PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

PERMIT SUMMARY SHEET

Permit No.: 0670173 C-12721

Source Name: Mid-Kansas Electric Company, LLC

Source Location: Northwest Quarter of Section 1, Township 29 South, Range 35 West
Grant County, Kansas

I. Area Designation

K.A.R. 28-19-350, Prevention of significant deterioration of air quality, affects new major sources and major modifications to major sources in areas designated as "attainment" or "unclassifiable" under section 107 of the Clean Air Act (CAA) for any criteria pollutant. Grant County, Kansas, where this construction is taking place, is in attainment for all the criteria pollutants.

II. Project Description

Mid-Kansas Electric Company, LLC (Mid-Kansas) plans to install 24 new spark ignition Caterpillar four stroke lean burn reciprocating internal combustion engine electricity generating units (EGUs) using pipeline quality natural gas at a new green-field site to be known as Rubart Station. The proposed facility will be located approximately 14 miles east of Ulysses, Kansas. Each EGU will be nominally rated at 10 megawatts (MW) of electricity for a combined power output of approximately 240 MW. The facility will also include two 450-kW pipeline quality natural gas fired emergency AC generators, a 190-HP diesel-fueled emergency fire pump, a 2 mmBtu/hr natural gas fired indirect fuel gas heater, twelve circuit breakers, and four circuit switchers. Sunflower Electric Power Corporation (Sunflower), on behalf of Mid-Kansas, will operate the generating units and the ancillary facilities and auxiliary equipment that will support the generating units to be constructed under this permit (the Project).

The Prevention of Significant Deterioration (PSD) air permit (Source ID 0670173) was issued to Mid-Kansas Electric Company, LLC (Mid-Kansas Electric) for Rubart Station on January 28, 2013. Twelve of the EGUs were constructed and began operation in 2014. In September and November 2014, stack testing was performed as required in the PSD permit. The testing showed that the EGUs could not meet the filterable particulate matter (PM) limit. After reviewing data for these and other engines, the BACT-based emission limitation for PM has been revised. This permit revision includes only correction of administrative errors in the permit, a PM BACT revision, and clarification of performance testing requirements.

III. **Significant Applicable Air Emission Regulations**

This source is subject to Kansas Administrative Regulations relating to air pollution control. The application for this permit was reviewed and will be evaluated for compliance with the following applicable regulations:

A. K.A.R. 28-19-300. Construction Permits and Approvals. “Any person who proposes to construct or modify a stationary source or emissions unit shall obtain a construction permit before commencing such construction or modification.”

B. K.A.R. 28-19-350 Prevention of significant deterioration of air quality. "The provisions of K.A.R. 28-19-350 shall apply to the construction of major stationary sources and major modifications of major stationary sources in the areas of the state designated as an attainment area or an unclassified area for any pollutant under the procedures prescribed by section 107(d) of the federal clean air act (42 U.S.C. 7407 (d))."

C. K.A.R. 28-19-720 New Source Performance Standards, which adopts by reference 40 CFR Part 60. The EGUs and two spark ignition emergency AC generators are subject to 40 CFR Part 60 Subpart JJJJ, Standards of Performance for Stationary Spark Ignition Internal Combustion Engines. The emergency fire pump is subject to 40 CFR Part 60 Subpart IIII, Standards of Performance for Compression Ignition Internal Combustion Engines.

D. K.A.R. 28-19-750 Maximum Achievable Control Technology, which adopts by reference 40 CFR Part 63. The EGUs, two emergency AC generators, and emergency fire pump are subject to 40 CFR Part 63 Subpart ZZZZ, National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines.

IV. **Air Emissions from the Project:**

Emissions of NO_x, CO, SO_2, VOC, PM, PM_{10}, $PM_{2.5}$, GHGs, sulfuric acid mist, lead and hazardous air pollutants (HAPs) from the project were evaluated The potential to emit GHGs, NO_x, CO, VOC, PM, PM_{10}, and $PM_{2.5}$ from this project exceed major source thresholds under 40 CFR 52.21, which is adopted by reference in K.A.R. 28-19-350. The potential-to-emit from the project is listed in Table 3-1 and Appendix C of the permit application. Emissions of SO_2, sulfuric acid mist, and lead were below the PSD significant emission thresholds.

Table 1 contains the potential to emit (PTE) for air pollutants to be emitted from the proposed Project:

Table 1. Estimated Emissions	
Pollutant	**Potential-to-emit (PTE)[1] (tons per year)**
NO_X [2]	400.6
CO	897.2
SO_2	14.6
VOC[2]	684.7
PM	26.3
PM_{10} and $PM_{2.5}$	151.2
Lead	4.3×10^{-6}
H_2SO_4	2.2
Total HAPs	483.3
Individual Hazardous Air Pollutants (HAPs)[3] -Formaldehyde -Acetaldehyde -Acrolein	 225.0 144.5 89.4
Carbon Dioxide Equivalent (CO_2e) Greenhouse Gases (GHG)[4]: -Carbon Dioxide (CO_2) -Methane (CH_4) -Nitrous Oxide (N_2O) -Sulfur Hexafluoride (SF_6)	1,194,003.4 1,192,849.3 433.9 675.6 44.7

[1] Potential-to-emit (PTE) means the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable.

[2] NO_X and VOC emissions for the Project exceed the 40 tons significance threshold. Therefore pursuant to 40 CFR 52.21, the Project is also significant for O_3. Since NO_X and VOCs are surrogates for O_3, BACT for NO_X and VOC will be considered BACT for O_3.

[3] Only the three individual HAPs with the largest PTE have been listed, which account for 95% of total HAPs. For detailed HAPs PTE estimates, which include all HAPs, refer to the permit application submitted July 10, 2012, Appendix C.

[4] CO_2 based emissions.

Emissions of the EGUs are discussed in Section 3.2.1 of the permit application submitted July 9, 2012 by email (hard copy on July 10). Emissions were analyzed at 50, 75, 85, and 100 percent load. An analysis with 25 percent load condition was submitted July 16, 2012. Startup emissions were based on a length of 30 minutes per startup, and 1095 startups per engine per year. Except as specified, emissions estimates are based on the vendor's guaranteed emission rates with specified emission controls. PM emission estimates, for the purposes of this permit, are based on filterable particulate only. This is consistent with the definition KDHE is currently in the process of adopting. 40 CFR 52.21, as revised on July 1, 2011 and as amended by 76 Federal Register 43507 (2011) and 77 Federal Register 65118 – 65119 (2012), is being adopted by reference, except as specified in paragraph (b)(2). PM emissions estimates were submitted by email on December 5, 2012. PM_{10} and $PM_{2.5}$ include both filterable and condensable particulate matter. SO_2 emissions are based on the sulfur content of pipeline quality natural gas. GHG emissions are based on vendor data for CO_2, methane, and nitrous oxide and were calculated using 40 CFR Part 98 emission factors, the appropriate CO_2 equivalency ratio applied, and summed to obtain total GHGs, or CO_2e. Startup emissions for the EGUs are based on the manufacturer's startup profile, three startups per 24-hour period per engine, and 1,095 startup events per year per engine.

Appendix C and Sections 3.2.4 through 3.2.7 discuss emission estimates for other facility emission units. The emissions from the fuel gas heater were calculated using AP-42 emission factors. Emissions from the emergency fire pump are based on the NSPS emission rates for PM, PM_{10}, and $PM_{2.5}$. Emissions for other pollutants are based on AP-42 emission factors. GHG emission factors from the EPA Mandatory Greenhouse Gas Reporting Rule (40 CFR Part 98) are used to estimate GHG emissions.

The potential to emit GHGs, NO_x, CO, VOC, PM, PM_{10}, and $PM_{2.5}$ from this project exceed major source and/or significant emission thresholds under K.A.R. 28-19-350. NO_x and VOC emissions for the Project exceed the significance threshold. Therefore pursuant to 40 CFR 52.21, the Project is also significant for ozone (O_3). Since NO_x and VOCs are surrogates for O_3, BACT for NO_X and VOC will be considered BACT for O_3. This project will be subject to the various aspects of K.A.R. 28-19-350, such as the use of best available control technology, ambient air quality analysis, and additional impacts upon soils, vegetation and visibility.

V. Best Available Control Technology (BACT)

BACT requirements apply to each new emissions unit and pollutant emitting activity. Also, individual BACT determinations are performed for each pollutant emitted from each emission unit. Consequently, the BACT determination must separately address, for each regulated pollutant with a significant emissions increase at the source, air pollution controls for each emissions unit or pollutant emitting activity subject to review. The facility was required to prepare a BACT analysis for KDHE's review according to the process described in Attachment A. KDHE's evaluation of the BACT for NO_x, CO, VOC, PM, PM_{10}, $PM_{2.5}$ for the 24 EGUs, the two 450-kW pipeline quality natural gas fired emergency AC generators, the 190-HP diesel-fueled emergency fire pump, and the 2 mmBtu/hr natural gas fired indirect fuel gas heater is presented in Attachment B. KDHE's evaluation of the BACT for greenhouse gases for the same emission units, as well as circuit breakers and switchers, is presented in Attachment C.

