance engineering methods, each of which included the boiler heat input rate in the calculations. All four mass balance methods used the same basic approach as EKPC to calculate the heat input rate, i.e., GCV times coal feed rate. The flow study compared these mass balance methods directly against flow rate measurements made with EPA Method 2. Since Method 2 is the principal reference method used for the relative accuracy test audits (RATAs) of Part 75 flow monitors, Method 2 data can be used as a surrogate for data that would be recorded by a certified flow monitor. Therefore, if there is a discrepancy between flow rates estimated by mass balance methods and flow rates measured by Method 2, this same discrepancy should exist between mass balance estimates of flow rate and measurements made with a certified stack flow monitor.

EPA was therefore able to proceed with the direct assessment of EKPC's proposed emission calculation method and make a determination of alternative substitute data consistent with the purposes of Part 75 and Section 412 of the Clean Air Act, i.e., in this context, to provide reasonable emissions estimates which (a) ensure that emissions are not underestimated and (b) provide a strong incentive for affected units to comply with CEMS requirements. The results of EPA's uncertainty assessment are presented below, followed by the Agency's re_estimation (based on the appropriate adjustment factors) of the 2000 through 2005 annual SO_2 emissions from Dale Units 1 and 2.

[3] "EPA Flow Reference Method Testing and Analysis", Section 3.1 (EPA/ 430_R_99_009a), June 1999.
[4] "EPA Flow Reference Method Testing and Analysis: Data Report" (EPA/430_R_98_009a), April 20, 1998.

1. <u>Uncertainty in the Part 60 SO_2 Concentration Data</u>

EPA first considered the relationship between SO_2 concentration monitoring under Part 60 and Part 75, specifically whether the former may underestimate SO_2 concentrations. There are many similarities, but also some distinct differences, in the quality assurance (QA) requirements for Part 60 monitors versus the QA requirements for Part 75 monitors. For example:

- Daily calibrations are required by both Part 60 and Part 75 and follow the same general procedures, but data validation criteria are more stringent under Part 75.

- Quarterly cylinder gas audits (CGAs), using 2 calibration gases, are required by Part 60. The quarterly linearity checks required by Part 75 are similar to, but use different procedures than, the CGAs. For example, 3 calibration gases are used, and the acceptance criteria are more stringent.
- RATAs follow the same general procedures under Part 60 and Part 75. However, the relative accuracy specification for the annual RATA is 20% under Part 60 versus 10% under Part 75.
- A bias adjustment factor (BAF) must be applied to Part 75 data, based on the RATA results. This is not required by Part 60.
- The requirements for setting the span and range for SO_2 concentration monitors are different under Part 60 than under Part 75 and can affect the application and effective stringency of QA criteria.

These similarities and differences must be taken into account when evaluating whether and to what extent data from a certified Part 60 monitor can be used to develop substitute data for purposes of Part 75. In light of this, EPA evaluated the hourly SO_2 concentration data from the Part 60 monitor on CS1, the common stack serving Dale Units 1 and 2 and found that:

- The QA tests conducted on the SO_2 monitor exceeded Part 60 requirements. Part 75 procedures were generally followed for the daily calibrations, linearity checks, and RATAs, and Part 75 specifications were generally met.
- The Part 60 SO_2 monitor had 99 percent monitor availability (PMA) and less than 100 total hours of missing data between 2000 and 2005.
- No BAF was applied to any of the Part 60 data. However, only one RATA would have resulted in a BAF greater than 1.000 (i.e., a 1.011 BAF from the 2003 RATA).

From this, EPA concluded that, although the SO_2 monitor was not fully certified by Part 75 standards, the data can be used, with proper adjustments, to estimate the units' SO_2 mass emissions.

Next, EPA compared the hourly SO_2 concentration data recorded by the Part 60 monitor on CS1 to data from the certified Part 75 SO_2 monitor installed on CS2, the common stack serving Dale Units 3 and 4. In the March 1, 2006 petition, EKPC states that the SO_2 values from the Part 60 and the Part 75 SO_2 monitors should be comparable because all of the Dale units (Units 1, 2, 3, and 4) burn the same coal at any given time. However, comparison of all hourly data recorded by the monitors from 2000 through 2005 indicates that, on average, the SO_2 concentration data from the Part 60 monitor are 4 percent lower than the data from the Part 75 monitor. A statistical t_test was performed on the two sets of hourly data, and the test confirmed that the apparent low bias in the Part 60 data is statistically significant.

