APPENDIX J

KCPL Hawthorn Variability Analysis Documentation

Support for 785 Pound per Hour 720 Hour Rolling Average Emission Rate at Hawthorn 5

The following provides support for a 785 lb SO2 per hour 720 hour average limit for Hawthorn Generating Station Boiler 5 based on 1) the individuality of the SO2 control system 2) EPA's malfunction protections in recent rulemakings that are pertinent to the operation of Hawthorn 5 and 3) EPA's startup and shutdown (SS) understanding in recent rulemakings.

Individuality of Hawthorn SO2 Control

Of 124 reporting Missouri electricity generating units in EPA's CAMD & Air Markets Database http://ampd.epa.gov/ampd/, only Hawthorn 5 is shown as having 'Dry Lime FGD' for SO2 control. Therefore, the unit's behavior cannot be readily modeled on similar units in the state as there are none.

Hawthorn 5's dry scrubber system was added in 2001 to replace equipment damaged in an accident. In that circumstance, the need to get back online compressed design, engineering and purchasing phases of a complex equipment install. The dry scrubber installed in 2001 is a first of its kind device that provides control when its two nozzles and their related pumps, valves, meters and other equipment are operating normally.

Being first of its kind, the scrubber is a challenging piece of equipment. One key aspect that cannot be corrected by time and learning is Hawthorn 5's dry scrubber is not "over designed" and does not "over control". Hawthorn 5's dry scrubber contains 2 nozzles or "atomizers". When one of the atomizers is incapacitated because of clogging, freezing, pump or valve malfunction the SO2 control of stack gas drops significantly.

When such a malfunction occurs time is required to diagnose the issue and stage the labor, tools, and replacement parts to resolve the event. Even though a backup lime pump is available on-site, because of spatial considerations, to resolve a pump malfunction the old pump must be disconnected before the new one can be placed online.

Unit Behavior

Unit performance variances can be observed over time by examining EPA hourly continuous emissions monitoring system (CEMS) data available at http://ampd.epa.gov/ampd/. In order to test the proposed 720 hour limit against actual unit behavior Kansas City Power & Light Company (KCP&L) looked back over 5 years at the control behavior of the dry scrubber unit using this hourly data. As an example of control challenges we focus on two periods in 2010: 1) January and 2) September-October.

The January 2010 hourly SO2 mass one hour and 720 hour average is shown charted in Attachment 1. Between January 8 and January 10 hourly rates oscillated between 44 and 1416 pounds per hour. Review of O&M records from the period show the cause of these oscillations as plugged and frozen lines to the atomizer. Since that incident those lines have been moved inside to a heated area.

In late September early October 2010 the pumps to the two atomizer nozzles failed alternatively causing hourly masses to range between 207 pounds per hour to 1441 pounds per hour of SO2 over five days. The hourly spikes drove the 720 hour average above 610 pounds per hour, see Attachment 2.

These two incidences while infrequent are examples of unit unpredictability and malfunctions outside of operator control.

EPA's Understanding of Dry Scrubber Capability

EPA allows a startup shutdown and malfunction exemption as well as an affirmative defense for SO2 exceedances in the state of the regulatory art for Hawthorn 5 class boilers, the MATS rule, at §63.10000(a):

> "These limits apply to you at all times except during periods of startup and shutdown."

The background for this exemption is that EPA acknowledges that dry scrubbers are typically ineffective at startup temperatures and pressures (see MATS preamble 77 Fed. Reg. 9,381 col. 30):

> "The EPA also is requiring sources to vent emissions to the main stack(s) and operate all control devices necessary to meet the normal operating standards under this final rule (**with the exception of dry scrubbers** and SCRs) when coal, solid oil-derived fuel, or residual oil is fired in the boiler during startup or shutdown."

> "the EPA is aware that dry scrubbers also need to be operated close to flue gas saturation temperature. Because these devices have specific temperature requirements for proper operation…"

Clear Affirmative Defense for Malfunctions

Sierra Club's Petition for Rulemaking, Treatment of Excess Emissions in State Rules by Sources During Periods of Startup, Shutdown, or Malfunction (SSM), Fed. Reg., Vol. 78, 12,460 and http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2012-0322-0055.

EPA defines "malfunction" in the proposed rule at as:

> "malfunction means a **sudden** and **unavoidable** breakdown of process or control equipment."

