

March 13, 2017

Mr. Peter Norgeot  
Designated Representative  
Entergy Corporation  
10055 Grogans Mill Road  
Parkwood II Building, Suite 400  
The Woodlands, TX 77380

Re: Petition to Adjust Reported CO<sub>2</sub> Concentration Data for Unit 2 at the  
Independence Power Plant (Facility ID (ORISPL) 6641)

Dear Mr. Norgeot:

The United States Environmental Protection Agency (EPA) has reviewed the petition submitted under 40 CFR § 75.66 by Entergy Corporation (Entergy) dated October 27, 2010 (and revised on February 10, 2011 and April 4, 2011) in which Entergy requested permission to adjust carbon dioxide (CO<sub>2</sub>) concentration values recorded from hour 09:00 on February 3, 2010 until hour 16:00 on June 22, 2010, for Unit 2 at the Independence Steam Electric Station. The requested adjustments to reported CO<sub>2</sub> concentration values in turn would cause adjustments to the values reported for CO<sub>2</sub> mass emissions, nitrogen oxides (NO<sub>x</sub>) emission rate, and heat input. EPA approves the petition, in part, with conditions, as discussed below.

### Background

Entergy operates and co-owns the Independence Steam Electric Station (Independence) in Newark, Arkansas. Independence Unit 2 is a coal-fired boiler serving a generator with a maximum generating capacity of 850 megawatts (MW). According to Entergy, Unit 2 is subject to the Acid Rain Program and during 2010 was also subject to the Clean Air Interstate Rule (CAIR) NO<sub>x</sub> Ozone Season Trading Program (as adopted in Arkansas' state implementation plan).<sup>1</sup> Entergy is therefore required to monitor and report sulfur dioxide (SO<sub>2</sub>), NO<sub>x</sub>, and CO<sub>2</sub> mass emissions, NO<sub>x</sub> emission rate, and heat input data for the unit in accordance with 40 CFR part 75. To meet these requirements, Entergy has installed and certified dilution-extractive continuous emissions monitoring systems (CEMS) for SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub>, as well as a stack gas

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<sup>1</sup> Starting with emissions occurring in 2015, Unit 2 is no longer subject to requirements under CAIR but is subject to similar requirements under the Cross-State Air Pollution Rule (CSAPR).

flow rate monitor. In a dilution-extractive CEMS, flue gas samples are extracted from the stack through a sample probe, diluted with conditioned air in a known ratio, and sent through an umbilical line to gas concentration analyzers. A single dilution probe on the Unit 2 stack is used to obtain the diluted flue gas samples sent to the SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub> concentration analyzers serving the unit.

In the course of a data audit, EPA found anomalies in the CO<sub>2</sub> concentration data reported for Unit 2, suggesting the possibility of a leak in a component of the unit's dilution-extractive system (e.g., sample probe or umbilical line). EPA informed Entergy of this finding, and upon examination Entergy identified the presence of a leak in the internal sample pump on the Unit 2 CO<sub>2</sub> analyzer, which would be expected to cause a low bias in measured CO<sub>2</sub> concentrations but would not affect measured SO<sub>2</sub> or NO<sub>x</sub> concentrations. Entergy conducted an investigation to determine the effect of the leak on the historical emissions and heat input data. Based on this investigation, Entergy determined that the measured CO<sub>2</sub> concentration data were suspect for a period which began with the replacement of the internal sample pump on February 3, 2010 and continued through June 22, 2010 when, according to Entergy, the gas filter correlation wheel in the CO<sub>2</sub> analyzer was replaced and "several leaks" were detected and sealed.

Under Entergy's monitoring plan for Unit 2, CO<sub>2</sub> concentration data are used directly in the computation of CO<sub>2</sub> mass emission rate (ton/hr) and mass emissions (tons), NO<sub>x</sub> emission rate (lb/mmBtu), and heat input rate (mmBtu/hr), making the values previously computed for these variables in this time period suspect. In contrast, the computed values for SO<sub>2</sub> and NO<sub>x</sub> mass emission rate (lb/hr) – which in turn are used to compute SO<sub>2</sub> and NO<sub>x</sub> mass emissions (tons) – are generally not implicated by a leak expected to affect CO<sub>2</sub> concentration data but not SO<sub>2</sub> or NO<sub>x</sub> concentration data. In the case of SO<sub>2</sub> mass emission rate and mass emissions data, CO<sub>2</sub> concentration data are not used in the computations at all. In the case of NO<sub>x</sub> mass emission rate and mass emissions data, based on the formulas used in Unit 2's monitoring plan, CO<sub>2</sub> concentration data are reflected in both the numerator and the denominator of the calculations for NO<sub>x</sub> mass emission rate values, such that the end results of those calculations – and the subsequent calculations of NO<sub>x</sub> mass emissions values in tons – would generally not be affected by any bias in the CO<sub>2</sub> concentration data, beyond minor differences caused by rounding in intermediate calculations or by the use of the diluent cap to calculate the NO<sub>x</sub> emission rate (lb/mmBtu) in certain hours.<sup>2</sup>

