minnesota power
AN ALLETE COMPANY

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June 10, 2020

**VIA E-FILING**
Will Seuffert
Executive Secretary
Minnesota Public Utilities Commission
121 7th Place East, Suite 350
St. Paul, MN 55101-2147

Re: **Annual Automatic Adjustment of Charges Report - Electric**
**Docket No. E999/AA-20-171**
**Supplemental**

Dear Mr. Seuffert:

Minnesota Power (or the "Company") respectfully submits to the Minnesota Public Utilities Commission a correction to Attachment 15 in the Annual Automatic Adjustment of Charges Report filed on March 2, 2020.

While the Company was reviewing the Department of Commerce, Division of Energy Resources ("Department") Response Comments filed on May 29, 2020, it was discovered that the GADS Equivalent MWh lost amount included in Attachment 15 for the Boswell Unit 4 Unplanned Outage related to the Hot Reheat Line Steam Leak was understated by 368,136 MWhs. Included is a corrected Attachment 15.

Minnesota Power is currently working on Reply Comments to the Department's Response Comments filed on May 29, 2020.

Please contact me at (218) 355-3455 or hcreurer@allete.com if you have any questions regarding this compliance filing.

Yours truly,

Hillary A. Creurer
*Regulatory Compliance Administrator*

HAC:th
Attach.

Corrected

# Annual Identification of Forced Outages, Lessons Learned and Mechanism for Information Sharing

Docket E-999/AA-10-884, dated April 6, 2012

**Annual Identification of Forced Outages and Lessons Learned**

Our maintenance practices and reliability programs are constantly being evaluated to ensure continuous improvement of our employees' skills and work processes to improve reliability. All of our craftspeople are required to be trained on precision maintenance as part of their apprenticeship. We also require classroom training for all of the operating staff for asset care and preservation. Those individuals are taught operational best practices for operating pumps, motors, valves etc. Since January 2011, over 60 employees at the leadership level – maintenance leads, operations and maintenance superintendents, maintenance planners, and engineers – have participated in Reliability University. Reliability University is a program that teaches students the best practices of equipment maintenance along with the tools needed to be proactive rather than reactive to ensure equipment reliability. Elements of Reliability University include condition monitoring, vibration analysis, system and components, troubleshooting, precision equipment installation and assembly, instrument and process variability and root cause failure analysis. Additionally, we have increased our expectations and requirements around specifications of new and rebuilt equipment and parts with enhanced use of overhaul specifications and visits to repair shops by engineers and technicians.

Our Outage Planning process continues to be a focal area. A systematic approach to outage planning with improved tools has resulted in projects safely and efficiently executed while ensuring equipment reliability. Outage duration is set based on project scope with project milestones identified, resources allocated, materials ordered, and safety plans in place. Automated reports allow for better coordination, communication, budget management, and analysis of work required. For example, inspection activities that can only be performed with the unit offline are identified so they can be scheduled as early as possible in an outage to allow time to complete work within the outage window.

We continue to implement a program called Operational Excellence. The focus of Operational Excellence is to teach Human Performance tools to employees (3 way communication, Peer Checking, Labeling, Procedure Use and Adherence etc.) resulting in increased elimination of potential errors occurring in the field. In addition to the Human Performance tool usage, a “lessons learned” process is completed when an event does occur and those learnings are shared throughout the facilities.

**Tube Leaks**

Tube leaks are statistically the most common cause of outages in coal fired power plants. The most common causes of tube leaks:

- thermal fatigue
- soot blower erosion
- fly ash erosion
- chemical attack

**Thermal fatigue** manifests itself as cracking of the boiler tubes - sometimes as very small "micro" cracks and sometimes as large cracks. This occurs as a result of changing boiler temperatures, usually when the boiler swings up or down to follow load and when the boilers start up and shut down. This is a similar effect to bending a paper clip back and forth - after so many cycles it eventually breaks. Minimizing boiler “swings” (base loading) helps minimize the impact of thermal fatigue. However, with the energy markets being what they are with the ever increasing impacts of intermittent wind generation, we are seeing more and more swings in output.

**Soot blower erosion** occurs in areas where soot blowers are used to 'blow off' ash or slag which accumulates on boiler tubes. Soot blowers use high pressure steam or high pressure air to do the cleaning. The ash removal is necessary to improve heat transfer which improves boiler thermal efficiency. Common practices to mitigate soot blower erosion are to add a weld overlay (commonly called “pad welding”) to existing tubes, add tube shields which are essential sacrificial attachments to the tubes, changing soot blower media pressure (usually not an option) and tube replacement in the affected

areas. The use of the soot blowers is essential in keeping the units on line. Coal composition can differ from mine to mine or even within the same mine. As we look to find the best low cost fuel blend for our customers, certain coals may cause more fouling than others. The increased potential of this fouling requires both the frequency and duration of soot blowing to increase which minimizes the buildup on the boiler tubes. We are increasing using higher alloy weld overlay to provide increased tube longevity.

