PERMIT BOOK

STATE OF MISSOURI

DEPARTMENT OF NATURAL RESOURCES

MISSOURI AIR CONSERVATION COMMISSION

PERMIT TO CONSTRUCT

Under the authority of RSMo 643 and the Federal Clean Air Act the applicant is authorized to construct the air contaminant source(s) described below, in accordance with the laws, rules and conditions as set forth herein.

Permit Number: 122010-011 Project Number: 2010-09-030

Parent Company: Associated Electric Cooperative, Inc.

Parent Company Address: P.O. Box 754, Springfield, MO 65801-0754

Installation Name: Thomas Hill Energy Center

Installation Number: 175-0001

Installation Address: State Road F, Clifton Hill, MO 65244

Location Information: Randolph County, S55, T19, R15W

Application for Authority to Construct was made for:
Revision of the carbon monoxide (CO) limit given in Permit No. 122009-002 which was for construction of equipment and associated used of CyClean additives in the cyclone boilers. This review was conducted in accordance with Section (8), Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required.*

☐ Standard Conditions (on reverse) are applicable to this permit.

☑ Standard Conditions (on reverse) and Special Conditions are applicable to this permit.

DEC 17 2010

EFFECTIVE DATE

James L Kavanaugh

DIRECTOR OR DESIGNEE
DEPARTMENT OF NATURAL RESOURCES

STANDARD CONDITIONS:

Permission to construct may be revoked if you fail to begin construction or modification within 18 months from the effective date of this permit. Permittee should notify the Air Pollution Control Program if construction or modification is not started within 18 months after the effective date of this permit, or if construction or modification is suspended for one year or more.

You will be in violation of 10 CSR 10-6.060 if you fail to adhere to the specifications and conditions listed in your application, this permit and the project review. In the event that there is a discrepancy between the permit application and this permit, the conditions of this permit shall take precedence. Specifically, all air contaminant control devises shall be operated and maintained as specified in the application, associated plans and specifications.

You must notify the Departments' Air Pollution Control Program of the anticipated date of start up of this (these) air contaminant sources(s). The information must be made available within 30 days of actual startup. Also, you must notify the Department of Natural Resources Regional office responsible for the area within which you are located within 15 days after the actual start up of this (these) air contaminant source(s).

A copy of this permit and permit review shall be kept at the installation address and shall be made available to Department of Natural Resources' personnel upon request.

You may appeal this permit or any of the listed special conditions to the Administrative Hearing Commission (AHC), P.O. Box 1557, Jefferson City, MO 65102, as provided in RSMo 643.075.6 and 621.250.3. If you choose to appeal, you must file a petition with the AHC within 30 days after the date this decision was mailed or the date it was delivered, whichever date was earlier. If any such petition is sent by registered mail or certified mail, it will be deemed filed on the date it is mailed. If it is sent by any method other than registered mail or certified mail, it will be deemed filed on the date it is received by the AHC.

If you choose not to appeal, this certificate, the project review and your application and associated correspondence constitutes your permit to construct. The permit allows you to construct and operate your air contaminant sources(s), but in no way relieves you of your obligation to comply with all applicable provisions of the Missouri Air Conservation Law, regulations of the Missouri Department of Natural Resources and other applicable federal, state and local laws and ordinances.

The Air Pollution Control Program invites your questions regarding this air pollution permit. Please contact the Construction Permit Unit at (573) 751-4817. If you prefer to write, please address your correspondence to the Missouri Department of Natural Resources, Air Pollution Control Program, P.O. Box 176, Jefferson City, MO 65102-0176, attention: Construction Permit Unit.

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

The special conditions listed in this permit were included based on the authority granted the Missouri Air Pollution Control Program by the Missouri Air Conservation Law (specifically 643.075) and by the Missouri Rules listed in Title 10, Division 10 of the Code of State Regulations (specifically 10 CSR 10-6.060). For specific details regarding conditions, see 10 CSR 10-6.060 paragraph (12)(A)10. "Conditions required by permitting authority."

