Entergy Services, Inc., on behalf of Entergy Arkansas, Inc.

# Analysis of Reasonable Progress
# Arkansas Regional Haze Program
# First Planning Period

Submitted to:

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# TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

# 1. EXECUTIVE SUMMARY

This report provides an update to the monitoring information originally provided by Entergy Arkansas, Inc. (EAI) and Trinity Consultants (Trinity) on August 7, 2015[1] and updated on November 15, 2016[2], and analyzes Reasonable Progress for the Regional Haze Program's first planning period (ending in 2018) – specifically addressing the controls that would be needed to meet the emission limits for EAI's Independence units in the final Arkansas Regional Haze Federal Implementation Plan (FIP).[3]

The Interagency Monitoring of Protected Visual Environments (IMPROVE) has established a network of monitoring stations at mandatory Federal Class I areas across the country to measure and record visibility parameters from the atmosphere, such as sulfate and nitrate particles. From this monitoring data, visibility impairment, or haze, is determined. As of the date of this report, the most recent annual summary available is for calendar year 2015. Though the complete dataset and summary for 2016 is not yet available, un-summarized monitoring data up to July 31, 2016 are available. From this, current visibility conditions can be derived.

As presented in this report, visibility at the Class I areas in Arkansas – Caney Creek Wilderness Area (CACR) and Upper Buffalo Wilderness Area (UPBU) – has improved at a rate faster than necessary to maintain the Uniform Rate of Progress (URP) towards the Regional Haze Program goal of elimination of manmade visibility impairment by 2064. The monitoring data demonstrate that visibility improvement at these Class I areas currently exceeds EPA's goals for the first planning period even though the majority of the emission controls prescribed by the FIP have yet to be installed. The same can be said of the two Class I areas in Missouri – Mingo Wilderness Area (MING) and Hercules-Glades Wilderness Area (HEGL) – as documented in Missouri's Five-Year Progress Report to EPA.[4]

The FIP mandates $NO_X$ and $SO_2$ emission limits for EAI's Independence units 1 and 2 to achieve reasonable progress towards the Regional Haze Program goal. However, due to the current and forecasted status of visibility in the Class I areas, the planned compliance strategies for Best Available Retrofit Technology (BART) requirements (*e.g.*, the cessation of coal burning at EAI's White Bluff facility in 2028),[5] implementation of other Clean Air Act (CAA) programs such as the

[1] Trinity Consultants, *Regional Haze Modeling Assessment Report – Entergy Arkansas, Inc. – Independence Plant*, August 7, 2015 (Trinity Project No. 154401.0074), submitted as an Exhibit C to Entergy Arkansas, Inc.'s *Comments On the Proposed Regional Haze and Interstate Visibility Transport Federal Implementation Plan for Arkansas*.

[2] Trinity Consultants, *Assessment of Recent Class I Area IMPROVE Monitoring Data*, November 15, 2016 (Trinity Project No. 163701.0059).

[3] Promulgation of Air Quality Implementation Plans; State of Arkansas; Regional Haze and Interstate Visibility Transport Federal Implementation Plan; Final Rule, 81 Fed. Reg. 66,332 – 66,421 (September 27, 2016).

[4] State of Missouri Regional Haze 5-Year Progress Report (https://dnr.mo.gov/env/apcp/reghaze/complete-RegionalHaze-5-yr-Rpt-submittal.pdf), August 29, 2014, p. 17.

[5] The emissions control technologies on which the BART $SO_2$ and $NO_X$ emissions limits are based are identified in Appendix C. Certain of the units subject to the FIP also intend to install $NO_X$ emissions controls to meet CSAPR. For example, EAI is planning to install low $NO_X$ burners and separated overfire air at White Bluff and Independence to comply with CSAPR's ozone season $NO_X$ program.

Cross State Air Pollution Rule (CSAPR), and considering the four reasonable progress factors[6] (including EAI's proposed cessation of coal use at Independence by 2030 as part of resolving the 8th Circuit Court of Appeals FIP litigation), the emission limits required by the FIP for EAI's Independence units 1 and 2 are not necessary.

[6] EAI asserts that consideration of these factors is not necessary with respect to Arkansas' sources for the first planning period. However, without waiver, the four factors are addressed herein to provide a more comprehensive evaluation of reasonable progress for Arkansas' Class I areas.

# 2. INTRODUCTION TO VISIBILITY AND HAZE INDEX

Visibility is most simply measured as the farthest distance that can naturally be seen by an average human. Light waves diffract and are absorbed as they pass through and around particles and molecules in the atmosphere. The level of visibility therefore naturally decreases at greater distances as light waves come into contact with a greater number of these miniscule obstacles. This natural scattering of light waves is called Rayleigh scattering. Additionally, both anthropogenic (manmade) and non-anthropogenic sources of pollution, which result in increased atmospheric concentrations of particles and molecules, have an effect on visibility. The primary contributors to visibility impairment or "light extinction" include sulfates, nitrates, organic carbon, elemental carbon, crustal material, and sea salt."[7,8] Through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program, concentrations of these species are monitored at each mandatory Federal Class I area[9] every three (3) days for 24 hours. The species concentrations are converted to light extinction using the Revised IMPROVE Equation:[10,11]

**Equation 1. Revised IMPROVE Equation**

$$\begin{aligned} b_{ext} = 2.2 \times f_S(RH) \times [Small\ Sulfate] \\ + 4.8 \times f_L(RH) \times [Large\ Sulfate] \\ + 2.4 \times f_S(RH) \times [Small\ Nitrate] \\ + 5.1 \times f_L(RH) \times [Large\ Nitrate] \\ + 2.8 \times [Small\ Organic\ Mass] \\ + 6.1 \times [Large\ Organic\ Mass] \\ + 10 \times [Elemental\ Carbon] \\ + 1 \times [Fine\ Soil] \\ + 1.7 \times f_{SS}(RH) \times [Sea\ Salt] \\ + 0.6 \times [Coarse\ Mass] \\ + Rayleigh\ Scattering\ (Site\ Specific) \\ + 0.33 \times [NO_2(ppb)] \end{aligned}$$

Where $b_{ext}$ represents the light extinction coefficient in inverse megameters ($Mm^{-1}$), and individual species concentrations are shown in brackets with units of micrograms per cubic meter ($\mu g/m^3$). The $f_L$ and $f_S$ terms are unitless water growth factors given as functions of relative humidity (RH) for concentrations of large and small sulfates and nitrates, while $f_{SS}$ represents the water growth factor for sea salt concentrations. The numerical constants given in the equation (e.g., 2.2) represent

[7] U.S. EPA, *Visibility in Mandatory Federal Class I Areas (1994-1998): A Report to Congress*. EPA-452/R-01-008. Chapter 1 – Introduction to Visibility Issues. November 2001.

[8] Kumar, Naresh, et al. "Revised Algorithm for Estimating Light Extinction from IMPROVE Particle Speciation Data." Journal of the Air & Waste Management Association JAWMA 57.11 (2007): 1326-336.

[9] Mandatory Federal Class I areas included all international parks (IP), national wilderness areas exceeding 5,000 acres, national memorial parks exceeding 5,000 acres, and national parks exceeding 6,000 acres, in existence on August 7, 1977, and are listed, by state, in 40 Code of Federal Regulations §§81.401 – 437.

[10] In 1999, an equation to estimate light extinction based on available IMPROVE data was incorporated into the Regional Haze Rule (Old IMPROVE Equation). In 2007, a revised equation was developed to reduce "bias for high and low light extinction extremes" and to make the equation "more consistent with the recent atmospheric aerosol literature (Revised IMPROVE Equation).