In order to support the identification of the specific time period when the measured CO<sub>2</sub> concentration data were biased low, Entergy provided graphs (and associated data) presenting the computed CO<sub>2</sub> mass emission rate (ton/hr) and heat input rate (mmBtu/hr) plotted on the y-

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<sup>2</sup> As identified in the Unit 2 monitoring plan, Entergy is using formula F-15 to determine the heat input rate (mmBtu/hr), formula F-6 to determine the NO<sub>x</sub> emission rate (lb/mmBtu), and formula F-24a to determine the NO<sub>x</sub> mass emission rate (lb/hr). The formulas can be found in the section 9.0 Monitoring Formula Data of the *ECMPS Reporting Instructions: Monitoring Plan (PDF)* available at <https://www.epa.gov/airmarkets/clean-air-markets-ecmps-reporting-instructions>.

axis and the hourly unit load (MW) plotted on the x-axis during four distinct time periods. The first time period included 417 unit operating hours immediately after the date of completion of the 2009 CO<sub>2</sub> RATA (September 15, 2009 to October 3, 2009) and was intended to represent valid data used as a baseline. The second time period (October 17, 2009 to February 3, 2010) was intended to represent valid data immediately prior to the period of low-biased CO<sub>2</sub> concentration data. The third time period (February 3, 2010 to June 22, 2010) was the period identified as having low-biased CO<sub>2</sub> concentration data. The fourth time period (June 22, 2010 to June 30, 2010) was intended to represent valid data immediately after the period with low-biased CO<sub>2</sub> concentration data.

Entergy also provided graphs intended to demonstrate that the identified leaks in the CO<sub>2</sub> analyzer did not affect the measured stack gas flow rate (scfh), SO<sub>2</sub> concentration (ppm), or NO<sub>x</sub> concentration (ppm) data or the computed SO<sub>2</sub> mass emission rate (lb/hr) or NO<sub>x</sub> mass emission rate (lb/hr) data.

Entergy submitted the graphs described above along with the following table, which provides a summary of emissions, heat input, and stack gas flow per MWh for the four distinct time periods. In Table 1, the bolded data period (February 3, 2010 to June 22, 2010) identifies the time period in which the measured CO<sub>2</sub> concentration data were biased low.

**Table 1: Average ratios of emissions, heat input, and stack gas flow rate to hourly unit load, as measured or computed before correction**

Data Period	Average Ratio				
	Tons CO <sub>2</sub> per MWh	mmBtu per MWh	1000 SCF per MWh	lbs SO <sub>2</sub> per MWh	lbs NO <sub>x</sub> per MWh
September 15, 2009 to October 3, 2009	1.032	9.840	14.764	4.613	2.240
October 3, 2009 to February 3, 2010	1.022	9.747	14.597	4.479	2.273
<b>February 3, 2010 to June 22, 2010</b>	<b>0.913</b>	<b>8.705</b>	<b>14.675</b>	<b>4.683</b>	<b>2.381</b>
June 22, 2010 to June 30, 2010	1.007	9.604	14.591	4.712	2.241

In the October 27, 2010 petition, Entergy stated that both tons of CO<sub>2</sub> per MWh and heat input per MWh for the period from February 3, 2010 to June 22, 2010 were 13 percent lower than the corresponding ratios measured during the baseline period following the September 2009 RATA (i.e., September 15, 2009 to October 3, 2009). Therefore, Entergy requested to apply a correction factor of 1.13 to the hourly CO<sub>2</sub> concentration data from hour 09:00 on February 3, 2010 through hour 16:00 on June 22, 2010. The corrected CO<sub>2</sub> concentration data would then be used to calculate revised CO<sub>2</sub> mass emissions, heat input, and NO<sub>x</sub> emission rates (lb/mmBtu)

for each operating hour in the affected time period. The recalculated data would be incorporated into Unit 2's first and second quarter 2010 emissions reports and resubmitted to the Clean Air Markets Division of EPA.