Thomas Hill Energy Center
Randolph County, S55, T19, R15W

1. Superseding Condition
   A. The conditions of this permit supersede Special Conditions 1.A, 1.B and 1.C found in the previously issued construction permit Permit Number 122009-002 issued by the Air Pollution Control Program.

2. Standards of Performance for Best Available Control Technology (BACT) for Carbon Monoxide (CO)
   A. Thomas Hill Energy Center shall not emit more than 0.55 pounds of CO per million British Thermal Units (lb/MMBTU) of heat input each from Unit 1 and Unit 2 based on a 30-day rolling average. This limit is exclusive of emissions occurring during start-up, shutdown and malfunction.

   B. Thomas Hill Energy Center shall not emit more than 13,873 tons per year of CO combined from Unit 1 and Unit 2. This limit is inclusive of emissions during start-up, shutdown and malfunction.

   C. Thomas Hill Energy Center shall operate continuous CO emission monitors on Unit 1 and Unit 2 to measure, record and report CO emissions compliance.

3. Continuous Emission Monitoring System (CEMS) – Unit 1 and Unit 2
   A. Thomas Hill Energy Center shall install, certify, operate, calibrate, test and maintain CEMS for CO and any necessary auxiliary monitoring equipment in accordance with all applicable regulations. If there are conflicting regulatory requirements, the more stringent shall apply.

   B. CEMS certification shall be made pursuant to 40 CFR Part 60, Appendix B, Performance Specification 4.

   C. Periodic quality assurance assessments shall be conducted according to the procedures outlined in 40 CFR Part 60, Appendix F.

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

D. Thomas Hill Energy Center shall install and operate a data acquisition and handling system to calculate emissions in terms of the emission limitations specified in this permit.

4. Record Retention Requirements
Thomas Hill Energy Center shall maintain all records required by this permit, on-site, for the most recent 60 months of operation and shall make such records available immediately to any Missouri Department of Natural Resources' personnel upon request.

5. Reporting Requirements
Thomas Hill Energy Center shall report CO emissions in their current semi-annual monitoring (SAM) report and in the annual compliance certification (ACC).

REVIEW OF APPLICATION FOR AUTHORITY TO CONSTRUCT AND OPERATE
SECTION (8) REVIEW
Project Number: 2010-09-030
Installation ID Number: 175-0001
Permit Number:

Thomas Hill Energy Center
State Road F
Clifton Hill, MO 65244

Complete: September 17, 2010

Parent Company:
Associated Electric Cooperative, Inc.
P.O. Box 754
Springfield, MO 65801-0754

Randolph County, S55, T19, R15W

REVIEW SUMMARY

- Thomas Hill Energy Center has applied for authority to revise the CO limit given in Permit No. 122009-002 which was for the construction of equipment and associated use of CyClean additives in the cyclone boilers.

- Hazardous Air Pollutant (HAP) emissions are not expected to increase as a result of the revised CO limitation.

- None of the New Source Performance Standards (NSPS) apply to the addition of the CyClean additives to the coal.

- None of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) apply to this installation. None of the currently promulgated Maximum Achievable Control Technology (MACT) regulations apply to the application of the CyClean additives.

- The Best Available Control Technology (BACT) requirements apply to the cyclone boilers, Unit 1 and Unit 2. Good combustion practices will control CO emissions to a level of 0.55 lb/MMBTU on a 30-day rolling average.

- This review was conducted in accordance with Section (8) of Missouri State Rule 10 CSR 10-6.060, Construction Permits Required. Potential emissions of carbon monoxide are above major source levels.

- This installation is located in Randolph County, an attainment area for all criteria pollutants.

- This installation is on the List of Named Installations found in 10 CSR 10-6.020(3)(B), Table 2. The installation's major source level is 100 tons per year and

fugitive emissions are counted toward major source applicability.