[11] U.S. EPA, *Visibility in Mandatory Federal Class I Areas (1994-1998): A Report to Congress*. EPA-452/R-01-008. Chapter 1 – Introduction to Visibility Issues. November 2001.

dry mass extinction efficiency terms in units of square meters per gram ($m^2/g$).[12] Measurements and calculated light extinction values are published by IMPROVE on a Colorado State University webpage.[13]

Because the units for light extinction ($Mm^{-1}$) are difficult to conceptualize and compare in practical terms, the haze index (deciview or dv) was developed. The haze index is calculated as a function of the ratio of the calculated light extinction coefficient to the approximate average extinction value due to Rayleigh scattering alone (10 $Mm^{-1}$).

**Equation 2. Formula for Haze Index (dv)**

$$Haze\ Index\ (dv) = 10 \times \ln\left(\frac{b_{ext}\ [Mm^{-1}]}{10\ [Mm^{-1}]}\right)$$

The deciview scale provides a simpler representation of visibility deterioration, with natural conditions having a calculated haze index of approximately zero deciviews, depending on the site-specific level of Rayleigh scattering.[14] The larger the haze index, the more degradation of visibility at a particular location. According to EPA, a one-deciview change represents a "small but noticeable change in haziness".[15] Other studies, however, have suggested that a "1-deciview change never produces a perceptible change in haze."[16]

[12] Kumar, Naresh, et al. "Revised Algorithm for Estimating Light Extinction from IMPROVE Particle Speciation Data." Journal of the Air & Waste Management Association JAWMA 57.11 (2007): 1326-336.

[13] IMPROVE. Regional Haze Rule Summary data through 1988-2015. (http://views.cira.colostate.edu/fed/SiteBrowser/Default.aspx)

[14] U.S. EPA, *Visibility in Mandatory Federal Class I Areas (1994-1998): A Report to Congress*. EPA-452/R-01-008. Chapter 1 – Introduction to Visibility Issues. November 2001.

[15] Regional Haze Regulations; Final Rule, 64 Fed. Reg. 35,725 - 35,727 (July 1, 1999).

[16] Ronald C. Henry, "Just-Noticeable Differences in Atmospheric Haze," Journal of the Air & Waste Management Association, Vol. 52 at 1,238 (October 2002).

# 3. REGIONAL HAZE RULE

Section 169A of the Clean Air Act (CAA) requires implementation plans which address visibility protection for federal Class I areas to include "emission limits, schedules of compliance and other measures as may be necessary to make reasonable progress toward meeting the national goal" of elimination of manmade visibility impairment at such areas.[17] To effectuate the CAA's national visibility goal, EPA promulgated the Regional Haze Rule, which has as its own goal to achieve natural visibility conditions in each Class I area by 2064.[18] There are two federal Class I areas located in Arkansas for which measures are required to make reasonable progress: Caney Creek Wilderness Area (CACR) and Upper Buffalo Wilderness Area (UPBU).

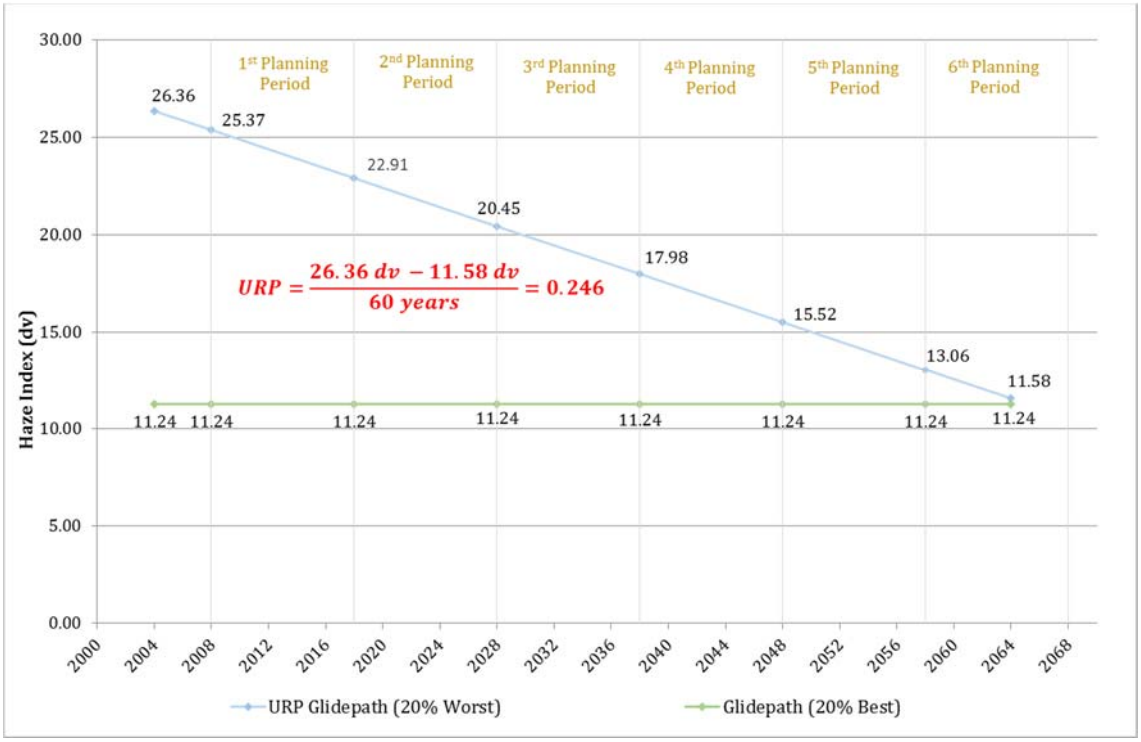
When tracking the progress of remedying visibility impairment at a particular Class I area based on measured data, EPA recommends taking the average of the haze indices, in deciviews, associated with the 20 percent most impaired days of the year (*i.e.*, "20 percent worst") and the 20 percent least impaired days of the year (*i.e.*, "20 percent best").[19] To achieve the goal, the average haze index for the 20 percent worst days must improve to meet the level of the 20 percent best days, and the 20 percent best days value must not degrade.[20]

A "glidepath" from the 20 percent worst days average to the 20 percent best days average is defined for each Class I area. It is called the Uniform Rate of Progress ("URP"). The URP is a straight line from baseline visibility conditions (average 20 percent worst days as of 2004) to natural visibility conditions (to be achieved in 2064 for the 20 percent worst days). The slope of that line is the difference between the two conditions divided by the 60-year program. The URPs for CACR and UPBU are presented in Figure 3-1 and Figure 3-2, respectively.