In short, KDHE has concurred with the facility's BACT analysis, and has required the following in the permit:

A. The emission of pollutants from each EGU shall be no greater than the specified limitations listed below. 40 CFR Part 60 Subpart JJJJ requirements are included in a separate section of the permit as applicable. A violation of a BACT limitation is not necessarily a violation of an NSPS limitation. NSPS limitations are not applicable during startup, shutdown, or malfunction. For the purpose of BACT emission limits, startup means the time from initial start until 30 minutes has elapsed.

1. The BACT emissions of NO_x shall not exceed 2.13 lb/hour at all times except during startup (one hour averaging period). This limitation is less than the NSPS limitation of 1.0 g/hp-hour (approximately 29.6 lb/hour at 100% load) and the NSPS limitation is therefore subsumed in the BACT emission limit.

2. The BACT emissions of CO shall not exceed 3.86 lb/hour at all times except during startup (one hour averaging period). This limitation is less than the NSPS limitation of 2.0 g/hp-hour (approximately 59.1 lb/hour at 100% load) and the NSPS limitation is therefore subsumed in the BACT emission limit.

3. The BACT emissions of VOC shall not exceed 5.82 lb/hour at all times except during startup (one hour averaging period). This limitation is less than the NSPS limitation of 0.7 g/hp-hour (approximately 20.7 lb/hour at 100% load) and the NSPS limitation is therefore subsumed in the BACT emission limit.

4. This requirement has been removed.

5. The BACT emissions of PM[5] PM_{10}[6] and $PM_{2.5}$[7] shall not exceed 1.31 lb/hour at all times except during startup (24-hour averaging period).

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[5] The term "PM" as used in this permit means that particulate matter (existing as a solid) emitted by a source that can be quantified by analysis under US EPA approved Reference Method 5 as set forth in Appendix A of 40 CFR Part 60.

6. The BACT emissions of CO_2e shall not exceed 10,692 lb/hour at all times except during startup (annual averaging period).

7. The BACT emission of NO_x shall not exceed 14.41 lb/hour during startup (one hour averaging period).

8. The BACT emission of CO shall not exceed 39.23 lb/hour during startup (one hour averaging period).

9. The BACT emission of VOCs shall not exceed 8.44 lb/hour during startup (one hour averaging period).

10. The BACT emission of PM, PM_{10} and $PM_{2.5}$ shall not exceed 1.68 lb/hour during startup (24-hour averaging period).

11. The BACT emission of CO_2e shall not exceed 10,476 lb/hour during startup (annual averaging period).

B. The BACT emission of pollutants from each of the Emergency AC generators shall be no greater than limitations specified below, excluding periods of startup, shutdown, and malfunction.

1. The BACT emissions of NO_x shall not exceed 2.0 g/hp-hr.

2. The BACT emissions of CO shall not exceed 4.0 g/hp-hr.

3. The BACT emissions of VOC shall not exceed 1.0 g/hp-hr.

4. The BACT emissions of PM, PM_{10}, and $PM_{2.5}$ shall not exceed 7.6E-5 g/hp-hr.

5. BACT for CO_2e shall be combustion control.

C. The BACT emission of pollutants from the Emergency Fire Pump shall be no greater than limitations specified below, excluding periods of startup, shutdown, and malfunction.

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[6] The term "PM_{10}" as used in this permit means that particulate matter (existing as solid, liquid, and gaseous form) emitted by a source that can be quantified by analysis either by EPA-approved Reference Methods 5 and 202 or by Methods 201A and 202 (with appropriate cyclone-sizing devices appropriate for quantification of PM_{10}), or other such EPA approved test methods.

[7] The term "$PM_{2.5}$" as used in this permit means that particulate matter (existing as solid, liquid, and gaseous form) emitted by a source that can be quantified by analysis either by EPA approved Reference Methods 5 and 202 or by Methods 201A and 202 (with appropriate cyclone sizing devices appropriate for the quantification of $PM_{2.5}$) or other such EPA approved test methods.

1. The BACT emissions of NO_x shall not exceed 3.0 g/hp-hr.

2. The BACT emissions of CO shall not exceed 2.6 g/hp-hr.

3. The BACT emissions of VOC shall not exceed 1.14 g/hp-hr.

4. The BACT emissions of PM, PM_{10}, and $PM_{2.5}$ shall not exceed 0.15 g/hp-hr.

5. BACT for CO_2e shall be selection of the most efficient engines that meet the facility's needs.

D. The BACT emissions of pollutants from the indirect fuel gas heater shall be no greater than limitations specified below, excluding periods of startup, shutdown, and malfunction.

1. The BACT emissions of NO_x shall not exceed 0.20 lb/hr.

2. The BACT emissions of CO shall not exceed 0.16 lb/hr.

3. The BACT emissions of VOC shall not exceed 0.11 lb/hr.

4. The BACT emissions of PM, PM_{10}, and $PM_{2.5}$ shall not exceed 0.015 lb/hr.

5. BACT for CO_2e shall be use of clean fuels, maintaining, and tuning the heater.

VI. Ambient Air Impact Analysis

The owner or operator of a proposed source or modification must demonstrate that allowable emission increases from the proposed source, in conjunction with all other applicable emissions increases or reductions, would not cause or contribute to air pollution in violation of:

A. any national ambient air quality standard (NAAQS) in any air quality control region; or

B. any applicable maximum allowable increase over the baseline concentration in any area.

The AERMOD modeling system Version 12060 was used to determine the maximum predicted ground-level concentration for each pollutant and applicable averaging period resulting from various operating loads.

The emission rates, point locations, and stack parameters for the emission sources used in the model were based on the data presented in the permit application received by KDHE on July 10, 2012 and addendum received on July 16, 2012 for the 25% load modeling scenario. Five (5) years of meteorological data from 2006-2010, surface and upper air, from Garden City and Dodge City, respectively, were used in the modeling.

In order to determine if a full impact (refined) modeling analysis and/or ambient air monitoring is necessary, a preliminary modeling analysis is first conducted. The preliminary analysis included only the proposed Rubart Station sources to determine if a modeled high first high (HIH) impact (or concentration) will exceed the Significant Impact Level (SIL) thresholds. For each pollutant and averaging time that the modeled HIH concentration is below the SIL threshold, no further analysis is necessary for that particular pollutant and averaging time. The preliminary/significance modeling results are shown in Table 2.

Table 2. Preliminary/Significance Modeling Results

Pollutant	**Averaging Period**	**Modeled Concentration (High First High, H1H) (μg/m^3)**	**Modeling Significant Impact Level (SIL) (μg/m^3)**	**Exceeds SIL?**	**Pre-application Monitoring Threshold Concentration (μg/m^3)**	**Exceeds Monitoring Threshold?**
NO_2	Annual	**1.50**	**1**	**Yes**	14	No
	1-hour	**134.14**[8]	**10**[9]	**Yes**	N/A	N/A
CO	1-hour	611.90	2000	No	N/A	N/A
	8-hour	475.30	500	No	575	No
$PM_{2.5}$	Annual	**0.84**	**0.3**	**Yes**	N/A	N/A
	24-hour	**11.30**	**1.2**	**Yes**	**4**	**Yes**
PM_{10}	Annual	0.84	1	No	N/A	N/A
	24-hour	**11.30**	**5**	**Yes**	**10**	**Yes**

The modeled H1H impacts of annual NO_2, 1-hour NO_2, annual $PM_{2.5}$, 24-hour $PM_{2.5,}$ and 24-hour PM_{10} exceed the SIL thresholds. Therefore, full impact (refined) modeling analyses are required for these pollutants and averaging times.

[8] The 1-hour NO_2 modeled impact from KDHE's modeling run was considered since it is higher (approximately 42 μg/m^3 higher) compared with Mid-Kansas' result.
[9] Interim SIL established by KDHE until EPA publishes a final SIL. The current EPA recommended SIL is 7.5 μg/m^3.

The modeled H1H impacts of 1-hour CO, 8-hour CO, and annual PM_{10} fall below SIL thresholds. Therefore, full impact (refined) modeling analyses are not required for these pollutants and averaging times.

The project exceeds preconstruction monitoring thresholds for 24-hour $PM_{2.5}$ and 24-hour PM_{10} averaging periods. KDHE has approved the use of existing monitoring in the region to satisfy the requirement for preconstruction monitoring. Update 1/28/2013: EPA's preconstruction monitoring threshold for $PM_{2.5}$ was vacated January 22, 2013 by the US Court of Appeals DC Circuit. Since the facility exceeded the threshold and KDHE has approved the use of existing monitoring, no change was needed as a result of this vacature.

Refined (cumulative) modeling was conducted to demonstrate compliance with the NAAQS for each pollutant and averaging period for which the SIL was exceeded. Evaluation of compliance with the NAAQS requires that the refined modeling accounts for the combined impact of the proposed project, nearby sources, and background concentrations.

Table 3 shows the radius of impact (ROI), the receptor grid size, and the nearby sources used in the refined/NAAQS modeling analysis. The significant impact area (SIA) for the 1-hour NO_2 averaging period exceeded beyond the 10 km by 10 km Cartesian receptor grid used, therefore, the receptor grid was extended to a 50 km by 50 km receptor grid for NAAQS modeling. Nearby NO_2 sources within 20 km from the center of the facility were included in the 1-hour NO_2 NAAQS modeling.