- Ambient air quality modeling was performed to determine the ambient impact of CO.
- Emissions testing is not required as a result of the revision to the CO limit.
- A revision to your Part 70 Operating Permit application is required for this installation within 1 year of equipment startup.
- Approval of this permit is recommended with special conditions.

INSTALLATION DESCRIPTION

Associated Electric Cooperative, Inc. Thomas Hill Energy Center (AECI Thomas Hill) includes three base load coal-fired steam electric generating units – Unit 1, Unit 2, and Unit 3. The maximum gross heat input ratings listed in the Acid Rain Program monitoring plan is 2,180, 3,579, and 8,182 million Btus per hour, respectively. The units utilize Powder River Basin (PRB) coal, but have the option of burning fuel oil. The units currently control particulate matter emissions using an electrostatic precipitator, while selective catalytic reduction (SCR) is utilized year round to control NO_X emissions.

The installation is a major source for both construction and operating permits. AECI Thomas Hill is considered a Part 70 source by operating permits and was issued Permit No. OP1999-169 in November 1999. Part 70 Operating Renewal (Project No. 2004-05-016) is currently under EPA final review.

The following permits have been issued to Associated Electric Cooperative, Inc. Thomas Hill Energy Center from the Air Pollution Control Program.

Table 1: Construction Permit History

Permit Number	Issue Date	Description
0278-001	2/6/1978	PSD permit issued by EPA for the construction of a 610 megawatt coal-fired electric generating unit.
0380-011	3/20/1980	Construction of a coal preparation plant and materials handling facility.
0181-002	12/29/1980	Increase in production of coal by 2,680,000 tons per year.
0380-011	1/24/1983	Permit delivery of 750,000 tons of washed coal per year through existing open air coal truck unloading dump to replace heavy machinery and coal piles.
0380-011	6/6/1983	Corrects and superseded previous amendment 0380-011 issued 1/24/1983. Clarifies that coal will be handled by the open air coal truck unloading dump or by heavy machinery from coal piles.
0380-011	9/23/1987	Modifications to truck dump into hopper, new truck dump transfer conveyor, transfer belt conveyor, collecting belt conveyor, rotary breaker, stockpiles
0380-011	8/12/1988	Relocate rotary breaker from power plant to preparation plant, install transfer belt and collecting belt conveyors for rotary breaker, establish 0.75 acre storage pile, increase coal deliveries to 4,500,000 tons per year, allow deliveries at either preparation plant or power plant
0493-017	4/29/1993	All necessary modifications for fuel switch from high sulfur to low sulfur coal.
0493-017A	6/4/1993	Delete radial stacker for coal transfer.
0493-017A	8/30/1993	Contingent condition to reevaluate dusting from coal transfer

		operations. Restore dustless unloader requirement omitted from 6/4/1993 amendment.
0596-041	5/24/1996	SO_3 injection system addition to the Unit 3 precipitator to improve precipitator performance.
0596-041A	10/24/2000	Amendment to 0596-041 to remove SO_2 emission limitation.
122009-002	12/2/2009	Construction of equipment associated with the CyClean process to lower mercury emissions from both boilers.

PROJECT DESCRIPTION

In December 2009, AECI obtained a construction permit (Permit No. 122009-002) for construction of equipment and the associated use of the CyClean additives in their cyclone boilers, Units #1 and #2, at the Thomas Hill Energy Center. The objective of the CyClean process is to improve combustion of sub-bituminous coal and remove mercury in cyclone boilers.

As stated in the previous permit, besides the enhanced mercury removal, the addition of CyClean can allow for the boiler operator to better optimize the combustion process and allow for further reduction of NO_x. Although the addition of CyClean, by itself, does not affect boiler emissions, it improves the bottom slag properties allowing for more sustainable operation with deeper combustion staging; thus allowing the operator to redirect more or less air from the burner to the overfire air as needed while maintaining proper slag viscosities. Ultimately, this allows the operator to stage combustion to a lower stoichiometric ratio which leads to lower NO_x emissions. Since NO_x and CO emissions are inversely related, there may be a possibility for an increase in CO emissions due to changes made to further reduce NO_x. In order to allow for the operation of the boilers with higher CO emissions, AECI has requested that the CO limit established in Permit No. 122009-001 be revised based on a BACT evaluation.