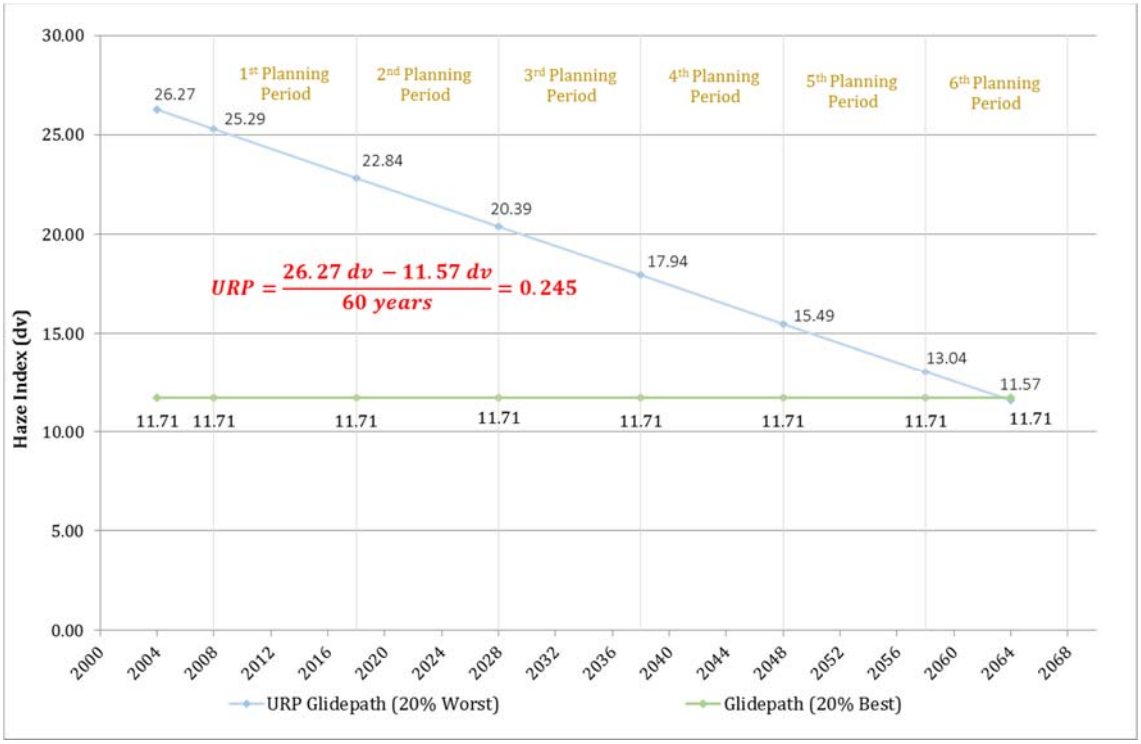
In addition to establishing URPs for each Class I area, as part of each state's Long Term Strategy, states (or EPA) also establish Reasonable Progress Goals (RPGs) for each area for the end of each planning period, i.e., 2018, 2028, and so on. The 2018 RPGs set by EPA for the Arkansas Class I areas are 22.47 dv for CACR and 22.51 dv for UPBU.[21]

[17] 42 U.S.C. § 7491(b)(2).
[18] Regional Haze Regulations; Final Rule, 64 Fed. Reg. 35,732 and 35,766 (July 1, 1999).
[19] Regional Haze Regulations; Final Rule, 64 Fed. Reg. 35.728 and 35,730 (July 1, 1999).
[20] Regional Haze Regulations; Final Rule, 64 Fed. Reg. 35.730 and 35,734 (July 1, 1999).
[21] Promulgation of Air Quality Implementation Plans; State of Arkansas; Regional Haze and Interstate Visibility Transport Federal Implementation Plan; Final Rule, 81 Fed. Reg. 66,354 (September 27, 2016).

## Figure 3-1. CACR Uniform Rate of Progress




## Figure 3-2. UPBU Uniform Rate of Progress



# 4. RECENT IMPROVE MONITORING DATA

The most recent and complete summary of annual monitoring data available from IMPROVE for CACR and UPBU covers the year 2015. However, as of the date of this report, non-summarized data through July 31, 2016, is available and can be used to calculate the light extinction coefficients (see Equation 1) and haze indices (see Equation 2) for January through July of 2016. Trinity obtained the non-summarized data and compiled an independent summary for January through July of 2016.[22] The species-specific and total light extinction and haze index values for the averages of the 20 percent worst days and the 20 percent best days for the first half of 2016 are shown in Table 4-1.

**Table 4-1. Independent Summary of Monitoring Data for January 1, 2016 through July 31, 2016**

| | 20 Percent Worst Days Average | | 20 Percent Best Days Average | |
|---|---|---|---|---|
| **Light Extinction Value ($Mm^{-1}$)** | **CACR** | **UPBU** | **CACR** | **UPBU** |
| Sulfate | 31.46 | 28.84 | 4.72 | 4.80 |
| Nitrate | 16.86 | 21.03 | 1.04 | 1.17 |
| Organics | 18.49 | 17.81 | 2.21 | 2.31 |
| Carbon | 2.96 | 3.58 | 0.32 | 0.38 |
| Soil | 3.20 | 2.78 | 0.10 | 0.10 |
| Coarse PM | 6.78 | 6.86 | 1.41 | 1.20 |
| Sea Salt | 1.12 | 0.81 | 0.06 | 0.06 |
| Total Light Extinction ($Mm^{-1}$) | 74.30 | 72.85 | 24.75 | 26.72 |
| **Haze Index (dv)** | **19.90** | **19.67** | **8.83** | **9.67** |

Table 4-2 presents a summary of the annual-average haze index values for each year from 2002 to 2016 (based on first half of the year).[23]

**Table 4-2. Summary of Annual Average Haze Index Values from 2002 through 2016**

| | 20 Percent Worst Days Average | | 20 Percent Best Days Average | |
|---|---|---|---|---|
| **Year** | **CACR** | **UPBU** | **CACR** | **UPBU** |
| 2002 | 27.21 | 26.74 | 11.88 | 12.83 |
| 2003 | 26.54 | 27.22 | 10.74 | 10.62 |
| 2004 | 25.34 | 25.58 | 11.11 | 10.74 |
| 2005 | 29.21 | 30.47 | 12.93 | 13.34 |
| 2006 | 25.68 | 25.42 | 12.51 | 13.00 |
| 2007 | -- | 26.17 | -- | 12.45 |
| 2008 | 23.70 | 24.60 | 9.24 | 10.49 |
| 2009 | 22.68 | 22.62 | 8.09 | 9.40 |
| 2010 | 22.94 | -- | 10.76 | -- |
| 2011 | 22.67 | 23.21 | 11.71 | 11.51 |
| 2012 | 21.49 | 21.56 | 9.54 | 10.31 |
| 2013 | 21.35 | 21.25 | 8.61 | 8.60 |
| 2014 | 20.72 | 20.49 | 8.52 | 8.13 |
| 2015 | 20.41 | 19.96 | 7.03 | 7.50 |
| 2016 | 19.90 | 19.67 | 8.83 | 9.67 |

[22] The calculations and data summarizing method were confirmed by downloading and processing the un-summarized data for 2014 and then comparing the results to the values in the 2014 summary found online.
[23] Summarized data are not available for CACR for 2007, UPBU for 2010, and MING for 2002 through 2005.

# 5. MONITORING DATA COMPARED TO REGIONAL HAZE GOALS

Figure 5-1 and Figure 5-2 present, for CACR and UPBU, respectively, comparisons of the observed haze index values (*see* Section 4) for each year of IMPROVE data, including values from the first half of 2016, to the URPs (*see* Section 3). The same comparisons are shown for the two Missouri Class I areas in Appendix B.