Emphasis is added here and reinforced throughout the document as Sierra Club petitions that **all** exceedances of emissions limits are violations. EPA does not agree with Sierra Club and differentiates startup and shutdowns from malfunctions:

> "The EPA does not agree with the Petitioner that appropriately drawn affirmative defense provisions for violations due to excess emissions that result from malfunctions are contrary to the CAA, and thus the EPA is proposing to deny the request to revise its interpretation of the CAA concerning affirmative defenses for malfunctions."

> "EPA's SSM Policy has long recognized that there may be limited circumstances in which excess emissions are entirely beyond the control of the owner or operator. Thus, the EPA believes that an appropriately drawn affirmative defense provision recognizes that, despite diligent efforts by sources, such circumstances may create difficulties in meeting a legally required emission limitation continuously and that emission standards may be violated under limited circumstances beyond the control of the source."

A further call for flexibility and reasonableness:

> "While "continuous" standards are required, there is also case law indicating that technology-based standards should account for the practical realities of technology. For example, in Essex Chemical v. Ruckelshaus, the court acknowledged that in setting standards under CAA section 111, "variant provisions" such as provisions allowing for upsets during startup, shutdown and equipment malfunction "appear necessary to preserve the reasonableness of the standards as a whole and that the record does not support the 'never to be exceeded' standard currently in force." Though intervening case law and amendments to the CAA call into question the relevance of this line of cases today, they support the EPA's view that a system that incorporates some level of flexibility is reasonable and consistent with the overall intent of the CAA."

Further support for malfunction affirmative defense:

> "Providing an affirmative defense to sources for violations that they could reasonably anticipate and prevent is not consistent with the theory that supports allowing such affirmative defenses for malfunctions, i.e., that where excess emissions are entirely beyond the control of the owner or operator of the source it is appropriate to provide limited relief to claims for monetary penalties."

And:

> "The distinction that makes affirmative defenses appropriate for malfunctions is that by definition those events are unforeseen and could not have been avoided by the owner or operator of the source…"

Malfunctions are unforeseeable:

> "the EPA's SSM Policy describes malfunctions as events that "did not stem from any activity or event that could have been foreseen and avoided, or planned for."

Again later:

> "EPA interprets the CAA to allow only affirmative defense provisions that are available for events that are entirely beyond the control of the owner or operator of the source. Thus, an affirmative defense may be appropriate for events like malfunctions, which are sudden and unavoidable events that cannot be foreseen or planned for."

EPA's definitive response to Sierra Club:

> "EPA does not agree with the Petitioner that affirmative defenses should never be permissible in SIPs. The EPA believes that narrowly drawn affirmative defenses can be permitted under the CAA for malfunction events, because where excess emissions are entirely beyond the control of the owner or operator of the source, it can be appropriate to provide limited relief to claims for monetary penalties."

In many cases at Hawthorn 5 startups and shutdowns are beyond the control of the operator, so called "forced outages". These events were unavoidable to prevent loss of life, personal injury, or severe property damage. It follows from EPA's "SIP Call" preamble:

> "EPA notes that the various criteria recommended for affirmative defenses for startup and shutdown to a large extent already mirrored those relevant for malfunctions, such as: (i) The event could not have been prevented through careful planning and design; (ii) the excess emissions were not part of a recurring pattern; and (iii) if the excess emissions

resulted from bypassing a control measure, they were unavoidable to prevent loss of life, personal injury, or severe property damage."

Next, we examine some of the paths of startup that may occur after a "forced outage".

Hawthorn 5 Startups Follow Many Different Paths

The goal of startup is to bring Hawthorn 5 up to steady-state operation as quickly as can be safely done so that the unit efficiently generates electricity, controls emissions, and generates maximum possible revenue. Startups can vary for each given unit, however, based on factors including, but not limited to: (1) the length of time the unit has been down (i.e., whether the start is a hot, cold, or warm); (2) testing or other needs for specific equipment during the startup process; (3) equipment glitches (e.g., plugging of bottom ash and flyash handling systems, ignitors going out because of inadequate pressure); (4) unexpected ambient conditions; and (5) natural variability of fuel characteristics.

Because startups require thousands of individual yet interrelated components and dozens of subsystems to be "set into operation," if even one component or subsystem fails to operate as intended, the entire startup process for an EGU can be delayed. Some detailed examples of the types of issues that can cause startup time periods to become excessive, and that make every startup unique, are discussed below. During a given startup, Hawthorn 5 may experience one or more of these (and other) conditions.