Table 3. Radius of Impact (ROI), Receptor Grid Size, Radius Selected (km) for Nearby Sources, and Number of Nearby Sources Used in the Refined/NAAQS Modeling Analysis

Pollutant	ROI (km)	Receptor grid size	Radius selected for nearby sources from center of the facility (km)	Number of nearby sources
1-hour NO_2	50	50 km by 50 km grid	20	120
Annual NO_2	10	10 km by 10 km grid	50	318
24-hour $PM_{2.5}$	10	10 km by 10 km grid	20	5
Annual $PM_{2.5}$	10	10 km by 10 km grid	50	54
24-hour PM_{10}	10	10 km by 10 km grid	20	5

The March 1, 2011 EPA Memorandum by Tyler Fox (Subject: Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard) recommends including nearby sources within about 10 km of the project location for the 1-hour NO_2 NAAQS modeling. KDHE typically uses a radius of 20 km to select nearby sources for short term standards (e.g., 1-hour standards and 24-hour standards) for NAAQS modeling. If a large source outside this radius is identified and is expected to cause a significant concentration gradient in the vicinity of the proposed source, it may also be included. For long-term standards (e.g. annual standards), KDHE used a radius of 50 km to select nearby sources for NAAQS modeling using AERMOD.

Table 4 shows the NAAQS refined modeling results.

Table 4. NAAQS Refined Modeling Results

Pollutant	Averaging period	Modeled concentration ($\mu g/m^3$)[10]		Background concentration ($\mu g/m^3$)	Total concentration ($\mu g/m^3$)	NAAQS Standard ($\mu g/m^3$)
NO_2	1-hour	**327.33** [11]	H8H	49.00	**347.0**	**188.70**
	Annual	14.40	H1H	7.50	21.90	100.00
$PM_{2.5}$	24-hour	10.90	H1H	17.00	27.90	35.00
	Annual	1.50	H1H	7.00	8.50	15.00
PM_{10}	24-hour	10.40	H6H	89.00	99.40	150.00

There are 91 receptors with modeled impacts that exceed the 1-hour NO_2 NAAQS. Further analysis demonstrated that the proposed Rubart Station is not a significant contributor to these 91 receptors. Therefore, the proposed Rubart Station does not cause or significantly contribute to a violation of any NAAQS.

There are no modeled NAAQS exceedances for annual NO_2, 24-hour $PM_{2.5}$, annual $PM_{2.5}$, and 24-hour PM_{10} averaging periods.

PSD increment is the maximum allowable increase in concentration that is allowed to occur above a baseline concentration for a pollutant. Significant deterioration in air quality is said to occur when the amount of new pollution would exceed the applicable PSD increment.[12]

To determine the PSD increment consumption (or expansion) in a PSD area, a PSD increment inventory is needed for the increment dispersion modeling analysis. The facility agreed to use the NAAQS nearby source inventory to determine compliance with PSD increment for annual NO_2, 24-hour $PM_{2.5}$, annual $PM_{2.5}$ and 24-hour PM_{10}.

[10] H8H = High Eight High; H1H = High First High; H6H = High Sixth High.
[11] The 1-hour NO_2 modeled impact from KDHE's modeling run was considered since it is higher (approximately 29 $\mu g/m^3$ higher) compared with Mid-Kansas' result.
[12] *October 1990 Draft New Source Review (NSR) Workshop Manual for PSD and Nonattainment Area Permitting.*

The proposed Rubart Station is the first completed PSD application submitted after the $PM_{2.5}$ trigger date of October 20, 2011, therefore, the minor source baseline date will be established by this PSD application. The PSD application was deemed complete by KDHE on December 20, 2012.

Table 5 shows the PSD increment modeling results. Seven (7) receptors, located approximately 8 km west-southwest of the proposed Rubart Station exceeded the 24-hour $PM_{2.5}$ PSD increment of 9.0 μg/m^3. Rubart Station's contribution to this increment exceedance is less than the SIL of 1.2 μg/m^3.

Table 5. PSD Increment Modeling Results

Pollutant	Averaging period	Modeled concentration (μg/m^3)[13]		PSD increment for Class II areas (μg/m^3)	Exceeds PSD Increment?
NO_2	Annual	14.40	H1H	25	No
$PM_{2.5}$	24-hour	12.20	H2H	9	**Yes**
	Annual	1.50	H1H	4	No
PM_{10}	24-hour	12.20	H2H	30	No

Table 6 shows PSD increment consumption from the proposed project. The concentration levels of 1-hour NO_2, 24-hour $PM_{2.5}$, annual $PM_{2.5}$ and annual PM_{10} from the proposed project would comply with applicable PSD increments. EPA has not established a 1-hour Class II maximum allowable increment for NO_2. Therefore, no calculation of the potential consumption of such increment is possible.

Table 6. Proposed Rubart Station PSD Increment Consumption

Pollutant	Averaging period	Modeled concentration (μg/m^3)[14]		PSD increment for Class II areas (μg/m^3)	Increment consumption (%)
NO_2	Annual	1.50	H1H	25	6.0
$PM_{2.5}$	24-hour	8.53[15]	H2H	9	94.8
	Annual	0.84	H1H	4	21.0
PM_{10}	24-hour	8.53	H2H	30	28.4

[13]From Rubart Station and nearby sources; H1H = High First High; H2H = High Second High.
[14] From Rubart Station only; H1H = High First High; H2H = High Second High.
[15] Modeled concentration at a receptor located on the Rubart Station's fenceline.

A. Additional Impact Analysis

The facility was required to provide an analysis of the impairment to visibility, and impacts on plants, soils and vegetation that would occur as a result of this project and to what extent the emissions from the proposed modification impacts the general commercial, residential, industrial and other growth.

1. Visibility Impairment Analysis

The facility did visibility impact analyses for two (2) local Class II areas close to the proposed project as follows: 1) Meade State Park, located approximately 72 km southeast of the project near Meade, Kansas and 2) Ulysses Airport, located approximately 24.5 km west of the project near Ulysses, Kansas. No assessment of visibility impacts at a Class I area was performed by the facility because there are no Federal Class I areas located within 300 km of the proposed facility.

The US EPA VISCREEN screening tool was used to determine the visual impacts to the Class II areas. The VISCREEN model is designed to determine whether a plume from a facility may be visible from a given vantage point. The primary variables that affect whether a plume is visible or not at a certain location are the quantity of emissions, the types of emissions, the relative location of the emission source and the observer, and the background visibility range.

Using current US EPA guidance from the *Workbook for Plume Visual Impact Screening Analysis (October, 1992)*, the Level 1 VISCREEN analysis was conducted for Meade State Park. The results indicate that there are no exceedances of the screening criteria inside or outside of the Meade State Park. Therefore, there are no potential visibility impacts for Meade State Park that would require additional analysis.

The Level 2 VISCREEN analysis was conducted for Ulysses Airport. The results indicate that there are no exceedances of the screening criteria inside or outside Ulysses Airport. Therefore, there are no potential visibility impacts for Ulysses Airport that would require additional analysis.

2. Impacts on Vegetation

The general land use in the vicinity of Rubart Station is irrigated row cropland and dry-land farming. Common crops produced in this area include wheat (*Triticum aestivum*), corn (*Zea mays*), grain sorghum

(*Sorghum bicolor*), alfalfa (*Medicago sativa*), sunflowers (*Helianthus annuus)*, cotton (*Gossypium* sp.), sweet corn (*Zea mays* convar. *saccharata* var. *rugosa*s), and potatoes (*Solanum tuberosum*).[16] Trees are generally uncommon but may occur in hedgerows and along riparian corridors.

The potential effects of NO_2, CO, PM, PM_{10}, $PM_{2.5}$, and CO_2e produced by the Project on vegetation within the immediate vicinity of Rubart Station were compared to scientific research examining the effects of pollution on vegetation.

In general, short-term, high concentrations of NO_2 are required for deleterious impacts on plants.[17] The injury threshold concentration for plants that are grown in Kansas is 7,380 $\mu g/m^3$ for tomato (*Lycopersicon esculentum*) and annual sunflower (*Helianthus annuus*). Lamb's quarters (*Chenopodium album),* a common, weedy plant found in disturbed areas in Kansas was not injured for two hours at concentrations of 1.9 $\mu g/m^3$ NO_2. Furthermore, short-term fumigations of approximately 1-hour, 20-hours, and 48-hours at NO_2 concentrations of 940 to 38,000 $\mu g/m^3$, 470 $\mu g/m^3$, and 3,000 to 5,000 $\mu g/m^3$, respectively, have been shown to impair photosynthesis in a number of herbaceous [tomato, oats (*Avena sativa*), alfalfa and woody plants.[18] Moreover, Taylor and McLean (1970),[19] in their review of NO_2 effects on vegetation, noted that long-term exposures of phytotoxic doses of NO_2 ranged from 280 to 560 $\mu g/m^3$. The maximum annual and 1-hour NO_2 modeled values of the facility for the project are 1.5 and 134.14 $\mu g/m^3$, respectively. These levels are low, so it is highly unlikely that NO_2 emissions will impact vegetation adjacent to or surrounding Rubart Station.