**Fly ash erosion** occurs when fly ash and combustion gases pass rapidly across superheated boiler tube surfaces. Because of the abrasiveness of fly ash, the surface of boiler tubes in the high flow areas slowly erode. Many things contribute to the amount of erosion, such a gas path restrictions (plugging- see reasons for soot blowing above), variations in coal quality (higher ash content), other additives which are added to the fuel mix typically for emission control, etc.

**Chemical attack** is becoming a common source of tube failures due to the corrosiveness of many of the additives being used to control emissions. When these chemicals come in contact with very hot boiler tubes, their normal corrosiveness is significantly increased. Since there tend to be few options for using alternate less corrosive additives, a common solution is to look at tube materials which perform better in the corrosive environment. This is usually a very expensive fix and can have environmental compliance implications.

Minnesota Power has a boiler reliability program which is very effective in proactively identifying areas of the boilers where tube leaks are likely to occur and minimizing that risk with proactive maintenance practices. The program uses a combination of visual inspections, non-destructive testing methods (NDT), tube sample analysis, tube failure history, and industry experiences to avoid forced outages due to unexpected tube leaks.

To give some perspective on the challenges with any boiler reliability program, consider the following:

- Boswell-3 boiler has 473,891 ft (89.7 miles) of varying diameter boiler tubes
- Boswell-4 boiler has 779,905 ft (147.6 miles) of varying diameter boiler tubes

The boiler tube surface area where a leak can occur is several hundred thousand square feet in either boiler.

A tube leak usually begins as a very small hole (0.10 inch or less) in the tube wall which can expand rapidly due to the high temperature and pressure. Considering the huge surface area in a boiler and the very small size of the hole or microscopic crack which results in a tube leak, it is very difficult to effectively screen the entire boiler to prevent all tube leaks. As part of our boiler reliability program, whenever there is an opportunity to get into the boiler to do an inspection – a forced or schedule outage – critical areas are inspected to evaluate erosion rates and to determine if repairs are needed. This information is used to plan for future capital expenditures to help minimize future tube leaks. During these inspection opportunities, small leaks are sometimes found and repaired. Similar proactive maintenance practices are routinely followed at the other Minnesota Power thermal facilities.

**Non Boiler related outages**

Minnesota Power has a Generation Reliability Group that is dedicated to monitoring and improving the reliability of not only the boiler but also the rotating equipment. The group is comprised of boiler, turbine and pulverizer engineers/specialists as well as specialists in predictive maintenance technologies. They work on a daily basis with the operating and maintenance groups at all facilities to improve the daily operating practices, planning for work and repairs to occur in future outages and establishing 5 and 10 year maintenance plans.

Rotating equipment that is monitored through various predictive technologies is summarized in a monthly reliability meeting with the specific plant. The manager is provided with a monthly scorecard as to their performance as well as identifying concerns and upcoming needs.

**Mechanism for Some Level of Information Sharing**

Minnesota Power is open to sharing lessons learned on a generic basis with the other utilities on an annual basis.

However, the concept of sharing lessons learned is more attractive in theory than in practice. Each utility's generating units are unique (manufacturer, date of installation, fuel type and mixture, base loaded vs. cyclic loading etc.), as is each company's operation and maintenance practices. Furthermore, sharing best practices regarding planned outages over and above what companies have already described in public filings borders on releasing confidential information about outage planning and energy marketing. This could work to harm that utility's customers if it were made available to other parties, since those practices provide the utility its best protection in acquiring replacement energy at the lowest cost possible.

Minnesota Power will continue to provide information on forced outages and what steps, if any, could have helped in avoiding or alleviating outages.