#### EPA's Determination

EPA performed its own analysis of the low-biased CO<sub>2</sub> concentration data reported for Unit 2 using an established control chart procedure which is designed to identify possible CEMS probe leaks.<sup>3</sup> Specifically, EPA's analysis focused on the reported CO<sub>2</sub> concentrations in a representative load bin for Unit 2. The control chart methodology uses CO<sub>2</sub> data for the analysis because of the relatively low variability of CO<sub>2</sub> concentration in a given load range as compared to other parameters that may vary more due to fuel variability or other factors in the combustion process. Therefore, differences in CO<sub>2</sub> concentration may be used to derive an appropriate bias correction factor when a uniform bias can be detected.

The Agency's analysis compared the low-biased CO<sub>2</sub> data recorded during the period from February 3, 2010 through June 22, 2010 to a baseline of quality-assured CO<sub>2</sub> concentration data collected in the period immediately following the 2009 CO<sub>2</sub> RATA (September 16, 2009 through November 2, 2009). To eliminate operational variation, the analysis was focused on the load bin in which the unit most often operated during the evaluation period (i.e., load bin 10). The baseline period consisted of the first 30 operating days following the RATA during which at least six hours of quality-assured CO<sub>2</sub> concentration data per day were collected with the unit operating in load bin 10. The following procedure was used to determine a correction factor:

- A) For each day in the baseline period, the daily average of quality-assured CO<sub>2</sub> concentration values for the hours where the unit was operating in load bin 10 was calculated;
- B) Using the daily average CO<sub>2</sub> concentrations from step A, the baseline period average CO<sub>2</sub> concentration and standard deviation were calculated;
- C) For each day in the low-bias period (i.e., February 3, 2010 to June 22, 2010) where the unit operated for at least 6 hours in load bin 10, the daily average of CO<sub>2</sub> concentration values for those hours was calculated;
- D) Using the daily averages from step C, the low-bias period average CO<sub>2</sub> concentration and standard deviation were calculated;

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<sup>3</sup> A paper describing EPA's control chart methodology and approach for evaluating potential CEMS data quality issues by examining the relationship over time of CO<sub>2</sub> concentration data to unit load data can be found at <https://www.epa.gov/airmarkets/control-chart-methodology-detecting-under-reported-emissions>.

E) The following equation was used to compute a correction factor that accounts for uncertainty in measurements during both the baseline period and the low-bias period and conservatively ensures that the corrected data will not result in under-reported emissions:<sup>4</sup>

$$CF = \frac{AvgCO2_{base}}{AvgCO2_{low}} \left( 1 + \sqrt{\left( \frac{SD_{base}}{AvgCO2_{base}} \right)^2 + \left( \frac{SD_{low}}{AvgCO2_{low}} \right)^2} \right)$$

Where:

- $CF$  = Correction factor to be applied to the low-biased emissions data, including uncertainty adjustment;
- $AvgCO2_{base}$  = Average of load-bin-10 daily average %CO<sub>2</sub> during the baseline period;
- $SD_{base}$  = Standard deviation of load-bin-10 daily average %CO<sub>2</sub> during the baseline period;
- $AvgCO2_{low}$  = Average of load-bin-10 daily average %CO<sub>2</sub> during the low-bias period; and
- $SD_{low}$  = Standard deviation of load-bin-10 daily average %CO<sub>2</sub> during the low-bias period.

Table 2 below summarizes the data inputs and results of the correction factor calculations.

**Table 2: Correction factor calculation summary (see equation above)**

Description	Variable	Value
Average baseline CO <sub>2</sub>	AvgCO2 <sub>base</sub>	12.57
Average low-bias CO <sub>2</sub>	AvgCO2 <sub>low</sub>	11.22
Standard deviation of baseline data	SD <sub>base</sub>	0.16
Standard deviation of low-bias data	SD <sub>low</sub>	0.42
Correction factor including uncertainty adjustment	CF	1.164

Ordinarily, for any unit operating hour in which valid, quality-assured data are not obtained with a certified monitor, the standard missing data provisions in §§ 75.33 through 75.37 would be used to determine the appropriate substitute data values to be reported. The standard missing data substitution provisions are intended to provide a conservative estimate of actual

<sup>4</sup> Note that the uncertainty of a quotient is equal to the square root of the sum of squared fractional uncertainties for the individual input values times the quotient result. See, for example, Taylor, J.R., *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements*, University Science Books, Mill Valley, CA, pp. 56-57 (1982).

emissions and to provide sources with an incentive to follow good operating and maintenance practices that will ensure high CEMS availability.