Particulates have been typically shown to be detrimental to vegetation within the immediate vicinity of the source. The most obvious effect of particle deposition on vegetation is a physical smothering of the leaf surface. This will reduce light transmission to the plant and cause a decrease in photosynthesis. The maximum PM_{10} and $PM_{2.5}$ 24-hour modeled values by the facility for the project are 11.3 $\mu g/m^3$ and 11.3 $\mu g/m^3$, respectively. This level is low, so it is highly unlikely that PM_{10} and $PM_{2.5}$ emissions will impact vegetation adjacent to Rubart Station.

[16] Kansas State University Extension 2012.
[17] Prinz and Brandt 1985.
[18] Hill and Bennett 1970; Capron and Mansfield 1976; Smith 1981
[19] Taylor and McLean 1970.

CO is not known to injure plants, nor has it been shown to be taken up by plants. Consequently, no adverse impacts to vegetation at or near Rubart Station are expected from CO stack emissions from the project.

CO_2 is not known to injure plants. Long-term exposure to elevated CO_2 levels has shown to improve the efficiency of nutrient, water, and photosynthesis in some plants.[20] However, the improved efficiencies that result from elevated CO_2 levels may not necessarily result in greater yields for crop plants.[21] No adverse impacts to vegetation at or near Rubart Station are expected from CO_2 stack emissions from the project.

Air pollutants are known to act in concert to cause injury to or decrease the functioning of plants.[22] Synergistic effects refers to the combined effects of pollutants when they are greater than is expected from the additive effect of the compounds. Inhibitory effects of SO_2 and NO_2,[23] NO_2 and NO,[24] NO_2 and ozone,[25] and ozone and SO_2[26] have been reported in various short-term studies for crop and woody plants (e.g., soybean, broad bean (*Vicia faba*), annual sunflower, tomato, and eastern cottonwood. Concentrations of pollutants (80 to 981 $\mu g/m^3$) in these studies are higher than the concentrations predicted to occur near Rubart Station. Consequently, no synergistic effects of the air pollutants are expected to inhibit vegetation at or near Rubart Station.

3. Impacts on Soils

Five (5) soil types are mapped at, or in the immediate vicinity of, the project site.[27] They include:

a. Otero-Ulysses complex, 0 to 5 percent slopes
b. Pleasant silty clay loam, ponded
c. Richfield silt loam, 0 to 1 percent slopes
d. Ulysses silt loam, 0 to 1 percent slopes and 1 to 3 percent slopes
e. Ulysses loam, 1 to 3 percent slopes

Sulfates and nitrates resulting from SO_2 and NO_2 deposition on soil can be both beneficial and detrimental to soils depending on their composition.

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[20] Drake, Gonzalez-Meler, and Long 1997; Leakey, Ainsworth, Bernacchi, Rogers, Long, and Ort 2009.
[21] Morgan, Bollero, Nelson, Dohleman, and Long 2005.
[22] *See* reviews of Reinert et al. 1975; Omrod 1982.
[23] White et al. 1974; Wright et al. 1986.
[24] Capron and Mansfield 1976.
[25] Furakawa et al. 1984; Okana et al. 1985.
[26] Costonis 1970, Carlson 1979; Jensen 1981; Omrod et al. 1981.
[27] Natural Resources Conservation Service 2012.

However, given the low expected deposition from the engines, operation of the EGUs should not materially affect the soils on-site or in the immediate vicinity.

4. Growth in Commercial, Residential and Industrial activity

The project is expected to increase employment in the area. The building phase will last approximately one (1) year. Construction employment is expected to peak at approximately 150 skilled construction jobs. Projected employment, reflecting full-time jobs directly tied to the operation of Rubart Station is estimated to be five (5) people at the facility. This will result in moderate amounts of secondary employment being created by the economic activity of the facility. In the immediate vicinity of the facility and as a result of the project at Rubart Station, increased vehicular traffic is expected. However, these activities are not expected to significantly impact air quality.

The construction work at Rubart Station may temporarily increase the number of people residing in the area. After construction is completed, many of the new employees are expected to already live in the area. However, some new employees are expected to move into the area, with only a slight increase in the residential growth in the area. This small increase in new residences is not expected to have an impact on the air quality in the area.

Adding additional electricity to the grid in this area may increase industrial growth. However, it is unknown how increasing available electrical power in this area may affect future industrial growth.

Attachment A

KEY STEPS IN THE "TOP-DOWN" BACT ANALYSIS

STEP 1: **IDENTIFY ALL POTENTIAL AVAILABLE CONTROL TECHNOLOGIES**.

The first step in a "Top-Down" analysis is to identify, for the emission unit in question, "all available" control options. Available control options are those air pollution control technologies or techniques with a practical potential for application to the emissions unit and the regulated pollutant under review. This includes technologies employed outside of the United States. Air pollution control technologies and techniques include the application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of the affected pollutant.

STEP 2: **ELIMINATE TECHNICALLY INFEASIBLE OPTIONS**.

The technical feasibility of the control options identified in Step 1 is evaluated with respect to the source-specific (or emissions unit specific) factors. In general, a demonstration of technical infeasibility should be clearly documented and should show, based on physical, chemical, and engineering principles, that difficulties would preclude the successful use of the control option on the emissions unit under review. Technically infeasible control options are then eliminated from further consideration in the BACT analysis.

STEP 3: **RANK REMAINING CONTROL TECHNOLOGIES BY CONTROL EFFECTIVENESS.**

All remaining control alternatives not eliminated in Step 2 are ranked and then listed in order of over-all control effectiveness for the pollutant under review, with the most effective control alternative at the top. A list should be prepared for each pollutant and for each emissions unit subject to a BACT analysis. The list should present the array of control technology alternatives and should include the following types of information:

1) control efficiencies;
2) expected emission rate;
3) expected emission reduction;
4) environmental impacts;
5) energy impacts; and
6) economic impacts.

STEP 4: **EVALUATE MOST EFFECTIVE CONTROLS AND DOCUMENT RESULTS**.

The applicant presents the analysis of the associated impacts of the control option in the listing. For each option, the applicant is responsible for presenting an objective evaluation of each impact. Both beneficial and adverse impacts should be discussed and, where possible, quantified. In general, the BACT analysis should focus on the direct impact of the control alternative. The applicant proceeds to consider whether impacts of unregulated air pollutants or impacts in other media would justify selection of an alternative control option. In the event the top candidate is shown to be inappropriate, due to energy, environmental, or economic impacts, the rationale for this finding should be fully documented for the public record. Then the next most stringent alternative in the listing becomes the new control candidate and is similarly evaluated. This process continues until the technology cannot be eliminated.

STEP 5: **SELECT BACT**.

The most effective control option not eliminated in Step 4 is proposed as BACT for the emission unit to control the pollutant under review.

Attachment B

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT'S EVALUATION

OF MID-KANSAS ELECTRIC COMPANY, LLC

PROPOSED NO_x, CO, VOC, PM, PM_{10}, $PM_{2.5}$ BACT OPTIONS

Mid-Kansas Electric Company, LLC evaluated the BACT options to control emissions from the Caterpillar four stroke lean burn reciprocating internal combustion engine electric generating units (EGUs), the fuel gas heater, the emergency fire pump, and the two emergency AC generators. The BACT analysis included normal operation and startup. The emergency fire pump and the two emergency AC generators will operate only for testing and maintenance and during periods of emergency.

I. NO_x BACT for the EGUs

NO_x control methods considered included non-selective catalytic reduction (NSCR), selective catalytic reduction (SCR), and lean-burn combustion.

NSCR uses the residual hydrocarbons and CO in the rich-burn engine exhaust as a reducing agent for NO_x. In an NSCR, hydrocarbons and CO are oxidized by O_2 and NO_2. The excess hydrocarbons, CO, and NO_x pass over a catalyst that reduces NO_x to N_2. Lean burn engines cannot be retrofitted with NSCR because of the reduced exhaust temperatures. Because lean burn engines cannot be fitted with NSCR, NSCR is not technically feasible for application to the EGUs.

SCR is a post combustion technology that employs ammonia in the presence of a catalyst to convert NO_x to nitrogen and water. The function of the catalyst is to lower the activation energy of the NO_x decomposition reaction. Technical factors related to this technology include the catalyst reactor design, optimum operating temperature, sulfur content of the fuel, de-activation due to aging, ammonia slip (ammonia that is left unreacted and exits the stack) emissions, and the design of the ammonia injection system. SCR represents state of the art controls for NO_x removal from this type of engine. SCRs are commercially available and have been used on similar engines. Therefore, SCR is technically feasible.

The EGUs used in this project are lean burn four stroke engines. These engines are also characterized as clean burn engines. The engines operate with air to fuel ratios between 20:1 and 50:1. Engines operating at high air to fuel ratios (greater than 30:1) may require combustion modification to promote stable combustion with the high excess air. These units are designed with a turbo charger, which is used to force more air into the combustion chamber. Lean burn engines typically have lower NO_x emissions than rich burn engines. Lean burn combustion with clean burn technology is standard on this type of engine, and is therefore a technically feasible option.