Water Chemistry Hold

Boiler component replacement and work performed on condensate and feedwater systems during outages can introduce impurities into the flow cycle. While the systems are kept as clean as possible prior to bringing the boiler online, not all of the impurities can be eliminated. Thus, as Hawthorn 5 is brought online and temperatures and water flows increase, some of these impurities will precipitate out and become entrained in the water flow cycle. For this reason, plant personnel monitor water chemistry closely during startup. When out-of-limit water chemistry parameters are detected, the boiler will be held at its current load/steam flow while the water treatment facilities work to purify the process water. This is called a "water chemistry hold."

Water chemistry holds can occur at any point during the startup process, including at low loads (less than 25% capacity). To collect and analyze a single round of water samples requires approximately one hour. Thus, during a startup, a water chemistry hold can often last two to four hours as plant personnel manually take and analyze multiple water samples and make the necessary adjustments to water treatment. In certain cases, such as following a boiler chemical cleaning (which occurs once every few years) or a long period of shutdown, the water chemistry hold can last 12 hours or more. If load is not held until the water chemistry is within parameters, the impurities can plate out on the turbine, leading to degradation in performance and efficiency. Poor water chemistry also can lead to internal corrosion of boiler tubes, which can contribute to boiler tube failures.

Turbine Differential Expansion

During startup, operators must carefully monitor and control the heating of the rotational and stationary turbine metal. As the boiler starts up and sends steam to the turbine for electricity generation, the different parts of the turbine heat up at different rates. Turbine rotors tend to heat up faster than the stationary turbine components (the shell). To prevent excessive stress caused by differential expansion of the metal of the different turbine parts, the boiler must often hold at an extremely low load (around 5% of capacity) for two to three hours to allow the machine to stretch slowly before the unit can proceed to the next step in the startup sequence. This is a common requirement during a cold start. If load is increased too quickly, the rotor metal will expand quicker than the shell metal, which will cause the already small gaps between the rotating and stationary components to close, leading to vibration issues in the turbine and turbine shutdown. (The turbine must obviously be shut down, whether automatically or manually, before the expansion reaches a point where the rotating parts will mechanically damage the stationary parts.) In the event of a turbine trip, resetting the process can take another eight hours, prolonging the overall startup of the unit. Although the turbine may trip in this event, in order to maintain boiler temperature, boiler combustion may not be halted.

Turbine Crossover Soak

The manufacturer requires a turbine crossover soak on all cold startups. The crossover soak allows the steam piping between the intermediate pressure ("IP") and low pressure ("LP") sections of the turbine to heat up to the proper temperature. The time required for the soak varies according to initial turbine and crossover metal temperature and is dictated by starting and loading charts provided by the manufacturer. Typical requirements include holding the turbine at 5% electricity generation load until crossover temperature reaches 350°F and then holding for an additional hour. It can take two to three hours to reach 350°F, depending on the metal temperature prior to startup and ambient temperature. Total soak time is usually three to four hours before the next steps in the startup sequence can even be initiated. If load is increased too quickly, at a minimum, a fracture in the crossover steam piping is likely to occur, which will take the unit offline and require repair.

Equipment Testing Following an Outage

When equipment or parts are changed during a maintenance outage, testing must often occur when Hawthorn 5 is brought back online to ensure the equipment is working properly and optimally. For example, after coal piping from the pulverizers to the boiler is replaced during an outage, coal line balancing must be performed to ensure that the coal flow is properly distributed for better combustion and efficiency. Some of this testing can be performed prior to bringing the unit back online, but some testing necessarily must occur with coal flowing through the piping. Hawthorn 5 has five pulverizers each with six coal lines. Each coal line must be tested to ensure even distribution in order to ensure optimal combustion in the boiler. Thus, testing of a single pulverizer can take six to eight hours. Before the unit can be brought to full load following this type of work, each pulverizer must be separately tested. The startup process and the time required following electricity generation but prior to 25% load can easily take much longer than six hours.

Another example when equipment considerations impact startup is following maintenance work on the turbine. Upon startup, the turbine can experience vibration issues as replaced or repaired parts interact with existing parts for the first time. If vibration is detected, plant personnel must perform diagnostics to determine whether the vibration level is acceptable or if adjustments need to be made. During this time, the unit may be held at low load (less than 25%) for as long as 12 hours. Certain levels of vibration over an extended period of time can damage the turbine. For this reason, if the vibration level is unacceptable, special analysis and calculations are required while the unit is running at this reduced state in order to determine the necessary size correction weight.