| Unit | Event Type | DOC Primary Reason for the Outage | GADS Equivalent MWh lost | GADS Start Date/Time of Actual Outage | GADS End Date/Time of Actual Outage | DOC Equipment or Condition that Resulted in the Outage | DOC Description of Equipment Failure (including identified root cause) | DOC Steps Taken to Alleviate Reoccurrence | DOC Change in Energy |
|---|---|---|---|---|---|---|---|---|---|
| BEC 2 | Unplanned Outage | Boiler Waterwall Leak | 2,542 | 7/16/18 14:34 | 7/18/18 4:30 | Superheat Tube Leak. | Tube failed due to fatigue. | Repair and inspect surrounding areas. The superheat is at the end of its useful life, however the unit will retire at the end of the year and no further action will be taken. | $ 20,840 |
| BEC 2 | Unplanned Outage | Boiler SH Tube Leak | 1,639 | 7/30/18 23:32 | 8/1/18 6:27 | Boiler Reheat Tube Leak | Fireside erosion. | Repair and inspect surrounding areas. The superheat is at the end of its useful life, however the unit will retire at the end of the year and no further action will be taken. | |
| BEC 4 | Unplanned Outage | Boiler SH Tube Leak | 34,636 | 7/17/18 0:02 | 7/19/18 11:45 | Superheat Tube Leak. | Fatigue stress cracking - overheating. | The refractories were removed to inspect every tube connection on the header. During that inspection an additional crack was repaired. | $ 122,673 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 12,860 | 7/25/18 22:07 | 7/27/18 10:39 | Waterwall tube. | Corrosion Fatigue. | Inspect and repair surrounding area. A capital project was completed in 2019 to address areas where failures occurred over the past 3 years. | $ (60) |
| BEC 2 | Unplanned Outage | Boiler Super Heat Tube Leak | 2,071 | 7/30/18 23:32 | 8/1/18 6:27 | Reheater and Superheat Tube Leak. | Fatigue stress cracking - overheating. | Reheat tube was sectioned out and replaced and the superheat tube was repaired in place. These elements are near the end of life and will not be replaced due to unit retirement at year-end. | $ (2,063) |
| BEC 1 | Unplanned Outage | Boiler Waterwall Leak | 2,102 | 8/9/18 22:10 | 8/11/18 5:32 | Waterwall Tube Leak. | Urea injection nozzle. | Repaired nozzle. | $ 10,095 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 12,596 | 8/14/18 23:59 | 8/16/18 11:46 | Waterwall Tube Leak. | Corrosion Fatigue. | Inspect and repair surrounding area. Additional inspection and repairs were completed in the spring 2019 outage. | $ 80,454 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 16,239 | 9/19/18 20:21 | 9/21/18 18:29 | Waterwall Tube Leak. | Corrosion Fatigue. | Inspect and repair surrounding area. Additional inspection and repairs were completed in the spring 2019 outage. | $ 17,190 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Tube Leak | 19,002 | 10/3/18 17:25 | 10/5/18 23:24 | Waterwall Tube Leak. | Corrosion Fatigue. | Repaired tube leak. 2019 outage project completed to remove seal skirt, grind weld, perform 100% inspection and reattach seal skirt. 22 tubes were replaced at this time. | $ 110,721 |
| BEC 4 | Unplanned Outage | Flash Tank Piping Leak | 8,700 | 10/14/18 21:57 | 10/15/18 12:57 | Boiler Flash Tank Pipe Connection. | Failure from fatigue. | Pipe connection was repaired. | $ 46,402 |
| BEC 1 | Unplanned Outage | Boiler Waterwall Leak | 2,478 | 11/9/18 0:05 | 11/10/1018 13:04 | Waterwall Tube Leak. | Sootblower erosion caused tube failure. | Inspected surrounding areas and repaired. Unit will be retired at year-end. | $ 4,914 |

| Unit | Event Type | DOC Primary Reason for the Outage | GADS Equivalent MWh lost | GADS Start Date/Time of Actual Outage | GADS End Date/Time of Actual Outage | DOC Equipment or Condition that Resulted in the Outage | DOC Description of Equipment Failure (including identified root cause) | DOC Steps Taken to Alleviate Reoccurrence | DOC Change in Energy |
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| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 20,340 | 11/12/18 18:02 | 11/15/18 3:49 | Waterwall Tube Leak. | Sootblower erosion caused tube failure. | Inspected and repaired pad weld and other tubes in the area. Also found pinhole leak on steam cooled spacer tube. | $ 383,147 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 10,026 | 11/29/18 0:24 | 11/30/18 4:53 | Waterwall Tube Leak. | Tube failed at a boiler connection / support. Appears to be corrosion fatigue. | 2019 outage project completed to remove seal skirt, grind weld, perform 100% inspection and reattach seal skirt. 22 tubes were replaced at this time. | |
| BEC 3 | Unplanned Outage | Condenser Tube Leak | 22,540 | 12/22/18 0:10 | 12/24/18 16:12 | Condenser. | Condenser tube corrosion fatigue at transition zone. | Eddy current testing of transition zone was completed in the 2019 spring outage. 7 tubes at risk of failing were identified and plugged. Condenser isolation valves were repaired in 2019 spring outage to allow isolation without taking the unit offline. | $ 26,582 |
| BEC 4 | Unplanned Outage | Condenser Tube Leak Repair | 29,435 | 12/29/18 21:15 | 1/1/19 0:00 | Condenser. | Use Condenser tube fatigue crack. | Plugged cracked tube. | $ 32,151 |
| BEC 4 | Unplanned Outage | Condenser Tube Leak Repair | 1,692 | 1/1/19 0:00 | 1/1/19 2:55 | Gas Ignitor Solenoid. | Solenoid failure. | Replaced solenoid. | $ 7,716 |
| BEC 3 | Unplanned Outage | Repair Hydrogen Leak | 11,252 | 2/2/19 22:50 | 2/4/19 6:48 | Generator Lead Box. | Hydrogen leak on generator lead box. | Leak was temporarily patched externally. Internal repairs were executed during the 2019 outage to eliminate the lead box leak. | $ 89,610 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 11,622 | 2/22/19 12:36 | 2/23/19 21:37 | Waterwall Tube Leak. | Corrosion Fatigue. | Inspect and repair surrounding area. A capital project was completed in 2019 to inspect for corrosion fatigue. | |
| BEC 4 | Unplanned Outage | Hot Reheat Line Steam Leak | 681,539 | 2/6/19 11:39 | 3/27/19 11:43 | Hot Reheat Steam Line. | Hot reheat line failed on longitudinal seam weld. | The failure occurred on a longitudinal seam, which had been inspected as part of a normal maintenance schedule. The entire steam line required inspection to identify potential for future failure and minimize risk to employees and equipment due to catastrophic failure of the line. The entire hot reheat line was scaffolded, insulation removed, and inspected by two different consultants. Three sections of pipe were replaced and 140' of patch plate installed on advice of consultants. The entire line will be replaced with seamless pipe in 2020. | $ 4,482,456 |
| BEC 3 | Unplanned Outage | Hydrogen Leak Repair | 70,676 | 6/14/19 15:01 | 6/22/19 23:47 | Generator Seal Oil System. | The generator failed the air test, losing hydrogen at an unacceptable rate. The cause was failure of the float trap valve. | Float Valve was replaced and added to inspection list for future overhauls on this Turbine. | $ 71,711 |