Please refer to the BACT analysis presented in Part 5 of the permit application for a more thorough evaluation of possible BACT. Refer also to the NO_x Emission Limitation Review letter dated November 20, 2012 and the RMB RICE Analysis Memo dated November 2, 2012.

KDHE reviewed the EPA's RACT/BACT/LAER Clearinghouse (RBLC) and other recently issued permits. Data indicated that recent installation of similar units utilized lean burn combustion with clean burn technology and SCR for the best controlled units. The PSD regulations require BACT, which requires the source to evaluate the control options for economic feasibility along with the impact on environment and energy use. If the top control is not chosen, an economic analysis to determine capital and annual control costs in terms of cost-effectiveness (i.e. dollars per ton of pollutant removed) of each control system will be conducted. The top control has been selected as BACT. The maximum emission reduction technically feasible control applied to this type of engine is SCR with lean burn combustion. Therefore, BACT for control of NO_x emissions from the EGUs is lean burn combustion with clean burn technology and SCR.

Emission rates from the RBLC were considered for engines in a comparable size range and located in attainment areas. KDHE also considered performance test data outlined in the RMB RICE Analysis Memo and discussion in the NO_x Emission Limitation Review letter. Emission rates from similar units were in the range 0.05 g/bhp-hr and higher. Engine design differences between manufacturers account for variation between emission rates achievable for different engines. The BACT limit for NO_x is 2.13 lb/hr for steady state operation, based on vendor guarantees, which equates to 0.07 g/hp-hr for steady state operation. The BACT emission rate averaging period is 1 hour.

II. CO BACT for the EGUs

The technically feasible technologies identified for reducing CO emissions are oxidation catalyst and combustion controls. The standard technology for reducing CO emissions is to follow good combustion practices by monitoring the combustion process through the air to fuel ratio. Review of the RBLC indicates combustion control or oxidation catalyst as the most prevalent technologies.

Oxidation catalysts are a post-combustion technology which use excess air present in the engine exhaust to oxidize CO to CO_2. Products of combustion are introduced into a catalyst bed, with the optimal temperature range of $700^{o}F$ to $1100^{o}F$. The addition of the catalyst bed onto the engine exhaust creates a pressure drop, resulting in back pressure to the engine. This has the effect of reducing the efficiency of the engine and the power generating capabilities.

Please refer to Section 5 of the permit application, and Appendix D, for additional information.

Oxidation catalysts come as standard equipment for these engines, and also represent the highest level of control for CO. Therefore, oxidation catalysts are BACT for these engines.

The facility has proposed, and KDHE has concurred with, a BACT emission level of 3.86 lb/hr based on guarantees from the equipment vendor. This rate is comparable to similar units in RBLC and is therefore considered BACT. The BACT emission rate averaging period is 1 hour.

III. VOC BACT for the EGUs

Similar to CO, VOC emissions result from incomplete combustion. VOC emissions occur when some gas remains unburned or is only partially burned during the combustion process. The technically feasible technologies identified for reducing VOC emissions from the EGUs are the same as those identified for CO control: an oxidation catalyst and combustion control. As discussed for CO BACT, oxidation catalysts come as standard equipment for these engines, and also represent the highest level of control for VOC. Therefore, oxidation catalysts are BACT for these engines.

The facility has proposed and KDHE has concurred with a BACT emission level of 5.82 lb/hr based on guarantees from the equipment vendor. The BACT emission rate averaging period is 3 hours.

IV. PM/PM_{10}/$PM_{2.5}$ BACT for the EGUs

Particulate matter emissions from natural gas combustion sources consist of inert contaminants in natural gas, sulfates from fuel sulfur or mercaptans used as odorants, dust drawn in from ambient air, and particulate of carbon and hydrocarbons resulting from incomplete combustion. Units firing low ash fuel, such as natural gas, and with high efficiency engines have low particulate emissions. No similar units have been identified that use ESPs or baghouses for particulate control. Because proper combustion control and firing fuels with negligible or zero ash content, such as natural gas, are the only control methods, they are considered to be BACT for the EGUs.

For the permit issued January 28, 2013, the facility proposed, and KDHE concurred with a BACT emission level of 0.25 lb/hr for PM, based on the minimum detection limit for Method 5 plus a very small safety factor. As discussed previously, PM emission estimates, for the purposes of this permit, are based on filterable particulate only. This is consistent with the definition KDHE is currently in the process of adopting. 40 CFR 52.21, as revised on July 1, 2011 and as amended by 76 Federal Register 43507 (2011) and 77 Federal Register 65118 – 65119 (2012), is being adopted by reference, except as specified paragraph (b)(2). The facility conducted stack testing in September and November, 2015 on the twelve EGUs that have been installed, and was unable to meet the existing BACT limit for PM. After reviewing BACT limits at other facilities and data for these engines, the PM BACT limit has been revised to the same limit as for PM_{10} and $PM_{2.5}$. BACT limits for PM, PM_{10} and $PM_{2.5}$ are based on an estimated maximum rate of 1.31 lb/hour. This rate includes filterable particulate matter only for PM, and both filterable and condensable particulate matter for PM_{10} and $PM_{2.5}$. The PM, PM_{10} and $PM_{2.5}$ BACT emission rate averaging period is 24 hours.

V. Startup BACT for the EGUs

Controls that are functional during normal operation are not available to control start-up and shutdown emissions. SCR and oxidation catalysts require minimum operating temperatures to control emissions. This temperature is not reached until approximately 30 minutes after the unit is turned on. In addition, the air-to-fuel ratio is highly variable until approximately 20% load for the lean-burn combustion. Therefore, there are no technically feasible control technologies for start-up emissions from the EGUs.

For the purpose of BACT emission limits, startup ends 30 minutes after a start sequence is initiated. Startup emission limits for the EGUs are as follows: the BACT emission limit for NO_x is 14.41 lb/hour, the BACT emission limit for CO is 39.23 lb/hour, the BACT emission limit for VOCs is 8.44 lb/hour, and the BACT emission limit for PM, PM_{10} and $PM_{2.5}$ is 1.68 lb/hour. The averaging periods for the BACT emission rate for each pollutant are the same as for normal operation.

VI. NO_x BACT for the Fuel Gas Heater

NO_x emission reduction controls available include SCR and dry low NO_x burners. SCR is technically feasible, but would result in cost per ton of NO_x removed of $108,515, and would therefore not be economical. Refer to Appendix E of the permit application for the complete economic analysis. Dry low NO_x burners are standard equipment and are considered BACT for this heater. The emission limit of 0.20 lb/hr is the BACT limit.

VII. CO, VOC, PM, PM_{10}, and $PM_{2.5}$ BACT for the Fuel Gas Heater

BACT control for these pollutants consists of good combustion practices. The associated BACT limits are as follows: The BACT emissions limit for CO is 0.16 lb/hr, the BACT emission limit for VOC is 0.11 lb/hr, the BACT emission limit for PM, PM_{10}, and $PM_{2.5}$ is 0.015 lb/hr. BACT limits exclude startup, shutdown, and malfunction.

VIII. NO_x, CO, VOC, PM, PM_{10}, and $PM_{2.5}$ BACT for the Emergency AC Generators

These units will operate 100 hours per year or less and will operate on natural gas. Combustion control and SCR are the only technically feasible control options. SCR results in a cost per ton of NO_x removal of $292,600 per ton, and would therefore not be economical. Refer to Appendix E of the permit application for the complete economic analysis. BACT is combustion control. The associated BACT limits are as follows: The BACT emissions limit for NO_x is 2.0 g/hp-hr, the BACT emissions limit for CO is 4.0 g/hp-hr, the BACT emission limit for VOC is 1.0 g/hp-hr, the BACT emission limit for PM, PM_{10}, and $PM_{2.5}$ is 7.6E-5 g/hp-hr. BACT limits exclude startup, shutdown, and malfunction.

IX. NO_x, CO, VOC, PM, PM_{10}, and $PM_{2.5}$ BACT for the Emergency Fire Pump

These units will operate 100 hours per year or less and will operate on ULSD fuel oil. Combustion control is the only technically feasible control and therefore is BACT for the emergency fire pump. The associated BACT limits are as follows: The BACT emissions limit for NO_x is 3.0 g/hp-hr, the BACT emissions limit for CO is 2.6 g/hp-hr, the BACT emission limit for VOC is 1.14 g/hp-hr, the BACT emission limit for PM, PM_{10}, and $PM_{2.5}$ is 0.15 g/hp-hr. BACT limits exclude startup, shutdown, and malfunction.

Attachment C

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT'S EVALUATION

OF MID-KANSAS ELECTRIC COMPANY, LLC

PROPOSED GHG BACT OPTIONS

I. Greenhouse Gas Emission Units Subject to Best Available Control Technology

The following greenhouse gas (GHG) best available control technology (BACT) analyses are based on the information prepared and submitted by the Mid-Kansas Electric Company, LLC (Mid-Kansas) to the Kansas Department of Health and Environment (KDHE) for evaluation. The GHG BACT analyses determine the most effective control of GHG emissions from the proposed Rubart Station, a power generation plant with nominal power output of approximately 240 megawatts (MW). The proposed station is designed to meet the reserve planning and capacity margins required by the Southwest Power Pool, Inc. (SPP). The reciprocating internal combustion engines (RICE) electric generating units (EGUs) to be installed at the proposed station are rapid-response RICE generation sources and will be dispatched in response to the intermittent nature of renewable resources such as the wind-based energy resources.