Characterization of startups as "normal" suggests that Hawthorn 5's startup is a predictable and consistent event. It is not. Even well-operated and maintained units will often have protracted startups due to the type of situations discussed above. The varying emissions profile of startups for the unit, demonstrates the variable nature of the startup period.

EPA's SSM Policies Also Do Not Prohibit "Exemptions"

EPA's various memoranda articulating a view that all excess emissions are violations[1] (referred to collectively as the "SSM policies") are not based on the CAA § 302(k) definition of "emission limitation." Up to now, EPA's policies have continued to recognize the appropriateness of these provisions for "technology-based" standards like the NSPS. In any event, those policies are not binding and largely confuse the issues by failing to distinguish between periods when the data reported as "excess emissions" are covered by the emission limitation, and periods when the data reported are not subject to the emission limitation.

While SSM policies correctly indicate that emissions in excess of an "applicable" standard may be violations, as the Bennett Memorandum on Continuous Compliance made clear, where a rule provides an exclusion for the period, there can be no violation even if the numerical standard is exceeded. Where exclusion is not provided, EPA recommends the use of enforcement discretion to deal with reported exceedances. In short, those SSM policies recognized states' ability to limit applicability of emission limitations to those periods when compliance reasonably could be expected, and viewed the concept of "continuous compliance" as the avoidance of otherwise

[1] (1) Memorandum from J. Rasnic to L. Murphy, Dir. Region I, Automatic or Blanket Exemptions for Excess Emissions During Startup, and Shutdowns Under PSD (Jan. 28, 1993) ("1993 Rasnic Memo"), (2) Memorandum from K. Bennett to Regional Administrators, Policy on Excess Emissions During Startup, Shutdown, Maintenance, and Malfunction (Sep. 28, 1982) ("1982 SSM Guidance"), (3) Memorandum from K. Bennett to Regional Administrators, Policy on Excess Emissions During Startup, Shutdown, Maintenance, and Malfunction (Feb. 15, 1983) ("1983 SSM Guidance"), (4) Memorandum from S. Herman to Regional Administrators, State Implementation Plans: Policy Regarding Excess Emissions During Malfunction, Startup, and Shutdown (Sept. 20, 1999) ("1999 SSM Guidance").

"preventable" exceedances. Bennett Memorandum on Continuous Compliance; see above previously mentioned p. 20.

EPA's current SSM policies also do not declare all "automatic exemptions" unlawful. While current policies restrict MDNR's use of generally applicable "automatic exemptions" for excess emissions due to SSM events, this is based on an assumption that such events are difficult to predict. Standards that account for inherent limitations or variability in the operation of control technology through specific exclusions, the impacts of which can be evaluated through RE calculations and modeling, are not prohibited by those policies as long as they meet EPA's criteria. See, e.g., 1999 SSM Guidance at 5-6 ("Source Category Specific Rules for Startup and Shutdown"), discussed below p. 42-44.

General Duty Requirements Qualify as Emission Limitations

CAA § 110(a)(2)(A) authorizes use of "emission limitations" and "other control measures, means, or techniques" to comply with the NAAQS. CAA § 302(k) defines "emission limitation" to include "any requirement relating to the operation or maintenance of a source to assure continuous emission reduction and any design, equipment, work practice or operational standard promulgated under this chapter." Those provisions, particularly when read in the context of MDNR's broad discretion to determine what controls are "appropriate or necessary," clearly authorize MDNR to employ a broad range of strategies to meet CAA related requirements. EPA interpretation of "emission limitation" mandates that states (and EPA) apply some control requirement at all times, the "general duty" requirements adopted by EPA and by states clearly would satisfy that standard. See, e.g., Citizens for a Better Env't v. EPA, 649 F.2d 522, 528-29 (7th Cir. 1981) (upholding a state's requirement for an "operating plan" to reduce fugitive emissions as clearly falling within the meaning of "any requirement relating to the operation" under § 302(k) despite the lack of requirement for state approval of the plan).