**Figure 5-1. CACR Monitored Observations Compared to Uniform Rate of Progress**

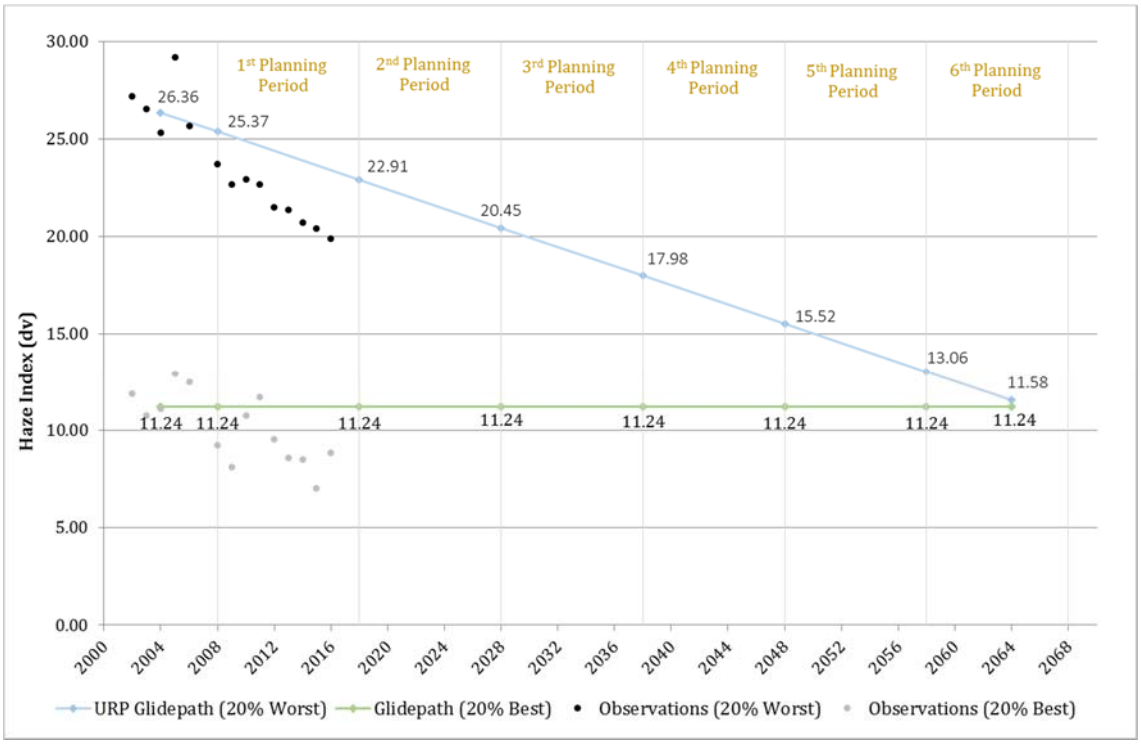
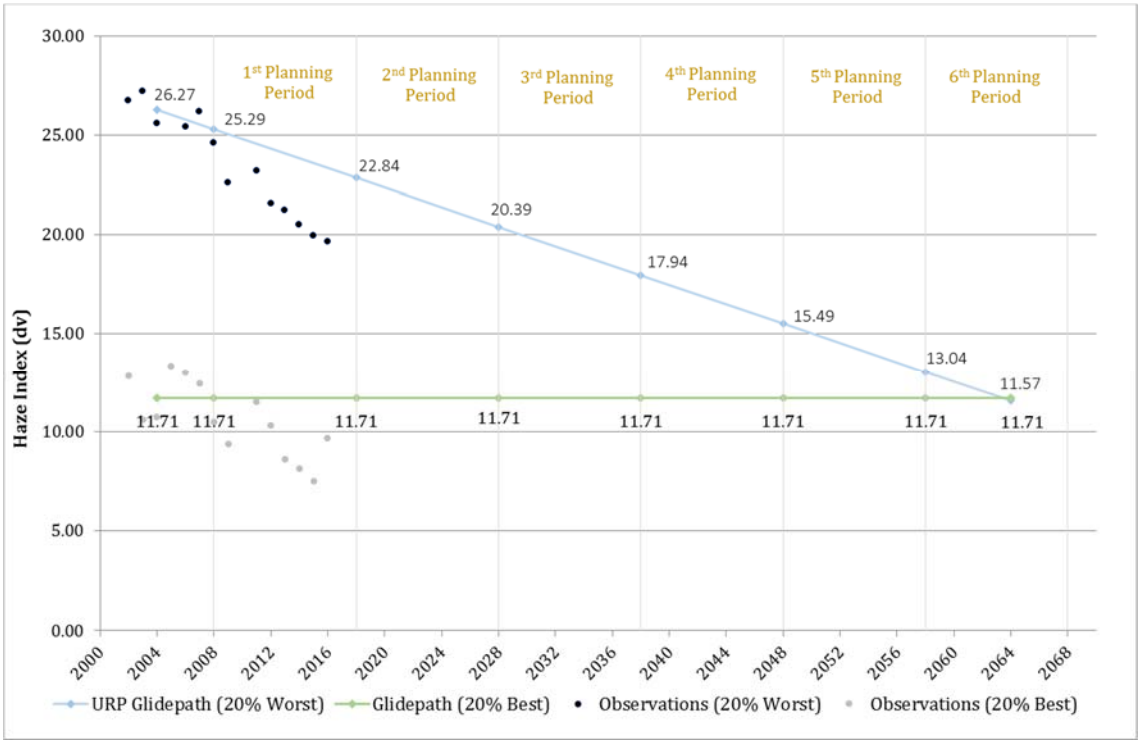


**Figure 5-2. UPBU Monitored Observations Compared to Uniform Rate of Progress**




As seen in the figures above, the actual visibility impairment, measured as the average of the 20 percent worst days each year, at these Class I areas has declined sharply from 2002 through July of 2016 (the most recent available data). According to the monitor data, the current (January through July 2016) observed 20 percent worst days average haze index values are below the URP values for 2018 as well as the 2018 RPG values. Table 5-1 presents a comparison of the 2016 observed values and the 2018 RPG values.

**Table 5-1. 2016 Observed Haze Index Values Compared to 2018 URPs and RPGs**

| Class I Area | Observed 20 Percent Worst Days Average for 2016 (first half year) | RPG for 2018 | Observed Value as % of RPG |
|---|---|---|---|
| CACR | 19.90 | 22.47 | 88.6 % |
| UPBU | 19.67 | 22.51 | 87.4 % |

# 6. REGIONAL HAZE REQUIREMENTS FOR FIRST PLANNING PERIOD

The visibility improvement in the Class I areas that are presented in previous sections of this report have been achieved without installation of any controls for BART or Reasonable Progress at Arkansas' point sources during the time period covered by the visibility index values presented above. Appendix C identifies the emissions control technologies on which the FIP's BART emissions limits are based. To meet the emission limits determined to represent reasonable progress towards the national visibility goal for the first planning period under the FIP, Independence must install $NO_X$ controls by April 27, 2018, and $SO_2$ controls by October 27, 2021.[24] However, these controls are clearly unnecessary to maintain the URP during the first planning period. Visibility improvement is already on an accelerated pace such that the rate of progress towards the national visibility goal exceeds the uniform rate necessary to remedy visibility impairment at CACR and UPBU by 2064. Given the visibility conditions and the Arkansas sources' ongoing environmental compliance strategies across the CAA programs, it should be concluded that no further measures are necessary for Arkansas to make reasonable progress toward the Regional Haze Program national goal in the first planning period.

This conclusion is consistent with EPA's own guidance to the states, which advises a long-term view of reasonable progress: "you should take into account the fact that the long-term goal of no manmade impairment encompasses several planning periods. It is reasonable for you to defer reductions to later planning periods in order to maintain a consistent glidepath toward the long-term goal."[25] Also, "[g]iven the significant emissions reductions that we anticipate to result from BART…and other Clean Air Act programs…it may be all that is necessary to achieve reasonable progress in the first planning period for some States."[26]

Specifically, the Reasonable Progress emission limits in the FIP--which would require the installation of Spray Dry Absorbers (SDA) on EAI's Independence units 1 and 2--are unnecessary for Arkansas to make reasonable progress toward meeting the national goal in the first planning period. EPA's primary justification for proposing Reasonable Progress limits at Independence is that "it would be unreasonable to ignore a source representing more than a third of the State's $SO_2$ emissions and a significant portion of $NO_X$ point source emissions."[27] EPA further supports its conclusion that emission limits based on the installation of major control technology are justified based on a finding that the proposed controls at Independence are cost effective.[28] However, the fact that a source may have significant emissions, or that it would be cost effective to control such

[24] Promulgation of Air Quality Implementation Plans; State of Arkansas; Regional Haze and Interstate Visibility Transport Federal Implementation Plan; Final Rule, 81 Fed. Reg. 66,332 - 66,421 (September 27, 2016). The $SO_2$ compliance date was reiterated by EPA on September 11, 2017, in 82 Fed. Reg. 42,639. EPA proposed to extend the $NO_X$ compliance deadline by 21 months to January 27, 2020, in 82 Fed. Reg. 32,284 (July 13, 2017).