Mid-Kansas is proposing to install and operate 24 natural gas-fired spark ignition (SI) RICE EGUs (each with 10 MW nominal power output) and auxiliary equipment that include one (1) 2 MMBTU/hr fuel-gas heater, one (1) emergency fire pump engine (with 190 hp power output), two (2) emergency AC generator sets (each with 450 kW power output; one (1) AC generator is considered as a redundancy unit), 12 circuit breakers, and four (4) circuit switchers to be located at the proposed Rubart Station in Grant County, Kansas, approximately 14 miles east of Ulysses, Kansas.

For more details, please refer to the following document prepared by the facility: ***Prevention of Significant Deterioration Air Construction Permit Application*** received on July 10, 2012 and *a* ***memorandum (Subject: Carbon Capture Technology for Rubart Station)*** received on October 9, 2012 containing the additional information on carbon capture and sequestration/storage (CCS).

The GHG emission rates (pounds per hour, lbs/hr) from each emission unit are listed in Table C-1. The facility-wide potential emission of carbon dioxide equivalent (CO_2e) (tons per year, tons/yr) are summarized in Table C-2. The GHG BACT and BACT emission limits are summarized in Table C-3.

The 24 natural gas-fired EGUS potential emissions of CO_2e during operation (including start-up operations) is approximately 1,191,367.44 tons/yr, which account for 99.8 % of the facility-wide CO_2e.

Table C-1. Greenhouse Gas (GHG) Emission Rates Per Emission Unit

Emission Unit/Process	Carbon dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Sulfur Hexaflouride (SF_6)
	lbs/hr, **except** for the start-up/shutdown and circuit breaker/circuit switchers emissions			
Natural gas-fired EGUs (steady-state operation)	10,682.80	0.17	0.02	0
Start-up emissions from natural gas-fired EGUs	5,125.50 [a]	-- [b]	-- [b]	0
Shutdown emissions from natural gas-fired EGUs	108.50 [a]	-- [b]	-- [b]	0
Fuel-Gas Heater	235	4.51E-03	4.31E-03	0
Emergency Fire Pump	79	3.19E-03	6.39E-04	0
Emergency AC Generator	623	1.18E-02	1.18E-03	0
Circuit breaker and circuit switchers	0	0	0	64.5 [c]

[a] The emission rates of the start-up and shutdown operation are in **lbs per 30 minute** period (per EGU).
[b] No available data.
[c] The emission rates of the circuit breaker/circuit switcher operation are in **lbs per breaker/switcher .**

Table C-2. Facility-wide Potential Emissions of CO_2 Equivalent (CO_2e)

Emission Unit/Process	Carbon dioxide (CO_2) [a]	Methane (CH_4) [a]	Nitrous Oxide (N_2O) [a]	Sulfur Hexaflouride (SF_6) [a]	Total facility-wide CO_2 equivalent (CO_2e)
	tons/yr				
Natural gas-fired EGUs (24 units)	1,122,978.00	383.04	595.20	0	1,123,956.24
Start-up emissions from natural gas-fired EGUs (24 units)	67,348.80	25.20	37.20	0	67,411.20
Shutdown emissions from natural gas-fired EGUs (24 units)	1,425.60	25.20	37.20	0	1,488.00
Fuel-Gas Heater (1 unit)	1,030.60	0.42	5.89	0	1,036.91
Emergency Fire Pump (1 unit)	3.90	0.0042	0.00992	0	3.91
Emergency AC Generator (2 units)	62.40	0.025	0.062	0	62.46
Circuit Breakers (12 units)	0	0	0	44.67	44.67

and Circuit Switchers (4 units)					
TOTAL	**1,192,849.30**	**433.89**	**675.56**	**44.67**	**1,194,003.42**

[a] CO_2e-based emissions. Global Warning Potentials (GWP): CO_2 = 1, CH_4 = 21, N_2O = 310, SF_6 = 23,900

Table C-3. CO_2e BACT Emission Limits, GHG BACT, and Compliance Demonstrations

Emission Units	**GHG BACT and BACT emission limit**
Natural gas-fired EGUs	• Use of lean-burn, four-stroke, spark ignition, natural gas-fired EGUs (with air-to-fuel ratio control, turbocharger, an open interface cooling system and a lube oil cooling system) • Use of pipeline quality natural gas • Good combustion practices in accordance with the manufacturer's recommendation (e.g., maintain efficiency of the engines) • The GHGs emissions from each EGU are limited to the following: 1. Carbon dioxide (CO_2) (during steady-state operation at full load) = 10,683 lb/hr 2. CO_2 (during start-up operation) = 10,467 lb/hr *(30 min start-up emissions + 30 min steady-state emissions)* 3. Methane (CH_4) = 0.17 lb/hr 4. Nitrous oxide (N_2O) = 0.02 lb/hr • Since the CO_2 emissions from the 24 EGUs (1) during steady-state operation at full load and (2) during start-up operation account for 99.8 % of total facility-wide CO_2e emissions, initial performance testing of CO_2 emissions from the 24 EGUs is required. • Since the CH_4 and N_2O emissions from the 24 EGUs are very minimal *(see Tables C-1 and C-2)*, no performance testing for these pollutants is required.
Fuel-Gas Heater	• Use of clean fuel (exclusive use of pipeline quality natural gas) • Good combustion practices in accordance with the manufacturer's recommendation (e.g., tuning the unit every two (2) years according to the manufacturer's specifications) • Since the CO_2, CH_4, and N_2O emissions from the fuel-gas heater are very minimal *(see Tables C-1 and C-2)*, no performance testing for these pollutants is required
Emergency Fire Pump	• Use of the most efficient stationary fire pump engine (e.g., use of most fuel efficient engine such as the Tier 3-certified engine) • Since the CO_2, CH_4, and N_2O emissions from the emergency fire pump are very minimal *(see Tables C-1 and C-2)*, no performance testing for these pollutants is required.
Emergency AC Generators	• Use of the most efficient emergency AC generator (e.g., use of most fuel efficient engine such as the NSPS-certified engine) • Since the CO_2, CH_4, and N_2O emissions from the emergency AC generators are very minimal *(see Tables C-1 and C-2)*, no performance testing for these pollutants is required.

Emission Units	GHG BACT and BACT emission limit
Circuit breaker and switchers	• State-of-the-art enclosed-pressure SF_6 circuit breakers and switchers with a guaranteed loss rate of 0.5% by weight or less by year; • Density monitor alarm system; and • Develop and implement a written LDAR program. • Since the SF_6 emissions from the 12 circuit breakers and four (4) circuit switchers are very minimal *(see Tables C-1 and C-2)*, no performance testing for this pollutant is required.

II. <u>GHG BACT for the 24 Natural Gas-Fired EGUs</u>

The EPA's "PSD and Title V Permitting Guidance for Greenhouse Gas" published in March 2011, indicated that control options that would **fundamentally redefine the nature** of the proposed source/project could be excluded in Step 1 of the BACT provided that the rationale are properly explained and documented in the permit record or permit application.

Section 2.3 of the PSD construction permit application describes in detail the necessary basic project design and operating objectives of the proposed Rubart Station. The proposed project is designed to meet the reserve planning and capacity margins required by the Southwest Power Pool, Inc. (SPP). SPP is a regional electric reliability organization whose purpose is to ensure the reliability of the bulk power system in North America by identifying system limitations, developing transmission upgrades, and determining the day-to-day reserves necessary to prevent avoidable regional blackouts.

A. Below are some of the necessary basic project design and operating objectives of the proposed Rubart Station:

1. Nominal size is no larger than 240 MW
2. Rapid startup/shutdown
3. Capable of service as black start units
4. Flexible and dispatchable resource (quick ramp-up/ramp-down)
5. Efficient across a wide range of operating loads (e.g., from 25 % up to 100 % load)
6. Utilize pipeline quality natural gas

B. The following **renewable** power generation technologies are assessed and determined by the facility as options that would not meet the project's design objectives and would fundamentally redefine the nature of the project, therefore, are not considered in Step 1 of BACT. Details are described in Section 2.7 through Section 2.7.6 of the PSD construction permit application.

Renewable power generation technologies:

1. Hydroelectric Processes

2. Geothermal Power Processes
3. Energy from biomass
4. Solar energy
5. Wind Energy

C. The following **conventional** power generation technologies and **alternative fuels** are assessed and determined by the facility as options that would not meet the project's design objectives and would fundamentally redefine the nature of the project, therefore, are not considered in Step 1 of BACT. Details are described in Section 2.7.7 through Section 2.7.7.4 and Section 5.8.4 of the PSD construction permit application.