Conclusion

Based on the individuality of the SO2 control system at Hawthorn 5, EPA's malfunction protections in recent rulemakings that are pertinent to the operation of Hawthorn 5 as well as

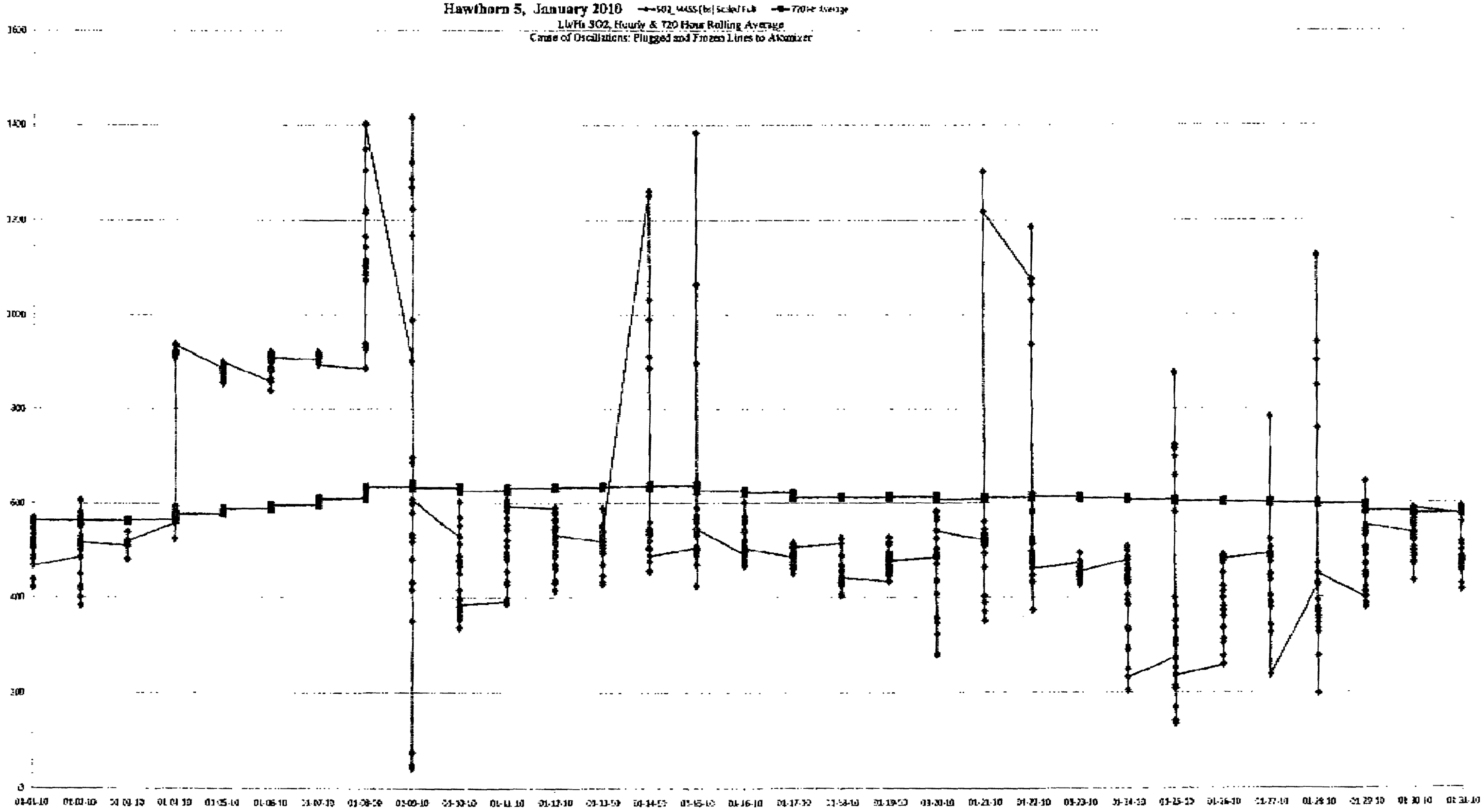
EPA's startup shutdown and (SS) understanding in recent rulemakings. KCP&L requests a value of 785 pounds per hour with a 720 hour rolling average at Hawthorn 5.

Attachment 1

Hawthorn 5, January 2010

Lb/Hr SO2, Hourly & 720 Hour Rolling Average

Cause of Oscillations: Plugged and Frozen Lines to Atomizer



Attachment 2

Hawthorn 5, Sept 25 to Oct 2, 2010

Lb/Hr SO2, Hourly & 720 Hour Rolling Average

Cause of Oscillations: Multiple Lime Pump Failures