However, in this instance, EPA finds that the use of the standard missing data substitution provisions would be unnecessarily conservative. Entergy's data analysis described above showed that there was a consistent, unidirectional bias in the CO<sub>2</sub> concentration data recorded by the CEMS installed at Unit 2 in the period extending from February 3, 2010 through June 22, 2010 attributable to an identifiable CEMS issue. In circumstances of this nature, the Agency has previously found that use of a correction factor with an appropriate statistical adjustment to account for measurement uncertainty can provide reasonable, yet conservatively high emissions data. EPA therefore approves 1.164 (rather than 1.13 as requested by Entergy) as the appropriate final correction factor to make an upward adjustment to measured CO<sub>2</sub> concentration data from hour 09:00 on February 3, 2010 through hour 16:00 on June 22, 2010, in lieu of using the standard part 75 missing data routines.

EPA concurs with Entergy's analysis showing that the identified leak in the internal sample pump on the Unit 2 CO<sub>2</sub> analyzer did not affect the measurements of NO<sub>x</sub> and SO<sub>2</sub> concentrations or stack gas flow rate. However, in addition to adjusting and resubmitting the CO<sub>2</sub> concentration data, it is necessary to also recalculate and resubmit the hourly CO<sub>2</sub> mass emission rate (ton/hr), heat input rate (mmBtu/hr), NO<sub>x</sub> emission rate (lb/mmBtu), and NO<sub>x</sub> mass emission rate (lb/hr) data, as well as the cumulative CO<sub>2</sub> mass emissions and NO<sub>x</sub> mass emissions data (tons), because these values are derived from the CO<sub>2</sub> concentration data.<sup>5</sup>

### Conditions of Approval

As conditions of this approval, Entergy must:

- (1) Adjust the hourly CO<sub>2</sub> concentration data recorded at Unit 2 during the low-bias period from hour 09:00 on February 3, 2010 through hour 16:00 on June 22, 2010, using the approved correction factor of 1.164.
- (2) Recalculate and report all hourly CO<sub>2</sub> mass emission rate (ton/hr), NO<sub>x</sub> emission rate (lb/mmBtu), NO<sub>x</sub> mass emission rate (lb/hr), and heat input rate (mmBtu/hr) values for the low-bias period, as well as cumulative CO<sub>2</sub> and NO<sub>x</sub> mass emissions values (tons), using the adjusted CO<sub>2</sub> concentration data.
- (3) Report each adjusted hourly CO<sub>2</sub> concentration and NO<sub>x</sub> emission rate (lb/mmBtu) value using the method of determination (MODC) code "53", which means "other

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<sup>5</sup> As discussed earlier, EPA expects that the resubmitted NO<sub>x</sub> mass emission rate (lb/hr) data will be very close to the previously submitted data because the changes in the recalculated NO<sub>x</sub> emission rate (lb/mmBtu) and heat input rate (mmBtu/hr) data will generally offset one another when those data are multiplied to recalculate NO<sub>x</sub> mass emission rate data. Likewise, EPA expects that the recalculated cumulative NO<sub>x</sub> mass emissions data (tons), which are computed from the hourly NO<sub>x</sub> mass emission rate data, will be very close to the previously submitted data.

quality assured methodology approved through petition.” These adjusted hourly values must be included in missing data lookbacks and are treated as available hours for percent monitor availability (PMA) calculations.

- (4) Resubmit the quarterly electronic data reports (EDRs) for Independence Unit 2 for all quarters of 2010. Coordinate the resubmission of the data with Mr. Craig Hillock, who may be reached at (202) 343-9105 or by e-mail at [hillock.craig@epa.gov](mailto:hillock.craig@epa.gov).
- (5) If necessary, resolve any allowance accounting issues for Unit 2 by contacting Mr. Kenon Smith, who may be reached at (202) 343-9164 or by e-mail at [smith.kenon@epa.gov](mailto:smith.kenon@epa.gov).

EPA’s determination relies on the accuracy and completeness of Entergy’s October 27, 2010 petition, as amended on April 4, 2011, and the associated electronic data reports previously submitted by Entergy; and is appealable under 40 CFR part 78. If you have any questions regarding this determination, please contact Mr. Travis Johnson at (202) 343-9018 or by e-mail at [johnson.travis@epa.gov](mailto:johnson.travis@epa.gov). Thank you for your continued cooperation.

Sincerely,

/s/  
Richard A. Haeuber, Acting Director  
Clean Air Markets Division

cc: Alan Breshears, Arkansas DEQ  
Raymond Magyar, EPA Region VI  
Travis Johnson, CAMD  
Craig Hillock, CAMD  
Kenon Smith, CAMD