1. Conventional power generation technologies:

   a. Nuclear Power Technology
   b. Brayton-Cycle (Simple-Cycle) Combustion Turbine
   c. Conventional Rankine-Cycle Stream Generator/Steam turbine
   d. Rankine-Brayton (Combined-Cycle) Combustion Turbine

2. Alternative Fuels:

   a. Propane
   b. Liquefied natural gas (LNG)
   c. Ultra low sulfur diesel (ULSD)

D. In the GHG guidance document, EPA has placed potentially applicable control alternatives for GHG BACT in the following three (3) categories:

1. **Inherently Lower-Emitting Processes/Practices/Designs** (e.g., a **more energy efficient** project or project design; applications of methods, systems, or techniques to **increase energy efficiency**; **energy efficient measure** in tandem with end-of-stack controls, etc.);

2. **Add-on Controls** (e.g., CO_2 capture and/or compression; CO_2 transport; and CO_2 storage); and

3. **Combinations of Inherently Lower-Emitting Processes/ Practices/ Designs and Add-on Controls.**

E. Additional Information on CCS

Mid-Kansas sent a memorandum (Subject: Carbon Capture Technology for Rubart

Station) on October 9, 2012 containing the additional information on CCS. In the memorandum, the facility described how the 24 EGUs are expected to operate at the proposed Rubart Station. The 24 EGUs to be installed at the proposed station are rapid-response RICE generation sources and will be dispatched in response to nearly constant changes in energy and voltage demand signals arising from integration with wind-based energy resources. It is expected that the 24 EGUs will be frequently started, loaded in response to wind-resource swings or SPP dispatch, then stopped. The facility expects to subject each EGU to up to three (3) start/stop sequences each day. Based on the additional information provided in the memorandum and in the analysis conducted, the facility found that **CCS is not an available control option** to the proposed project. Some specific reasons cited in memorandum to support that CCS is not an available control option include the following:

1. An amine-type capture process that might possibly be a potentially applicable post-combustion CO_2 capture system to rapid-response units has never been demonstrated on the exhaust of natural gas-fired RICE at any scale and would still require considerable research and development stage/process; and

2. The exhaust gases from individual RICE will not be continuously emitted in large amounts and are not of high-purity CO_2 concentration (CO_2 concentration will be only about 6% of the gas stream).

F. Five Step BACT Process

1. **BACT Step 1 (Identify Available Control Options)**

The following control options, which are identified as the most stringent controls for the proposed project, have been considered in Step 1 of GHG BACT for the 24 EGUs. Details are described in Section 5.8 of the PSD construction permit application.

Available Control Options
1. Use of lean-burn, four-stroke, spark ignition, natural gas-fired RICE (with air-to-fuel ratio control, turbocharger, an open interface cooling system and a lube oil cooling system)
2. Use of pipeline quality natural gas
3. Good combustion practices in accordance with the manufacturer's recommendation (e.g., maintain efficiency of the engines)

The facility indicated that the only way to reduce the amount of CO_2 generated by a fuel-burning power plant is to design and operate it through the use of the **most efficient generating technologies** for the anticipated load requirements.

A fundamental objective of the proposed project is to utilize pipeline quality natural gas. (The definition of pipeline quality gas is specified in the PSD construction permit.) In comparison to all other potential fuels, natural gas will achieve the lowest emissions of CO_2 and other GHGs. A comparison of emission rate factors for the various fuels is presented in Table 5-12 of the PSD application and shows that natural gas, when used as a fuel in stationary sources, typically produces less CO_2 (lbs/MMBTU) than other fuels.

Based on the project design size and objectives, Mid-Kansas has determined that RICE technology, firing pipeline quality natural gas and with RICE sizes between 4 to 10 MW, constitutes the most efficient electric generating technology for the project.

The high efficiency and operational design aspects of the RICE technology includes the following: lean burn four-stroke configuration employing spark ignition in the Otto process, use of clean fuels, air-to-fuel control, turbocharger technology, open interface cooling system, and a lube oil cooling system designed as an integral part of the engine.

2. **BACT Step 2 (Eliminate Technically Infeasible Options)**

The control options identified in Step 1 of BACT are all integral part of the engine design, thus, technically feasible for the proposed project.

3. **BACT Step 3 (Ranking of Controls)**

The control options identified in Step 1 of BACT for the proposed project are the **most effective control alternative** (i.e., the option that achieves the lowest emission level) identified.

4. **BACT Step 4 (Economic, Energy, and Environmental Impacts)**

Because the facility will utilize the most stringent control for reducing the GHG emissions, no detailed analysis was provided by the facility to compare the available and feasible control technologies in terms of economic, energy, and environmental impacts.

5. **BACT Step 5 (Selecting BACT)**

The following is the GHG BACT for the 24 EGUs:

a. Use of efficient lean-burn, four-stroke, spark ignition, natural gas-fired RICE (with air-to-fuel ratio control, turbocharger, an open interface cooling system and a lube oil cooling system);
b. Use of pipeline quality natural gas;
c. Good combustion practices in accordance with the manufacturer's recommendation (e.g., maintain efficiency of the engines);
d. The CO_2 BACT emission limit for each RICE during steady-state operation at full (100 %) load is **10,683 lb/hr**.

The GHG BACT emission limits were based on CO_2 emissions from the EGUs during steady-state operation at full load and during start-up operations (see Section III.C.2 below) since these emissions account for 99.8 % of total facility-wide CO_2e emissions.

G. BACT Compliance

The following describe the federally-enforceable compliance demonstration to the GHG BACT for each 10 MW EGU:

1. The owner or operator shall keep records of the type and/or specifications of engine installed at proposed station.

2. The owner or operator is limited to firing pipeline quality natural gas only in the 24 EGUs and shall keep records of the type and/or specifications of the pipeline quality natural gas used. Definition of pipeline quality gas is specified in the PSD construction permit.

3. The owner of operator shall keep records of the good combustion practices for each EGU, in accordance with the manufacturer's recommendation to maintain efficiency of the engines.

4. The owner or operator shall conduct initial performance testing of CO_2 emissions from each of the 24 EGUs during steady-state operation at full load. Performance testing of CH_4 and N_2O emissions from the 24 EGUs is not required since emissions from these pollutants are very minimal. Details of the performance testing are listed in the PSD construction permit.

III. <u>GHG BACT for the Start-up and Shutdown of the 24 natural gas-fired EGUs</u>

The following account is based from Section 5.9 of the PSD construction permit application. Each EGU has potentially 1-3 start-up/shutdown events per day or 1,095 start-up/shutdown events per engine per year. Start-up emissions, on a lb/hr basis, will be higher than the full (100%) load operation during normal steady-state operation because the control devices (i.e., selective catalytic reduction (SCR) system and oxidation catalysts) cannot operate until the respective catalysts reach certain minimum temperatures. Shutdown emissions, however, are less than the full load operation.

According to the facility, for the purposes of this permit application, it is assumed that all start-ups are "cold start-ups", which is a very conservative approach as a "cold start-up" has more emissions than a "warm start-up". The facility expects to have many "warm start-ups" due to the expected daily fluctuations in electrical demand. A "cold start-up" is one which requires about 30 minutes of fired-operation for the SCR and oxidation catalysts to reach their respective minimum operating temperatures and has higher emissions than a "warm start-up" because it takes less time to reach the proper operating temperature required for the catalyst systems.

A. Five Step BACT Process

1. **BACT Step 1 (Identify Available Control Options) and BACT Step 2 (Eliminate Technically Infeasible Options)**

Controls that are functional during normal operation are **not available** to control start-up and shutdown emissions. SCR and oxidation catalysts require minimum operating temperatures to control emissions. This temperature is not reached until approximately 30 minutes after the unit is turned on. In addition, the air-to-fuel ratio is highly variable until approximately 20% load for the lean-burn combustion. Therefore, there are **no technically feasible control technologies** for start-up and shutdown emissions from the EGUs.

2. **BACT Step 3 (Ranking of Controls) and BACT Step 4 (Economic, Energy, and Environmental Impacts)**

Because there are no technically feasible control technologies for start-up and shutdown emissions, BACT Step 3 and BACT Step 4 are not applicable.

3. **BACT Step 5 (Selecting BACT)**

The following is the GHG BACT for the start-up events of the RICE:

The CO_2 BACT emission limit for each EGU during start-up operation is **10,467 lb/hr** (calculated based on 30 min start-up emissions plus 30 min steady-state at full load emissions.)

B. BACT Compliance

The following describe the federally-enforceable compliance demonstration to the CO_2 BACT emission limit for the start-up event of each 10 MW EGU:

The owner or operator shall conduct initial performance testing of CO_2 emissions from each of the 24 EGUs during start-up. Performance testing of CH_4 and N_2O emissions from the 24 EGUs during start-up is not required since emissions from these pollutants are very minimal. Details of the performance testing are listed in the PSD construction permit.

IV. GHG BACT for the Fuel-Gas Heater

The following account is based from Section 5.10.5 of the PSD construction permit application. The fuel-gas heater will be fired exclusively on natural gas and is used to pre-heat that fuel to facilitate rapid starts and meet RICE engine manufacturer requirements. The unit is rated at approximately 2.0 MMBtu/hr, and will be fired a total of 8,760 hours per year. GHG emissions from this unit are estimated to be **1,037.0 tons CO_2e/yr**. This GHG emission is *de minimus*, when compared to the EGUs GHG emissions or the project's total GHG emissions.