In summary, EKPC's Part 60 SO_2 concentration monitor on CS1 generally met the QA requirements of Part 75, but the monitor was never certified under Part 75 and provided emissions data with a statistically significant low bias. Under these circumstances and in light of the purposes of Part 75 and Section 412 of the Clean Air Act, EPA determines that a conservative, yet reasonable, 4 percent upward adjustment to the SO_2 concentration data is warranted.

2. <u>Uncertainty in Stack Gas Flow Rates Derived from Mass Balance</u>

As previously noted, EKPC used a mass balance approach to estimate the heat input to Dale Units 1 and 2. There are two factors associated with this method that introduce uncertainty into the estimated heat input values and may result in underestimation in developing hourly SO_2 emission estimates:

- The coal feed rate system (i.e., the type of system used and the calibration method); and
- The coal sampling and analysis methods used.

For coal_fired units, Part 75 requires the use of a stack flow monitor to determine heat input. Each Part 75 flow monitor must pass a RATA, in which monitor readings are compared to a reference method (generally EPA Method 2). In contrast, the mass balance approach used by EKPC for Dale Units 1 and 2 derives heat input estimates from coal feed rates and measurements of the coal GCV. The coal feed rate is determined using a volumetric feed system and the coal density. The coal feed rate is measured prior to the bunker, which is upstream of the coal pulverizers. The feed rate system is calibrated twice a year. Coal GCV data are determined from weekly composites of coal which are analyzed by ASTM procedures outlined in Method 19 in Appendix A of Part 60. The weekly composites are made up of daily coal samples.

In the aforementioned EPA flow study, measurements and estimates of the stack gas volumetric flow rate were made at a large coal_fired boiler, using a number of different methodologies. These included EPA Method 2 and four mass balance engineering methods that use coal feed rates and GCV values in the calculations. The facility in the study used procedures similar to those employed by EKPC to measure coal feed rate and GCV (i.e., a calibrated volumetric system for coal feed rate and ASTM methods for GCV). Table 3_5 in section 3 of the EPA study (previously referenced in footnote 3) presents the results of 20 comparison tests between Method 2 and the four engineering methods.

The flow rates measured by Method 2 were consistently higher than those estimated by the mass balance methods. The average of the highest percentage differences between measurements under Method 2 and estimates under the individual mass balance methods was 11 percent. At first glance, this appears to indicate that calculating stack gas flow rate by a mass balance method could result in significant underestimation of the actual flow rate. However, there are other factors to consider.

First of all, the flow patterns in the stack were known to be cyclonic, i.e., the stack gas swirls as it travels toward the stack exit, rather than flowing parallel to the stack wall. The flow angles associated with this swirling motion (known as “yaw” and “pitch” angles) were measured during the study. According to the EPA study, the average yaw angle was 13.9 degrees and the average pitch angle was 2.4 degrees.

When Method 2 is used to measure stack gas flow rate, the impact openings of the Type_S pitot tube are aligned parallel to the stack wall, and the gas flow is assumed to be axial (“straight_up”). However, when yaw and pitch angles are present, the flow is non_axial and flow rates measured by Method 2 will be higher than the true values. To get the true flow rate when non_axial flow exists in the stack, corrections for yaw and pitch angle must be applied to the Method 2 data. To correct the Method 2 data for non_axial flow, the Method 2 results must be multiplied by the cosines of the yaw and pitch angles. This is consistent with Method 2F in Appendix A of Part 60, which was developed using data from the EPA flow study. That is:

$$Q_{adj} = Q_{RM2} (\cos y)(\cos p)$$

Where: Q_{adj} = Stack gas flow rate, corrected for non_axial flow
Q_{RM2} = Unadjusted stack gas flow rate, measured by Method 2
cos y = cosine of the average yaw angle
cos p = cosine of the average pitch angle