| Unit | Event Type | DOC Primary Reason for the Outage | GADS Equivalent MWh lost | GADS Start Date/Time of Actual Outage | GADS End Date/Time of Actual Outage | DOC Equipment or Condition that Resulted in the Outage | DOC Description of Equipment Failure (including identified root cause) | DOC Steps Taken to Alleviate Reoccurrence | DOC Change in Energy |
|---|---|---|---|---|---|---|---|---|---|
| BEC 3 | Unplanned Outage | Boiler Circulation Pump 3C Replacement | 18,351 | 7/5/19 20:00 | 7/8/19 0:08 | 3C Boiler Circulation Pump. | Failed mechanical seal on the 3C Boiler Circulation Pump. | 3C BCP was replaced with spare on hand. | |
| BEC 3 | Unplanned Outage | Turbine Trip Caused by "A" Phase Bushing Failure | 150,773 | 7/8/19 19:13 | 7/26/19 15:33 | Generator Bushing Failure. | Unit tripped on stator ground fault. | "A" phase line side bushing failed. The OEM was brought in to diagnose and repair. The OEM had no conclusive answer as to why this particular bushing failed. Since the other bushings were of a similar age and labor and parts were already mobilized, it was decided to replace all six bushings and gaskets in the lead box area. | $ 1,736,961 |
| BEC 3 | Unplanned Outage | Boiler SH Tube Leak | 15,828 | 8/1/19 19:17 | 8/3/19 16:15 | Boiler Superheat Tube Leak. | Thermal fatigue. | Sectioned out and replaced. Superheat platen pendant inspection scheduled for next outage of sufficient length. | $ 217,669 |
| BEC 4 | Unplanned Outage | Condenser Cleaning | 35,535 | 8/16/19 19:17 | 8/19/19 8:33 | Condenser. | Mechanical failures of the online condenser cleaning system allowed for biological buildup in condenser that created excessive backpressure. | Online cleaning system was repaired. Engineering assessment initiated to evaluate options to improve the online cleaning system. Repairs planned for 2020. | $ 244,491 |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 10,202 | 10/10/19 21:54 | 10/12/19 2:53 | Boiler Waterwall Leak. | Corrosion Fatigue. | Leak was ground out and repaired following MN Power Weld Program guidelines. | $ (4,044) |
| BEC 3 | Unplanned Outage | Boiler Waterwall Leak | 22,956 | 12/19/19 22:19 | 12/22/20119 15:29 | Waterwall and superheat tube leak | Dissimilar metal weld failure. | Crack repaired, dissimilar metal weld inspection to be completed at next outage of sufficient duration. | $ 28,383 |

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| | ) ss | ELECTRONIC FILING |
| COUNTY OF ST. LOUIS | ) | |

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Tiana Heger of the City of Duluth, County of St. Louis, State of Minnesota, says that on the 10th day of June, 2020, she served Minnesota Power's Supplemental filing in **Docket No. E999/AA-20-171** on the Minnesota Public Utilities Commission and the Energy Resources Division of the Minnesota Department of Commerce via electronic filing. The persons on E-Docket's Official Service List for this Docket were served as requested.

Tiana Heger