EMISSIONS/CONTROLS EVALUATION

Increased emissions of CO resulting from the use of CyClean additives are the pollutant of concern. Potential emissions were based on an emission rate of 0.55 lb/MMBtu of CO from each of the boilers operating at 100% load. Heat input for Unit 1 and Unit 2 was assumed to be 2,180 MMBtu per hour and 3,579 MMBtu per hour, respectively.

The following table provides an emissions summary for this project. Existing potential emissions were taken from Permit No. 122009-002. Existing actual emissions were taken from the applicant's 2009 Emissions Inventory Questionnaire (EIQ) submittal. Potential emissions of the application represent the CO emissions from the cyclone boilers based on the CO BACT analysis, assuming continuous operation (8760 hours per year).

Table 2: Emissions Summary (tons per year)

Pollutant	Regulatory *De Minimis* Levels	Existing Potential Emissions	Existing Actual Emissions (2009 EIQ)	Potential Emissions of the Application	New Installation Conditioned Potential
PM_{10}	15.0	Major	548.48	N/A	N/A
$PM_{2.5}$	10.0	Major	456.07	N/A	N/A
SOx	40.0	Major	16,628.60	N/A	N/A
NOx	40.0	Major	4,088.02	N/A	N/A
VOC	40.0	Major	179.51	N/A	N/A
CO	100.0	Major	4,578.06	13,873	13,873
HAPs	10.0/25.0	Major	131.94	N/A	N/A

N/A = Not Applicable

PERMIT RULE APPLICABILITY

This review was conducted in accordance with Section (8) of Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required*. Potential emissions of CO are above the major source threshold.

APPLICABLE REQUIREMENTS

Thomas Hill Energy Center shall comply with the following applicable requirements. The Missouri Air Conservation Laws and Regulations should be consulted for specific record keeping, monitoring, and reporting requirements. Compliance with these emission standards, based on information submitted in the application, has been verified at the time this application was approved. For a complete list of applicable requirements for your installation, please consult your operating permit.

GENERAL REQUIREMENTS

- *Submission of Emission Data, Emission Fees and Process Information,* 10 CSR 10-6.110
  The emission fee is the amount established by the Missouri Air Conservation Commission annually under Missouri Air Law 643.079(1). Submission of an Emissions Inventory Questionnaire (EIQ) is required June 1 for the previous year's emissions.

- *Operating Permits*, 10 CSR 10-6.065

- *Restriction of Particulate Matter to the Ambient Air Beyond the Premises of Origin*, 10 CSR 10-6.170

- *Restriction of Emission of Visible Air Contaminants*, 10 CSR 10-6.220

- *Restriction of Emission of Odors*, 10 CSR 10-3.090

BACT ANALYSIS

Any source subject to Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required*, Section (8) must conduct a BACT analysis on any pollutant emitted in greater than de minimis levels. The BACT requirements are detailed in Section 165(a)(4) of the Clean Air Act, at 40 CFR 52.21 and 10 CSR 10-0.60(8)(B).

BACT analysis is required for CO at AECI's Thomas Hill Energy Center. The addition of CyClean additives to Unit 1 (2,180 MMBtu per hour) and Unit 2 (3,579 MMBtu per hour) cyclone boilers has resulted in the ability by boiler operators to further optimize boiler performance. However, in order to get the highest reductions of pollutants such as NO_x as allowed by the addition of CyClean additives, the CO emissions may increase. The proposed increase in the permitted emission rate of CO does not involve any physical changes to the plant; however, it can be categorized as a change in the method of operation. Since a significant emissions increase and a significant net emissions increase is projected to occur, the proposed project is a major modification and is subject to PSD review for CO.