[25] U.S. EPA, *Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program*, June 1, 2007, p. 1-4.

[26] Ibid, p. 4-1.

[27] Promulgation of Air Quality Implementation Plans; State of Arkansas; Regional Haze and Interstate Visibility Transport Federal Implementation Plan; Final Rule, 81 Fed. Reg. 18,992 (September 27, 2016).

[28] Ibid, pp. 18,994-97. As noted in EAI's comments on the Proposed FIP, however, EPA's cost calculations substantially underestimated the costs to install dry scrubbers at Independence and an accurate estimate of the costs would have rendered the controls not cost effective for reasonable progress purposes. Entergy Arkansas, Inc. Comments on the Proposed Regional Haze and Interstate Visibility Transport Federal Implementation Plan for Arkansas, at 44 (Aug. 7, 2015), EPA Docket No. EPA-R06-OAR-2015-0189-0166 ("EAI Comments").

emissions, is irrelevant for Reasonable Progress purposes for the reasons stated above. Moreover, as discussed below, the FIP-required emission limits at Independence--allegedly established to achieve reasonable progress for the first planning period despite that fact that visibility at Arkansas' Class I areas is already better than EPA's own RPGs for that period--are unreasonable in consideration of the four statutory factors for evaluating the feasibility of reasonable progress requirements.[29]

A. **The non-air quality environmental impacts of SDA at Independence.** Non-air quality environmental impacts of SDA primarily relate to available water resources and waste byproducts. SDA systems consume a significant quantity of water, and the required water must be relatively clean. In addition, SDA systems also generate a large waste byproduct stream, containing calcium salts, which must be landfilled. If not fixated during the disposal process, the calcium salts are soluble and may dissolve and appear in the landfill leachate.

B. **The cost of compliance, time necessary for compliance, and remaining useful life (RUL) of the Independence coal units.** As part of resolving the 8th Circuit FIP appeal litigation, Entergy proposes to cease to combust coal at the Independence units by the end of 2030. When the coal units' RUL is properly considered along with the time necessary for compliance with the $SO_2$ emission limit (*e.g*. the 5-year compliance deadline in the FIP), the costs of compliance for each unit are approximately $4,000/ton of $SO_2$ removed according to EPA's own cost estimates.[30] These costs are not reasonable or cost-effective.

   Figure 6-1 presents cost effectiveness values for SDA for the Independence units calculated using the spreadsheet developed by EPA for the FIP[31], revised to reflect a 9-year equipment life. The 9-year life is based on a 2030 date for the end of the coal-burning life and, conservatively, on the FIP's compliance date of 2021.[32]

[29] 42 U.S.C. § 7491(g)(1). EAI asserts that consideration of these factors is not required because no further measures are necessary for Arkansas to make reasonable progress toward the Regional Haze Program national goal during the first planning period. However, without waiver, the four factors are addressed herein to provide a more comprehensive evaluation of reasonable progress for Arkansas' Class I areas.

[30] All cost values in this report are presented solely for the purpose of this report and without waiving previously documented positions regarding proper cost estimating methods and inputs. *See* EAI Comments at 7-11.

[31] "White Bluff_R6 cost revisions2-revised.xlsx" from EPA Docket EPA-R06-OAR-2015-0189-0205. Before revising the equipment life value, the cost effectiveness ($/ton) results matched the values presented in the final FIP: $2,853/ton and $2,634/ton for Unit 1 and Unit 2, respectively.

[32] Considering the current state of the FIP and the replacement SIP that Arkansas is developing, a more realistic compliance date would be 2023 – five years from an anticipated final approval of the SIP in 2018. The five-year compliance timeline is the minimum necessary for engineering, procuring, installing, and commissioning a SDA.

**Figure 6-1. EPA Estimated Cost Effectiveness for SDA for Independence Units 1 and 2, Revised to Consider a Shortened Remaining Useful Life**

| Independence Unit 1 | | |
|---|---|---|
| Item | Corrected White Bluff Cost to 0.68 lbs/MMBtu | Comments |
| Total Annualized Cost | $54,903,656 | Assumed same as White Bluff Unit 1 |
| Interest Rate (%) | 7 | |
| Equipment Lifetime (years) | 9 | |
| Capital Recovery Factor (CRF) | 0.1535 | |
| SO2 Emission Rate (lbs/MMBtu) | 0.63 | Max monthly value from 2009-2013 for Unit 1 |
| Controlled SO2 Emission Rate (%) | 90.49 | Assume 95%. If outlet < 0.06 lbs/MMBtu, then assume % control for 0.06 lbs/MMBtu. |
| SO2 Emission Baseline (tons) | 14,269 | 3 -yr avg. 2009-2013 for Unit 1, excluding max and min |
| SO2 Emission Reduction (tons) | 12,912 | |
| Cost Effectiveness ($/ton) | $4,252 | |

| Independence Unit 2 | | |
|---|---|---|
| Item | Corrected White Bluff Cost to 0.68 lbs/MMBtu | Comments |
| Total Annualized Cost | $54,903,656 | Assumed same as White Bluff Unit 1 |
| Interest Rate (%) | 7 | |
| Equipment Lifetime (years) | 9 | |
| Capital Recovery Factor (CRF) | 0.1535 | |
| SO2 Emission Rate (lbs/MMBtu) | 0.61 | Max monthly value from 2009-2013 for Unit 2 |
| Controlled SO2 Emission Rate (%) | 90.19 | Assume 95%. If outlet < 0.06 lbs/MMBtu, then assume % control for 0.06 lbs/MMBtu. |
| SO2 Emission Baseline (tons) | 15,511 | 3 -yr avg. 2009-2013 for Unit 2, excluding max and min |
| SO2 Emission Reduction (tons) | 13,990 | |
| Cost Effectiveness ($/ton) | $3,925 | |

(red text reflects revised equipment life values; no other inputs or equations/cell-references were changed; yellow-highlighting is original to EPA's spreadsheet;)

**A. The minimal contribution that the Independence units – and Arkansas point sources in general – have on visibility impacts in the Class I areas.** As documented in EAI's comments on the proposed FIP[33] and further explained in Appendix A to this report, the emissions from Independence are one of many factors contributing to haze at Arkansas' Class I areas but have only a minimal impact on visibility impairment. Therefore, emissions controls at Independence would have no discernable impact on visibility.

[33] *See* EAI Comments at 17-43.

# 7. LONG TERM STRATEGY CONSIDERATIONS

Visibility impairment has steadily declined throughout the first planning period. The reductions in visibility-impairing emissions have occurred across nearly the entire spectrum of source types – from point sources to areas sources and mobile sources. It is expected that further improvements will be more difficult as visibility impairment values move closer to natural conditions. For example, the difficulty of even quantifying improvements from area sources was recognized by EPA when it agreed not to evaluate such sources for Reasonable Progress controls in the first planning period.[34] As documented in Appendix A, the single largest source type influencing Arkansas' share of the contribution to visibility impairment is area sources (not point sources like Independence). However, planned emissions decreases, e.g., resulting from the implementation of CSAPR and the increasingly more stringent National Ambient Air Quality Standards (NAAQS)[35], should cause visibility impairment to continue to decline. The cessation of coal usage at both White Bluff in 2028 and at Independence in 2030 will supplement these decreases.