For the facility in the EPA flow study, the average yaw and pitch angles were 13.9 degrees and 2.4 degrees, respectively. Applying these angles to correct for non_axial flow, the above equation becomes:

$$Q_{adj} = Q_{RM2} (\cos 13.9^o)(\cos 2.4^o) = Q_{RM2} (0.97)$$

Application of the yaw and pitch angles results in the adjusted stack gas flow rate (Q_{adj}) being 97 percent of the stack flow rate measured by Method 2 (Q_{RM2}). Therefore, the flow rates measured by Method 2 need to be adjusted (i.e., lowered) by 3 percent, and applying this adjustment factor reduces the apparent discrepancy between the Method 2 flow rates and the flow rates measured by the mass balance methods from 11 percent to 8 percent.

Second, the Method 2 data do not take into account the velocity decay near the stack wall, i.e., the "wall effects". It is well_established engineering knowledge that the stack gas velocity is significantly lower near the stack wall than in the stack interior and that the velocity drops to zero at the stack wall. When Method 2 is used, the pitot tube readings are taken at a number of traverse points (12 or 16, for most Part 75 applications) located at specified distances from the stack wall, along two perpendicular diameters. For 12_ and 16_point applications of Method 2, the traverse points are not close enough to the stack wall to capture the wall effects, and Method 2 will overestimate the stack flow rate. In all Method 2 test runs in the EPA study, 16 traverse points were used. Therefore, it is appropriate to correct the Method 2 data for wall effects.

Wall effects were measured during the Method 2 testing. When the wall effects data were used in the calculations, the average stack gas velocity (which is directly proportional to the stack gas flow rate) was approximately 2 percent lower than the uncorrected average velocity. This is documented in Table 7 in Appendix A of the EPA study data report (previously referenced in footnote 4). Therefore, applying a "wall effects adjustment factor" of 2 percent to the Method 2 data appears to be justified. This further reduces the discrepancy between the Method 2 data and the engineering methods data, from 8 percent to 6 percent.

In view of these considerations and in light of the purposes of Part 75 and Section 412 of the Clean Air Act, EPA determines, that a conservative, yet reasonable, 6 percent upward adjustment to the stack gas volumetric flow rates derived from the mass balance methods is warranted.

3. Approved Alternative Substitute Data Calculation Method

EPA approves, in part, EKPC's request to use an alternative SO_2 missing data substitution methodology for Dale Units 1 and 2. However, the approved data substitution method, and the resulting SO_2 mass emissions substitute data, for 2000-2005 differ from the method and emissions values proposed by EKPC in the March 1, 2006 petition, as follows.

Based on EPA's uncertainty assessment of EKPC's alternative substitute data calculation method for the SO_2 mass emissions from Dale Units 1 and 2 and in light of the purposes of Part 75 and Section 412 of the Clean Air Act, the Agency has concluded that the following upward adjustments to EKPC's mass emission estimates must be made: (1) a 4 percent upward adjustment for uncertainty in the SO_2 concentration data measured by the Part 60 monitor; and (2) a 6 percent upward adjustment for uncertainty in stack gas flow rates estimated by mass balance methods. EPA believes that this approach results in reasonable, conservative substitute data values that ensure that emissions will not be underestimated, while providing a strong incentive for EKPC to comply with the Part 75 emission monitoring requirements.

The estimated 2000 through 2005 SO_2 emissions for Dale Units 1 and 2 provided by

EKPC are presented in Table 2, along with EPA's approved SO_2 mass emissions substitute data for those years. The "EKPC Petition" values in Table 2 are from the March 1, 2006 petition. The "EPA re_estimation" values represent the results of EPA's recalculation of the SO_2 mass emissions, using the supplementary data provided by EKPC with the petition and applying the 4 percent and 6 percent upward adjustment factors described above. The specific methodology used by EPA to recalculate and adjust the SO_2 mass emissions for Units 1 and 2 was as follows:

Step 1. The monthly coal feed rates (ton/month) were apportioned to hourly values by using the hourly output (i.e., megawatt) data for Units 1 and 2.