Potential CO Control Technologies

CO emissions can be controlled by either minimizing CO formation during combustion or by oxidizing any CO formed in the combustion process with post-combustion oxidation systems.

- Combustion Controls
  - Good Combustion Practices
- Post-Combustion Controls
  - Catalytic Oxidation
  - Thermal Oxidation

Combustion Controls:

Good combustion practices prevent formation of CO during combustion. A number of measures can be taken to ensure that CO generation is minimized, including: maintaining proper fuel-to-air-flow ratios; visually monitoring combustion conditions for excessive haze, ash agglomeration and bridging on boiler tubes; periodically checking coal mill performance for coal fineness; periodically measuring unburned carbon to determine how combustion can be optimized; determining proper control settings for optimum efficiency and minimal CO generation; and empirically determining optimal CO emission rates and NO_x emission reduction during unit testing and tuning.

Post-Combustion Controls:

Two post-combustion control systems were identified for potential application for Thomas Hill Energy Center's cyclone boilers: catalytic oxidation and thermal oxidation. Both of these post-combustion control systems are currently used to control VOC and CO emissions from other types of sources in other industries.

Catalytic oxidation requires oxygen, minimal heat and a catalyst to convert CO to CO_2.

Catalytic oxidation is widely used in the refinery industry and for gas turbines in the utility industry. However, the noble metal catalysts typically used are highly susceptible to poisoning from high sulfur compounds. High particulate loading can also cause rapid deactivation and fouling. Placement of the oxidation unit downstream from the particulate matter control device would make re-heating of the exhaust stream necessary from approximately 300 ºF to 500-600 ºF, increasing emissions of NO_x and PM_{10} from combustion of additional fuel. The conditions necessary for CO conversion also favor the conversion of $SO_2 \rightarrow SO_3$. The applicant states that as great as 50% conversion could occur. The SO_3 would combine with moisture in the flue gas, increasing sulfuric acid mist emissions from the stack.

Thermal oxidation also uses heat and oxygen for the $CO \rightarrow CO_2$ conversion, but without the use of a catalyst. Temperatures in excess of 1,500 ºF are required. As with the catalytic oxidation unit, to prevent fouling, the thermal oxidizer would need to be located downstream of the particulate matter control device. Heat exchangers and a natural gas furnace would be needed to raise the temperature from approximately 300ºF to the required temperature. Additional NO_x and PM_{10} emissions would result.

There are no post-combustion controls in use on coal-fired boilers at this time; these controls use has historically been for the control of volatile organic compounds. Neither catalytic nor thermal oxidation is considered to be technically or commercially feasible for reducing CO emissions from utility-sized cyclone boilers. For these reasons and the ones cited above, post-combustion controls will not be further considered.

BACT for CO

Good combustion practices are the only technically feasible alternative for minimizing CO emissions. Unit 1 and Unit 2 have been operating with CyClean additives since July 1, 2010 and August 25, 2010, respectively. This is approximately 3 months or less at the time of this permit. Initial CO emissions from CEMS data since the start-up of use of the CyClean additives are lower than the first 6 months of operation for the year. However, this is attributed to operator diligence in improving combustion efficiency on the units. In addition, the boilers have been operating for a relatively short-term with the Cyclean which does not represent long-term emissions.

Regardless, one of the main benefits of the CyClean addition is improved combustion characteristics that allow for optimized over-fire air operation. In other words, CyClean is believed to aid in staging combustion to a lower stoichiometric ratio and thus further reducing NO_x emissions. Although CO emissions are a result of incomplete combustion, they are inversely related to NO_x emissions. Minimizing CO emissions remain in the installation's best interest financially; electrical generation per ton of coal combusted decreases with increasing CO emissions. However, controlling CO emissions must be balance with requirements to control NO_x emissions.