[34] Approval and Promulgation of Implementation Plans; Arkansas; Approval of Regional Haze State Implementation Plan Revision and Withdrawal of Federal Implementation Plan for $NO_X$ for Electric Generating Units in Arkansas; Proposed Rule, 82 Fed. Reg. 42,632 (September 11, 2017).

[35] The Arkansas Department of Environmental Quality (ADEQ), in consultation with Federal Land Managers and other states, addressed additional ongoing air pollution control programs as well as mitigation of construction activities, source retirements/replacements, smoke management, and other visibility-affecting measures related to all sources – major and minor stationary sources, mobile sources, and area sources – as part of its Long Term Strategy in its September 9, 2008 *State of Arkansas Regional Haze Rule State Implementation Plan.*

# APPENDIX A: ANALYSIS OF SOURCE CATEGORY AND SOURCE-SPECIFIC CONTRIBUTIONS TO CLASS I AREA VISIBILITY IMPACTS

*All data presented in this Appendix were extracted from the modeled source apportionment extinction data from the Central Regional Air Planning Association (CENRAP) Particulate Matter Source Apportionment Technique (PSAT) tool. The data were organized by geographic region and source category, so that the individual contribution of each source category in each geographic region could be determined.*

EPA's Reasonable Progress analysis primarily focused on point source contributions to light extinction at CACR and UPBU. As a result, EPA chose to limit its evaluation of potential Reasonable Progress controls solely to Arkansas' largest emitting point sources - specifically, to Independence. However, Arkansas point sources are relatively insignificant contributors to visibility impairment in CACR and UPBU compared to most of the other regions modeled by CENRAP and are not even the biggest source group contributor in Arkansas to visibility impairment in these Class I areas.

Figures A-1 and A-2 display the modeled percent contribution of elevated and low-level point sources to the total light extinction at CACR and UPBU from the significantly contributing geographic regions.[36] Also included in these figures is the combined total percentage contribution from all point sources in all geographic regions. As shown in the CACR figure, of a total point source contribution of 61.85 percent at CACR in 2002, Arkansas's point sources contributed only 2.87 percent, making Arkansas point sources only the eighth highest point source contributor. Similarly, of the 60.35 percent total point source contribution at UPBU in 2002, Arkansas point sources were the ninth highest point source contributor with only a 2.47 percent contribution.

[36] These figures were originally presented as Figure 3 and Figure 4 in Entergy Arkansas Inc., *Comments On the Proposed Regional Haze and Interstate Visibility Transport Federal Implementation Plan for Arkansas*, Docket No. EPA-R06-OAR-2015-0189, August 7, 2015.

**Figure A-1. Regional Point Source Percentage of Total Extinction at CACR (20 Percent Worst, 2002)**

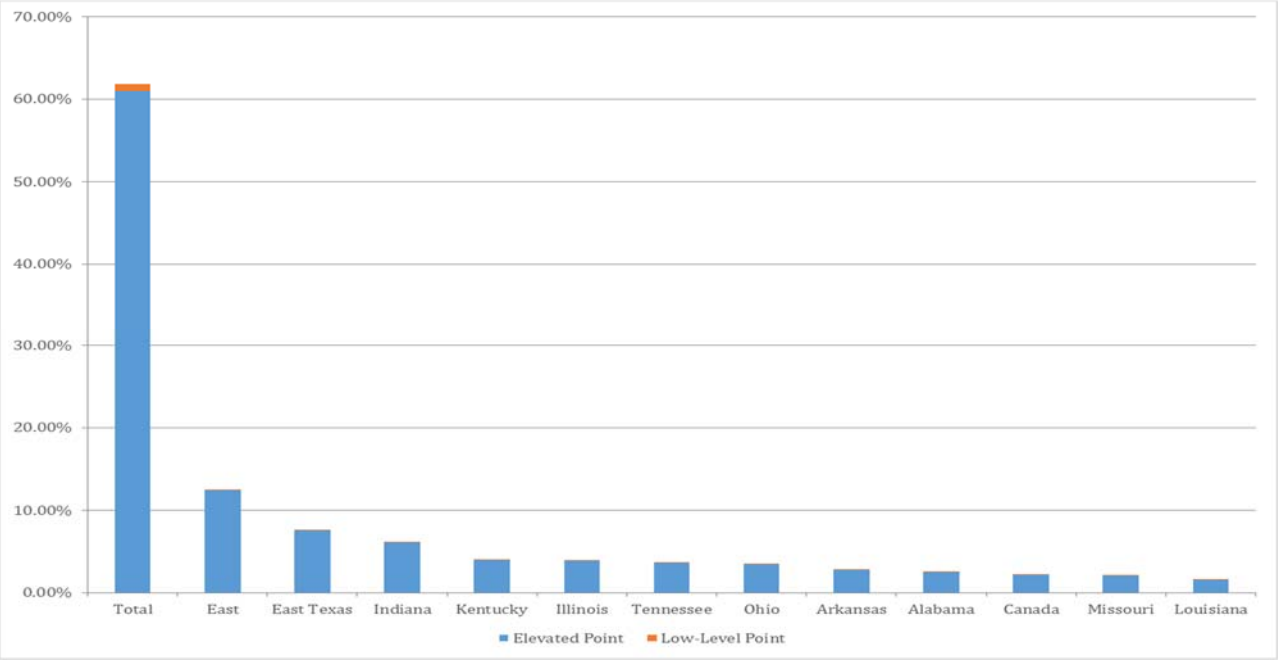
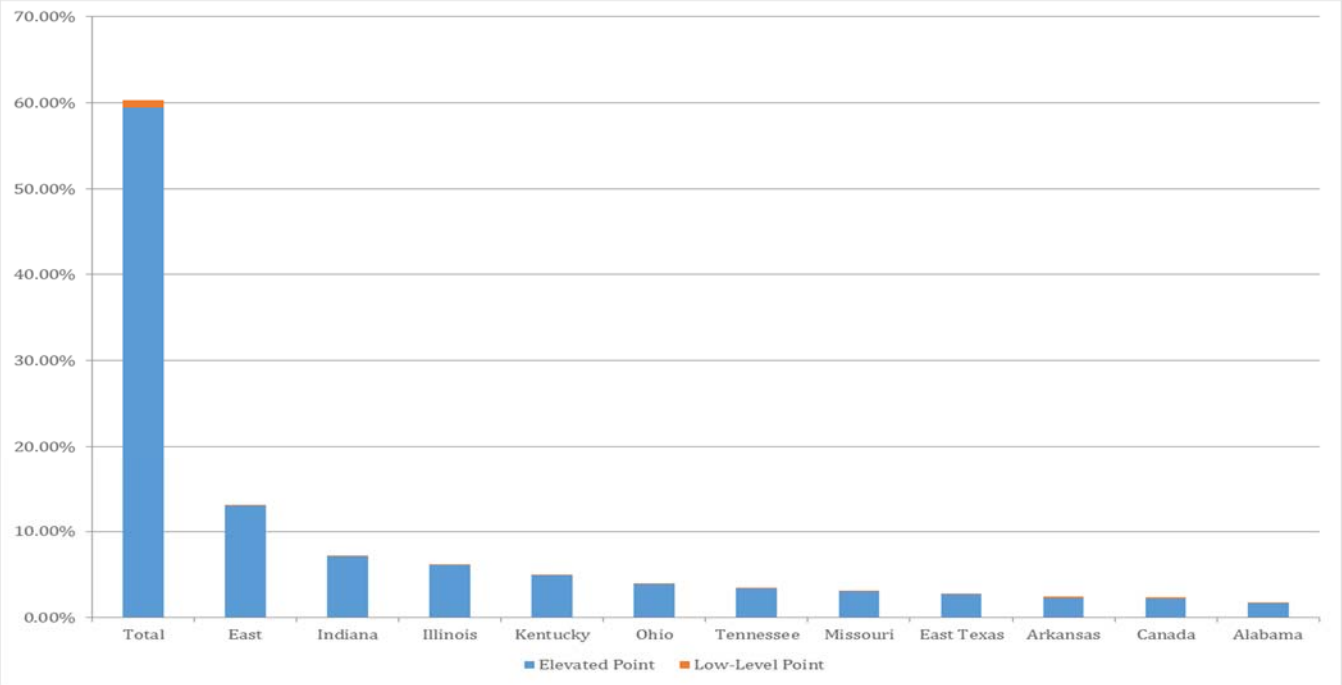



**Figure A-2. Regional Point Source Percentage of Total Extinction at UPBU (20 Percent Worst, 2002)**




In addition, as demonstrated in Figures A-3 and A-4 below, most of Arkansas' share of the contribution to visibility impairment comes from area and mobile sources, not point sources.[37] At

[37] These figures were originally presented as Figure 5 and Figure 6 in Entergy Arkansas Inc., *Comments On the Proposed Regional Haze and Interstate Visibility Transport Federal Implementation Plan for Arkansas*, Docket No. EPA-R06-OAR-2015-0189, August 7, 2015.

CACR, Arkansas area sources contribute 3.75 percent of the overall extinction and Arkansas' combined point source category (*i.e.*, elevated and low-level point sources) contributes only 2.87 percent. Even more significantly, Arkansas area sources contributed 5.09 percent towards extinction at UPBU compared to 2.47 percent from the combined Arkansas point sources.

**Figure A-3. Regional Percentage of Total Extinction at CACR (20 Percent Worst, 2002)**

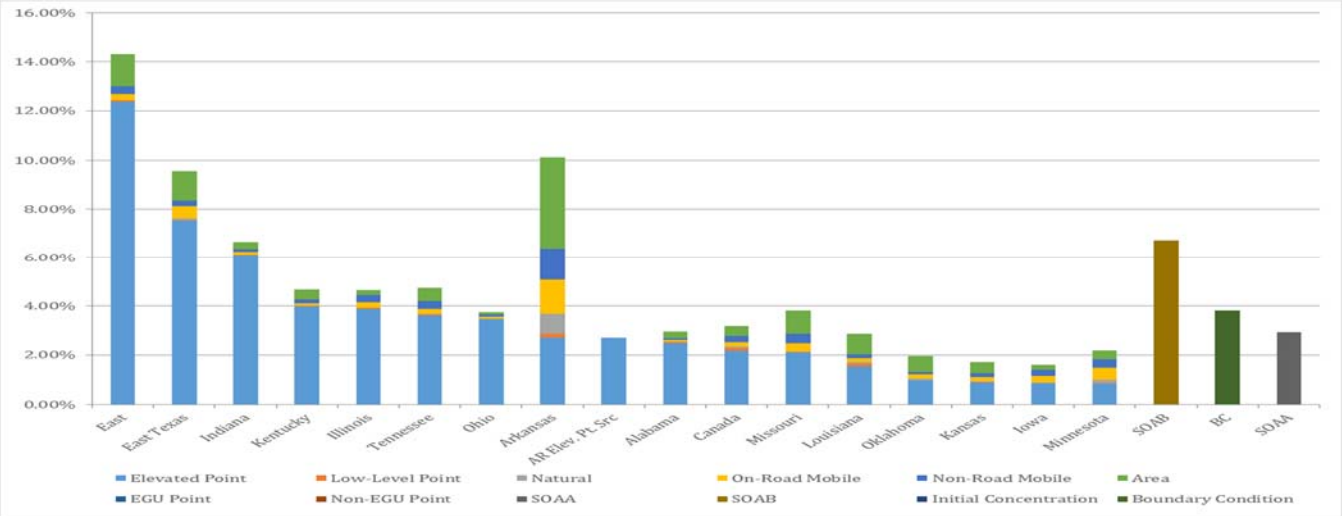
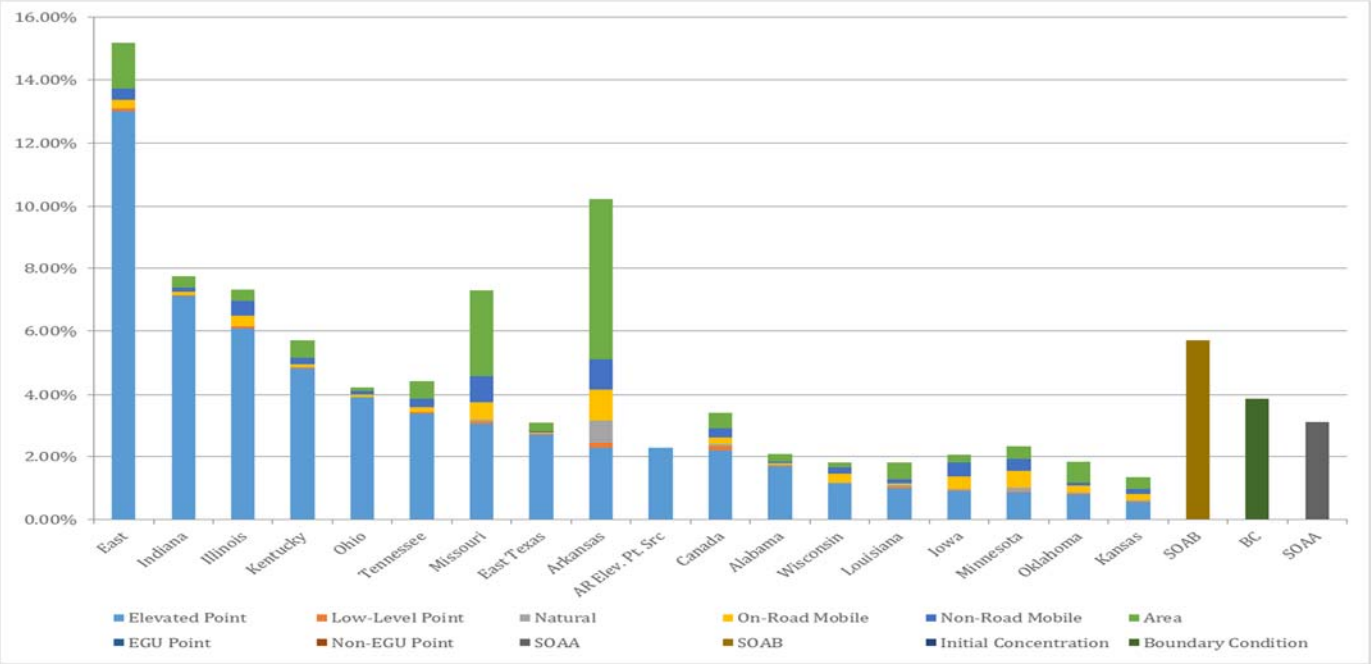