Step 2. The hourly heat input value (mmBtu/hr) was calculated by multiplying the hourly coal feed rate value (lb/hr) times the coal GCV (mmBtu/lb) for that hour. (The GCV for an hour was obtained from the most recent weekly sampling analysis prior to that hour.)

Step 3. The hourly SO_2 mass emissions value (lb/hr) was calculated by multiplying the derived hourly heat input (mmBtu/hr) from Step 2 times the SO_2 emission rate (lb/mmBtu) measured by the Part 60 monitor.

Step 4. The hourly SO_2 mass emissions value (lb/hr) was multiplied by the 4 percent and 6 percent adjustment factors (i.e., by 1.04 x 1.06), to yield the adjusted hourly SO_2 mass emissions (lb/hr).

Table 2. Estimated Annual SO_2 Emissions for Dale Units 1 and 2

Annual SO_2 Emissions for Dale Units 1 & 2	**Calendar Year**					
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
EKPC Petition (tons)	2,009	2,075	2,247	2,424	2,502	2,540
EPA Re-estimation (tons)	2,227	2,299	2,525	2,686	2,765	2,809

The EPA re-estimated SO2 mass emissions were calculated on an hourly basis because Dale Units 1 and 2 are required to report hourly emissions data to EPA for all unit operating hours. For each year, the hourly SO_2 mass emission values (lb/hr) were converted to pounds (lb) and summed to an annual total SO_2 mass (lb), which was then converted to tons, to give the EPA re_estimation value in Table 2. (Following this letter, EPA will provide electronically a

spreadsheet setting forth the calculations underlying EPA's recalculated emissions estimates for 2000-2005.)

Note that for each hour of missing data for SO_2 concentration from the Part 60 monitor, the average of the SO_2 concentrations recorded before and after the missing data period was used in the calculations. Averaging the hour before and hour after values to provide substitute data for short (< 24 operating hours) missing data periods is consistent with the standard missing data procedures for SO_2 concentration under §75.33. (As previously noted, in 2000_2005, there were less than 100 total operating hours for which valid Part 60 data were not obtained with the SO_2 monitor on CS1, and no individual missing data period was longer than 24 operating hours.)

4. Emissions Data for 2006

EPA's above-described approval of an alternative missing data substitution methodology, and the resulting SO_2 mass emissions, for Dale Units 1 and 2 cover the period 2000-2005. EPA will address, in a separate response, the portion of EKPC's petition concerning SO_2 emissions data for the units for 2006. In this separate response, which will be provided in the near future, EPA will address what type of emissions data should be reported, what reporting format should be used, and what reporting deadlines should be met for 2006.[5]

[5] These reporting deadlines will not affect or supersede the originally applicable deadlines for submission of any quarterly reports as set forth in Part 75.

EPA's determination relies on the accuracy and completeness of the information provided by East Kentucky Power Cooperative in the March 1, 2006 petition, as amended on March 22, 2006 and of the supplemental information that the company provided [6], and is appealable under Part 78. If you have any questions or concerns about this determination, please contact Manuel J. Oliva, at (202) 343-9009.

Sincerely,

/s/
Sam Napolitano, Director
Clean Air Markets Division

cc: David McNeil, EPA Region IV
Jerry Slucher, Kentucky DEP
Manuel J. Oliva, EPA CAMD
Adam Kushner, EPA OECA
Meredith Miller, EPA OECA

[6] EKPC provided the following supplemental information at EPA's request: emissions data, stack test data, fuel information, missing Part 60 CEMS data, and information on the Part 60 CEMS (4/18/06), coal analysis data (4/28/06), coal usage data (5/01/06), coal analysis reports (5/04/06), coal feed rate data (5/25/06), Part 60 CEMS QA test data and coal analysis data (5/26/06), stack characteristics and information on the Part 60 CEMS (6/08/06), coal feed system information (6/13/06), information on the Part 60 CEMS and Part 60 CEMS test data (6/14/06), coal sampling methods information (6/15/06), information on the boilers and the Part 60 CEMS (6/23/06), and stack characteristics (6/28/06).