A. Five Step BACT Process

1. BACT Step 1 (Identify Available Control Options) and BACT Step 2 (Eliminate Technically Infeasible Options)

The following are the GHG BACT for the fuel-gas heater:

a. Use of clean fuel (exclusive use of pipeline quality natural gas); and

b. Good combustion practices in accordance with the manufacturer's recommendation (e.g., tuning the unit every two (2) years according to the manufacturer's specifications).

2. BACT Step 3 (Ranking of Controls) and BACT Step 4 (Economic, Energy, and Environmental Impacts)

Because the facility will utilize the most stringent control for reducing the GHG emissions from the fuel-gas heater, no detailed analysis was provided for BACT Step 3 and BACT Step 4.

3. BACT Step 5 (Selecting BACT)

As identified in Step 1 of the BACT, the following are the GHG BACT for the fuel-gas heater:

a. Use of clean fuel (exclusive use of pipeline quality natural gas); and

b. Good combustion practices in accordance with the manufacturer's recommendation (e.g., tuning the unit every two (2) years according to the manufacturer's specifications).

Since the CO_2, CH_4, and N_2O emissions from the fuel-gas heater are very minimal *(see Tables C-1 and C-2),* no performance testing for these pollutants is required.

B. BACT Compliance

The following describe the federally-enforceable compliance demonstration to the GHG BACT for the fuel-gas heater:

1. The owner or operator is limited to firing pipeline quality natural gas only in the 24 EGUs and shall keep records of the specifications of the pipeline quality natural gas used.

2. The owner of operator shall keep records of the good combustion practices for the fuel-gas heater, in accordance with the manufacturer's recommendation.

V. <u>GHG BACT for the Emergency Fire Pump</u>

The following account is based from Section 5.11.5 of the PSD construction permit application. The emergency fire pump will be used for no more than 100 hours per year. Consistent with the rationale for the BACT determination for GHG emissions from the EGU engines, BACT for this source involves selection of the most efficient stationary fire pump engine that can meet the project's needs. The facility has estimated the total GHG emissions from the emergency fire pump at **4 tons of CO_2e per year**. These GHG emissions also are *de minimus* when compared to the EGU GHG emissions or the project's total GHG emissions.

A. Five Step BACT Process

1. BACT Step 1 (Identify Available Control Options) and
BACT Step 2 (Eliminate Technically Infeasible Options)

The following is the GHG BACT for the emergency fire pump:

Use of the most efficient stationary fire pump engine (e.g., use of most fuel efficient engine such as the Tier 3-certified engine).

2. BACT Step 3 (Ranking of Controls) and BACT Step 4 (Economic, Energy, and Environmental Impacts)

Because the facility will utilize the most stringent control for reducing the GHG emissions from the emergency fire pump, no detailed analysis was provided for BACT Step 3 and BACT Step 4.

3. BACT Step 5 (Selecting BACT)

As identified in Step 1 of the BACT, the following is the GHG BACT for the emergency fire pump:

a. Use of the most efficient stationary fire pump engine (e.g., use of most fuel efficient engine such as the Tier 3-certified engine)

b. Use of the ULSD fuel with sulfur content of no more than 0.0015% by weight

c. Maximum hours of operation is 100 hours per year.

Since the CO_2, CH_4, and N_2O emissions from the emergency fire pump are very minimal *(see Tables C-1 and C-2)*, no performance testing for these pollutants is required.

B. BACT Compliance

The following describes the federally-enforceable compliance demonstration to the GHG BACT for the emergency fire pump:

1. The owner or operator shall keep records of the type of emergency fire pump installed at proposed station.

2. The owner or operator is limited to firing ULSD fuel with sulfur content of no more than 0.0015% by weight content and shall keep records of the sulfur content of ULSD fuel used.

3. The owner or operator shall keep records of the number hours of operation per year.

VI. GHG BACT for the Emergency AC Generators

The following account is based from Section 5.12.5 of the PSD construction permit application. Only one (1) emergency AC generator (450 kW) will be operated at a time and will be limited to 100 hours per year of operation.

A. Five Step BACT Process

1. BACT Step 1 (Identify Available Control Options) and BACT Step 2 (Eliminate Technically Infeasible Options)

The following is the GHG BACT for the emergency AC generator:

Use of the most efficient emergency AC generator (e.g., use of most fuel efficient engine such as the NSPS-certified engine).

2. BACT Step 3 (Ranking of Controls) and BACT Step 4 (Economic, Energy, and Environmental Impacts)

Because the facility will utilize the most stringent control for reducing the GHG emissions from the emergency AC generator, no detailed analysis was provided for BACT Step 3 and BACT Step 4.

3. BACT Step 5 (Selecting BACT)

As identified in Step 1 of the BACT, the following is the GHG BACT for the emergency AC generator:

a. Use of the most efficient emergency AC generator (e.g., use of most fuel efficient engine such as the NSPS-certified engine);

b. Maximum hours of operation is 100 hours per year per generator. Only one (1) emergency AC generator will be operated at a time.

Since the CO_2, CH_4, and N_2O emissions from the emergency AC generators are very minimal *(see Tables C-1 and C-2)*, no performance testing for these pollutants is required.

B. BACT Compliance

The following describes the federally-enforceable compliance demonstration to the GHG BACT for the emergency AC generators:

1. The owner or operator shall keep records of the type of emergency AC generators installed at proposed station.
2. The owner or operator shall keep records of the number hours of operation per year.

VII. GHG BACT for the Circuit Breakers and Switchers

The following account is based from the BACT document for the circuit breakers and circuit switchers submitted on October 24, 2012.

Sulfur hexafluoride (SF_6) is a very potent GHG with a global warming potential (GWP) of 23,900. SF_6 is a gaseous dielectric used in circuit breakers and circuit switchers. The project will have a maximum of 12 circuit breakers and a maximum of four (4) circuit switchers that will contain small amounts of SF_6. Leakage is expected to be minimal, and is expected to occur only as a result of circuit interruption and at extremely low temperatures.

Emissions of SF_6 from the circuit breakers and switchers are listed in Tables C-1 and C-2. SF_6 emissions are based on a maximum leakage rate of 0.5% per year, based on vendor guarantees, to calculate the annual potential-to-emit emissions. Based on the calculations for all 12 circuit breakers and all four (4) circuit switchers, the maximum CO_2e emission is **44.7 tons per year**.

A. Five Step BACT Process

1. BACT Step 1 (Identify Available Control Options) and BACT Step 2 (Eliminate Technically Infeasible Options)

The following control options are identified by the facility. For the discussion on the technical feasibility of the controls, refer to the BACT document for the circuit breakers and circuit switchers submitted on October 24, 2012.

a. Use state-of-the-art SF_6 technology with leak detection systems to limit fugitive emissions. This option is **technically-feasible**.

b. Substitution of another, non-greenhouse-gas substance for SF_6 such as the use of a different dielectric oil or compressed air (air-blast) circuit breaker as the dielectric material in the breakers. This option is **not technically-feasible**.

c. Use an emerging technology to replace SF_6 with a material that has similar dielectric and arc-quenching properties, but without the drawbacks of oil and air-blast breakers. This option is **not technically-feasible**.

d. Develop and implement a Leak Detection and Repair (LDAR) program, similar to NSPS, Subpart Wa (40 CFR 60.480a through 60.489a). This option is **technically-feasible**.

2. BACT Step 3 (Ranking of Controls) and BACT Step 4 (Economic, Energy, and Environmental Impacts)

The facility will utilize the use state-of-the-art SF_6 technology with leak detection systems to limit fugitive emissions and the LDAR program. Because the facility will utilize the most stringent controls for reducing the GHG emissions from the circuit breakers and switchers, no detailed analysis was provided for BACT Step 3 and BACT Step 4.

3. BACT Step 5 (Selecting BACT)

As identified in Steps 1 through 3 of the BACT, the following is the GHG BACT for the circuit breaker and switchers:

a. State-of-the-art enclosed-pressure SF_6 circuit breakers and switchers with a guaranteed loss rate of 0.5% by weight or less by year;

b. Density monitor alarm system; and

c. Develop and implement a written LDAR program.

Since the SF_6 emissions from the 12 circuit breakers and four (4) circuit switchers are very minimal *(see Tables C-1 and C-2)*, no performance testing for this pollutant is required.

B. BACT Compliance

The following describes the federally-enforceable compliance demonstration to the GHG BACT for the emergency AC generators:

1. In place of direct monitoring of the fugitive SF_6 emissions, conduct surrogate monitoring through measuring the amount of SF_6 lost and use a conversion factor to assess annual SF_6 fugitive emissions in terms of CO_2e.

2. Implement a density monitor alarm system with threshold of 10%, that is, the alarm will alert controllers when the circuit breakers and circuit switchers lose 10% of its SF_6. In the event of an alarm, the facility will investigate the event and take any necessary corrective action to address any problems.

3. The facility will provide a copy of the LDAR program and documentation regarding observations and/or repairs made in accordance with the LDAR program to KDHE upon request.