**Figure A-4. Regional Percentage of Total Extinction at UPBU (20 Percent Worst, 2002)**




On a source-specific (Independence-only) basis, the contribution is even smaller. CENRAP's predictive modeling demonstrates that sulfate from all (elevated and low level) Arkansas point sources is responsible for 3.58 percent of the total light extinction at CACR and 3.20 percent at UPBU; and nitrate from Arkansas point sources is responsible for 0.29 percent of the total light

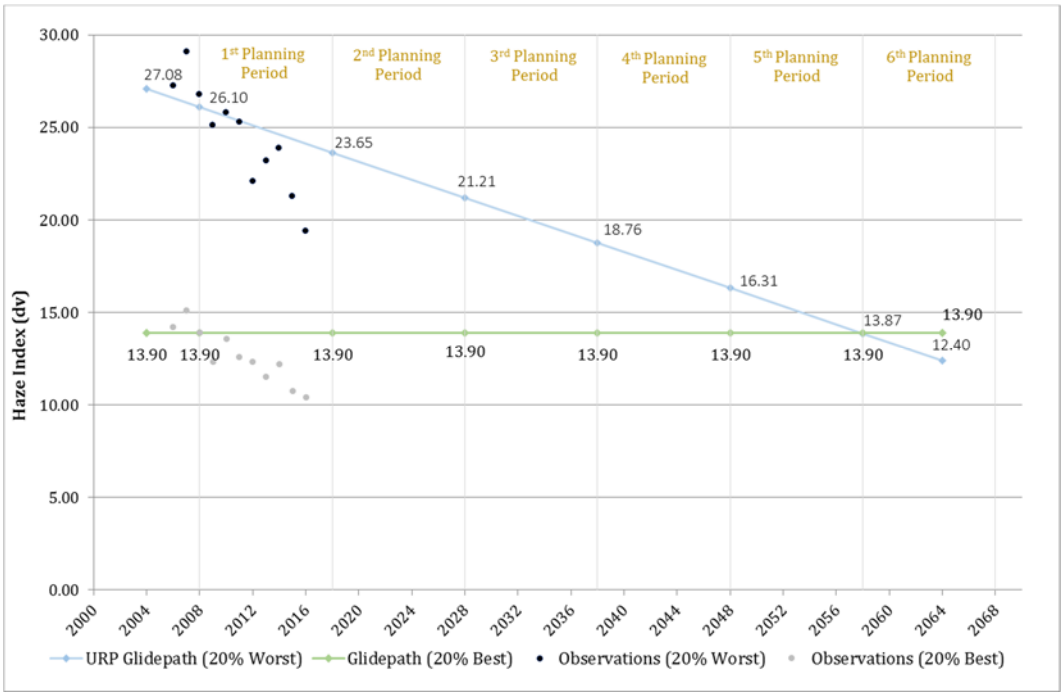
extinction at CACR and 0.25 percent at UPBU.[38] The Independence units' share of emissions to this minimal contribution from Arkansas point sources to visibility impairment is even less. EAI and Trinity submitted CAMx modeling showing that the contribution to visibility impairment by Independence is less than one half of one percent of the visibility impairment in both Arkansas Class I areas.[39]

[38] Promulgation of Air Quality Implementation Plans; State of Arkansas; Regional Haze and Interstate Visibility Transport Federal Implementation Plan; Final Rule, 81 Fed. Reg. 18,990 (September 27, 2016).

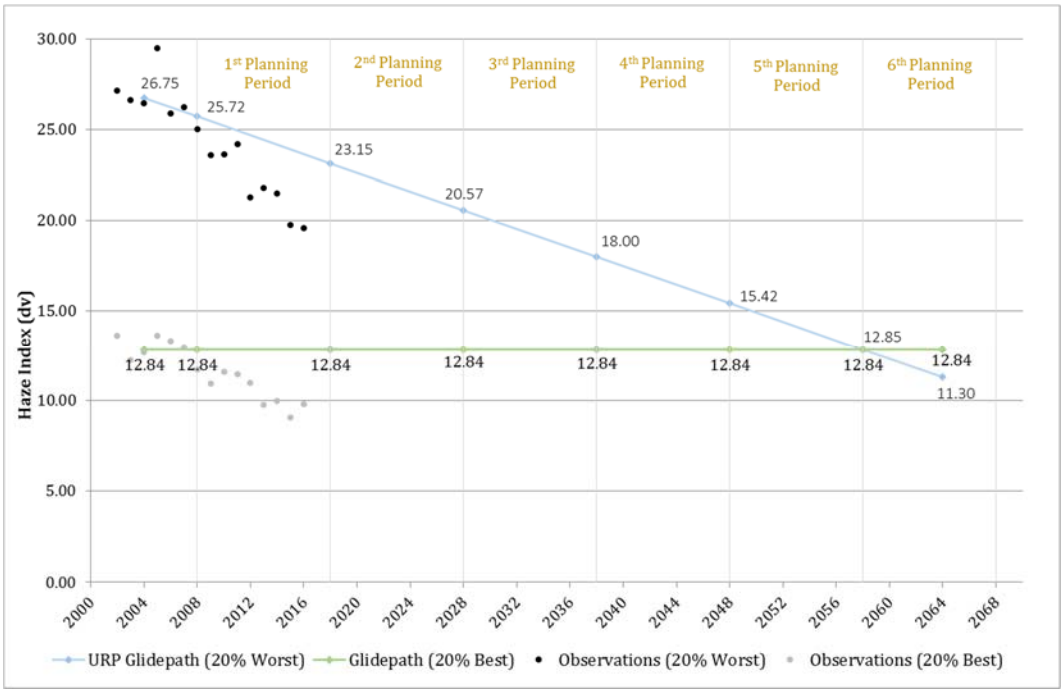
[39] Entergy Arkansas Inc., *Comments On the Proposed Regional Haze and Interstate Visibility Transport Federal Implementation Plan for Arkansas*, Docket No. EPA-R06-OAR-2015-0189, August 7, 2015.

# APPENDIX B: OBSERVATIONS COMPARED TO UNIFORM RATES OF PROGRESS FOR MISSOURI'S CLASS I AREAS

## Figure B-1. MING Monitored Observations Compared to Uniform Rate of Progress




## Figure B-2. HEGL Monitored Observations Compared to Uniform Rate of Progress



# APPENDIX C: CONTROLS ON WHICH THE BART EMISSIONS LIMITS ARE BASED

The FIP's BART emission limits are based on the following emissions control technologies:[40]

| Company | Facility | Unit | Controls | Compliance Deadline |
|---|---|---|---|---|
| AEP/SWEPCO | Flint Creek | 1 | Novel Integrated Desulfurization (NID) | April 27, 2018 |
| | | | Low $NO_X$ Burners & Over Fire Air (LNB/OFA) | April 27, 2018 |
| AECC | Bailey | 1 | Fuel sulfur content limit | October 27, 2021 |
| AECC | McClellan | 1 | Fuel sulfur content limit | October 27, 2021 |
| EAI | White Bluff | 1 | Spray Dry Absorber (SDA) | October 27, 2021 |
| | | | LNB/OFA | April 27, 2018 |
| | | 2 | SDA | October 27, 2021 |
| | | | LNB/OFA | April 27, 2018 |
| EAI | Lake Catherine | 4 | Burners Out Of Service (BOOS) | October 27, 2019 |
| Domtar | Ashdown | Boiler 2 | Additional scrubbing reagent | October 27, 2021 |
| | | | LNB | October 27, 2021 |

[40] Promulgation of Air Quality Implementation Plans; State of Arkansas; Regional Haze and Interstate Visibility Transport Federal Implementation Plan; Final Rule, 81 Fed. Reg. 66,332 - 66,421 (September 27, 2016).