Thomas Hill Energy Center's cyclone boilers are being permitted at the lowest level of CO emissions for boilers of their type. A review of the RACT/BACT/LAER Clearinghouse has not identified any additional units for CO controls on cyclone boilers since the New Madrid Power Plant in Permit No. 092006-004 (September 18, 2006)

underwent PSD review for CO for the installation of over-fire air (OFA) combustion controls on Units 1 and 2. As noted in that permit, cyclone burner combustion is a different process than combusting coal in a pulverized coal (PC) boiler. Cyclone boilers are inherently less efficient at combusting coal than PC boilers. In addition, the cyclone boilers at New Madrid were originally engineered for combustion of higher heat content bituminous coal. As a result, their design is smaller/shorter than ideal for burning subbituminous coal (lower Btu coal) and thus does not allow for sufficient residence time at sufficient temperatures to convert all CO to carbon dioxide (CO_2). For these reasons among others, the New Madrid units were not directly compared to the limits achieved or permitted by other boiler types.

A level of 0.55 lb/MMBTU heat input is chosen as the BACT limit (exclusive of start-up, shutdown and malfunction) on a 30-day rolling average. This is equal to the previously approved BACT limit for the New Madrid units. The Thomas Hill Energy Center shall utilize CEMS to monitor the CO emissions from Units 1 and 2. In addition to the lb/MMBTU emissions limit, an annual CO emissions limit of 13,873 tons on a 12-month rolling basis will include start-up, shutdown and malfunction.

AMBIENT AIR QUALITY IMPACT ANALYSIS

AECI – Thomas Hill Energy Center submitted a Class I and Class II Ambient Air Quality Impact Analysis (AAQIA). The Class I AAQIA was for Hercules Glades. Based upon the model reviewed by the Air Pollution Control Program staff, the study submitted by AECI is complete and demonstrates that AECI will not contribute to any violation of the National Ambient Air Quality Standards (NAAQS) or available increment. For a more thorough discussion of the modeling methodology used and the results, please refer to the attached memorandums entitled *Ambient Air Quality Impact Analysis (AAQIA) for Associated Electric Cooperative, Inc. (AECI)-Prevention of Significant Deterioration (PSD) Modeling-Thomas Hill Energy Center, Clifton Hill, Missouri* dated October 14, 2010.

STAFF RECOMMENDATION

On the basis of this review conducted in accordance with Section (8), Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required*, I recommend this permit be granted with special conditions.

_____ _____

Susan Heckenkamp Date
Environmental Engineer

PERMIT DOCUMENTS

The following documents are incorporated by reference into this permit:

- The Application for Authority to Construct form, dated September 14, 2010, received September 14, 2010, designating Associated Electric Cooperative, Inc. as the owner and operator of the installation.
- U.S. EPA document AP-42, *Compilation of Air Pollutant Emission Factors*, Fifth Edition.
- Northeast Regional Office Site Survey, dated Month Day, Year.

Mr. Todd Tolbert
Environmental Specialist
Associated Electric Cooperative, Inc.
P.O. Box 754
Springfield, MO 65801-0754

RE: New Source Review Permit - Project Number: 2010-09-030

Dear Mr. Tolbert:

Enclosed with this letter is your permit to construct. Please study it carefully. Also, note the special conditions, if any, on the accompanying pages. The document entitled, "Review of Application for Authority to Construct," is part of the permit and should be kept with this permit in your files. Operation in accordance with these conditions, your new source review permit application and with your revised operating permit is necessary for continued compliance. The reverse side of your permit certificate has important information concerning standard permit conditions and your rights and obligations under the laws and regulations of the State of Missouri.

If you have any questions regarding this permit, please do not hesitate to contact Susan Heckenkamp, with the Department's Air Pollution Control Program, P.O. Box 176, Jefferson City, MO 65102 or by phone at (573) 751-4817. Thank you for your attention to this matter.

Sincerely,

AIR POLLUTION CONTROL PROGRAM

Kendall B. Hale
New Source Review Unit Chief

KBH:shm

Enclosures

c: Northeast Regional Office
PAMS File: 2010-09-030

Permit Number: