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March 1, 2022

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

Re: In the Matter of an Investigation into Self-Commitment and Self-Scheduling of Large Baseload Generation Facilities
Docket No. E999/CI-19-704
Annual Compliance Filing

Dear Mr. Seuffert:

Minnesota Power respectfully submits its annual compliance report analyzing the Company's 2021 self-commitment of its baseload generation facilities pursuant to the Minnesota Public Utilities Commission Orders in Docket Nos. E999/AA-18-373 and E999/CI-19-704.

Attachments 1 and 2 to this filing contain information Minnesota Power considers Trade Secret. The Company believes this filing comports with the Minnesota Public Utilities Commission's Notice relating to Revised Procedures for handling Trade Secret and Privileged Data, pursuant to Minn. Rule 7829.0500. As required by the revised procedures, a statement providing the justification for excising the trade secret data is attached to this letter.

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.

STATEMENT REGARDING JUSTIFICATION FOR EXCISING TRADE SECRET INFORMATION

Pursuant to the Commission's revised Procedures for Handling Trade Secret and Privileged Date in furtherance of the intent of Minn. Stat. § 13.37 and Minn. Rule 7829.0500, Minnesota Power has designated portions of its attached compliance filing as Trade Secret.

Minnesota Power has excised material from this Self-Commitment and Self-Scheduling of Large Baseload Generation Facilities compliance filing ("Report") because the format of the Report requires Minnesota Power to compile and provide information regarding its operating parameters, power supply, and fuel costs. This is highly confidential information relating to Company financial and planning information; Minnesota Power's competitors and vendors would acquire highly confidential commercial information about Minnesota Power if this information were publicly available. In addition, unauthorized disclosure of this information may violate certain federal securities regulations.

Minnesota Power follows strict internal procedures to maintain the secrecy of this information in order to capitalize on economic value of the information to Minnesota Power on behalf of its customers. Minnesota Power respectfully requests the opportunity to provide additional justification in the event of a challenge to the trade secret designation provided herein.

STATE OF MINNESOTA
BEFORE THE
MINNESOTA PUBLIC UTILITIES COMMISSION

In the Matter of an Investigation into Self-Commitment and Self-Scheduling of Large Baseload Generation Facilities	Docket No. E999/CI-19-704 **MINNESOTA POWER'S 2021 COMPLIANCE FILING**

I. OVERVIEW

Minnesota Power (or the "Company") submits this calendar year 2021 annual compliance filing in the above referenced docket in response to following orders issued by the Minnesota Public Utilities Commission ("Commission") in Docket No. E999/AA-18-373 and Docket No. E999/CI-19-704:

- Docket No. E999/AA-18-373, Order Accepting 2016-2017 Reports and Setting Additional Requirements, February 7, 2019 ("February 2019 Order");
- Docket No. E999/AA-18-373, Order Accepting 2017-2018 Electric Reports and Setting Additional Requirements, November 13, 2019 ("November 2019 Order");
- Docket No. E999/CI-19-704, Order Evaluating Self-Commitment and Self-Scheduling Reports and Establishing Additional Filing Requirements, January 11, 2021 ("January 2021 Order"); and
- Docket No. E999/CI-19-704, Order Accepting Reports and Setting Additional Requirements, December 1, 2021 ("December 2021 Order").

2021 Highlights

A few of the highlights from 2021 include the transition of Boswell Energy Center ("Boswell") Unit 3 to economic dispatch and reducing the operational minimums of Boswell Unit 3 from 175 MW to 75 MW, creating significantly more flexibility for the unit in its daily dispatch and an overall customer benefit of **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]** when the units were self-committed and operating in a must run status.

Hourly Data

Hourly data required from Order Point 10 of the November 2019 Order, as well as Order Point 5 from the January 2021 Order, are included in Attachments 1 for Boswell Unit 3

and Attachment 2 for Boswell Unit 4 for the period of January 1, 2021 through December 31, 2021. Attachments 1 and 2 have been designated Trade Secret in their entirety due to the information included.

Joint Ownership

Boswell Unit 4 is a co-owned unit with WPPI Energy ("WPPI") and currently the operating agreement does not allow for a change in how the unit is operated without prior approval of both partners. However, as discussed below in the Economic Dispatch section, the Company is currently in discussion with WPPI on an economic dispatch transition and also with the Midcontinent Independent System Operator ("MISO") on transmission reliability concerns.

II. ANNUAL REPORT

A. 2021 Self-Commitment Analysis

Minnesota Power experienced customer load loss of about 13 percent in 2020, which was roughly equivalent to the loss of its entire residential customer class. That customer load loss, combined with the impacts of the global COVID-19 pandemic, lower energy markets and lower generation levels at Boswell Units 3 and 4 made 2020 an unprecedented year

Challenges continued into 2021 as the power markets experienced major price volatility due to extreme weather events like the polar vortex in February and the significant heat and drought conditions, which started in June and continued through the year. In addition to the extreme weather events, concerns over coal supply and a tightening of global energy markets resulted in a significant increase in both natural gas and power market prices. Natural gas prices increased by approximately 95 percent compared to 2020, while power prices saw an even more dramatic impact, increasing by about 120 percent at MP.MP compared to 2020. Due to the significant increase in market prices and a strong return of its industrial customers in 2021, the Company saw an increase in generation of approximately **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]** more than budgeted at Boswell Units 3 & 4.

Net Cost/Benefit Analysis

As directed by the Commission, Minnesota Power evaluated the financial impact of self-commitment for Boswell Units 3 and 4 for the period of January 1, 2021 through December 31, 2021. As shown in Table 1 below, Minnesota Power's self-commitment of the units resulted in a net benefit of **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]**. This number does not include reliability and other customer benefits from self-commitment. The analysis evaluated all the hours during the year where the unit had a commitment status of must run, and compared the fuel and variable O&M cost to operate versus the net energy payments Minnesota Power received from the MISO market during these same periods. The net (cost)/benefit was calculated in accordance with Order Point 9 of the November 2019 Order.

Table 1: (Cost) / Benefit When Boswell Units are Self-Committed

	(Cost) / Benefit		
	All Hours	**On-Peak /2**	**Off-Peak /3**
	[TRADE SECRET DATA BEGINS		
Boswell Unit 3 Hours with Cost /1	[redacted]	[redacted]	[redacted]
Boswell Unit 3 Hours with Benefit	[redacted]	[redacted]	[redacted]
Boswell Unit 3 (Cost) / Benefit	[redacted]	[redacted]	[redacted]
Boswell Unit 4 Hours with Cost	[redacted]	[redacted]	[redacted]
Boswell Unit 4 Hours with Benefit	[redacted]	[redacted]	[redacted]
Boswell Unit 4 (Cost) / Benefit	[redacted]	[redacted]	[redacted]
Combined Boswell Units 3 and 4	[redacted]	[redacted]	[redacted]
	TRADE SECRET DATA ENDS]		

/1 Boswell Unit 3 was in economic dispatch from July 20, 2021 through December 31, 2021
/2 On-Peak: HE 7-22 Monday-Friday
/3 Off-Peak: HE 23-24, 1-6 Monday-Friday and HE 1-24 Saturday-Sunday

In accordance with Order Point 5.f, Table 2 below includes an analysis of all hours during the year where the unit had a commitment status of must run and compared the total production costs to the net payments Minnesota Power received from MISO. Total production costs as defined in the January Order includes unit fuel, variable O&M, and preventative maintenance. The net MISO payment includes the energy payment plus ancillary service and make-whole payments. Since Boswell Unit 3 transitioned to economic dispatch on July 20, 2021, Table 2 below does not capture any costs or

benefits from July 20, 2021 through December 31, 2021. If Boswell Unit 3 was included in the table below there would be approximately **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]** in additional net benefit during that time period.

It is important to note the preventative maintenance data included in Attachments 1 and 2 are the best information the Company was able to obtain utilizing its accounting and budget system. However, it is not inclusive of all preventative maintenance and could include predictive maintenance costs as well. Minnesota Power does not track generation maintenance costs by predictive, preventative, or corrective maintenance. Instead the accounting for generation maintenance costs is tracked consistent with FERC requirements. It is also important to note that preventative maintenance is not utilized in the MISO offer curve.

Table 2: Net (Cost) / Benefit including Preventative, Ancillary Services and Make-Whole Payments

	(Cost) / Benefit
	[TRADE SECRET DATA BEGINS
Boswell Unit 3 Net MISO Payment	[redacted]
Boswell Unit 3 Production Costs	[redacted]
Boswell Unit 3 (Cost) / Benefit	[redacted]
Boswell Unit 4 Net MISO Payment	[redacted]
Boswell Unit 4 Production Costs	[redacted]
Boswell Unit 4 (Cost) / Benefit	[redacted]
Combined Boswell Unit 3 and 4 Benefit	[redacted]
	TRADE SECRET DATA ENDS]

Net (Cost)/Benefit Analysis with Operational Dynamics Included

To provide additional information for the Commission and stakeholders, Minnesota Power augmented the net (cost)/benefit analysis shown in Table 1 above by incorporating additional Boswell Units 3 and 4 operational dynamics into the analysis. The intent of the exercise is to improve the net (cost)/benefit calculation by continuing to include costs that "hypothetically" could have been avoided if Boswell Units 3 and 4 were economically dispatched in 2021, when the enhancement is excluding costs that could not have been avoided because of plant operating constraints. For example, a coal unit could be economically dispatch by MISO on a Monday, but be required to operate on Tuesday per its minimum run time requirements – this analysis takes this

operational dynamic into consideration. Minnesota Power intentionally used the word "hypothetically" above, because several of the milestones, discussed later, need to be met prior to moving to economic dispatch are still in progress. Furthermore, this analysis did not capture changes in ancillary service revenue, changes to market prices if these units were offline for economics, or situations where the units were needed for reliability or for supplemental heat to prevent the power plant from freezing up. The analysis started with the workbook used in the net (cost)/benefit analysis shown in Table 1 and layered on when Boswell Units 3 and 4 would have hypothetically been dispatched by MISO economically based on actual data such as hourly Locational Marginal Prices ("LMPs"), fuel costs, planned/forced/ economic outages, as well as reagent and wear and tear adders, along with factoring in minimum run times and minimum times offline.[1] The result is a more realistic representation of the costs/benefits calculation. The analysis included all hours during the year where the unit had a commitment status of must run.

As shown in Table 3 below, the net benefit is increased to **[TRADE SECRET DATA BEGINS [redacted] TRADE SECRET DATA ENDS]** when compared to the net benefit shown in Table 1.

Table 3: Net (Cost)/Benefit with Operational Dynamics Included

	(Cost) / Benefit
	[TRADE SECRET DATA BEGINS
Boswell Unit 3 /1	[redacted]
Boswell Unit 4	
Total (Cost) / Benefit	
	TRADE SECRET DATA BEGINS]

/1 Boswell Unit 3 transitioned to Economic dispatch on July 20, 2021; therefore, only January 1, 2021 through July 19, 2021 were included in the operational dynamics analysis.

B. Order Point 5.g Analysis

Minnesota Power provided, as part of Attachments 1 and 2, the number of times in the analysis that each unit incurred losses over a duration greater than its minimum de-commit time and the associated costs. Boswell Unit 3 and 4 have a de-commit time of **[TRADE SECRET DATA BEGINS [redacted] TRADE SECRET DATA ENDS]**.

[1] A production cost model was used to determine when MISO might have dispatched Boswell Units 3 and 4 for economics using historical data for 2021.

However, this analysis does not take into consideration that the minimum run time for Boswell Units 3 and 4 is **[TRADE SECRET DATA BEGINS [redacted] TRADE SECRET DATA ENDS]**. Provided below, in the Economic Dispatch section, Minnesota Power includes a future economic dispatch production cost model which looks at the potential average annual savings when Boswell Unit 4 transitions to economic dispatch for a portion of the year. This production cost model provides a more realistic savings potential since it is able to capture the operational limitations.

C. Ancillary Services

Eligible generation has the opportunity to make ancillary services available to the MISO market and receive payment for these services. These ancillary service products are required to ensure energy is compensated financially for being able to respond to imbalances between generation and load. The Boswell facility received approximately **[TRADE SECRET DATA BEGINS [redacted] TRADE SECRET DATA ENDS]** in revenue for providing several ancillary service products, as shown in Table 5 below. The majority of the ancillary service revenue came from providing regulation, which requires these units to increase or decrease generation within seconds to respond to small imbalances due to renewable generation and load variation. Regulation is a critical reliability service provided by these units, and it is important to note that Boswell can only provide these ancillary services if the units are online and generating at minimum levels.

Table 5: Monthly Revenue from Ancillary Service

	Boswell Unit 3			Boswell Unit 4		
	Regulation	Spinning Reserve	Supplemental Reserve	Regulation	Spinning Reserve	Supplemental Reserve
	[TRADE SECRET DATA BEGINS					
January 2021						
February 2021						
March 2021						
April 2021						
May 2021						
June 2021						
July 2021						
August 2021						
September 2021						
October 2021						
November 2021						
December 2021						
2021 Total						
Total Ancillary Service Revenue (January 1, 2021 – December 31, 2021)						
TRADE SECRET DATA ENDS]						

D. Make Whole Payments

Resources that are dispatched economically by MISO in either the Day Ahead or Real Time markets are basically guaranteed recovery of their production costs (offer, start-up and no load costs) by way of the market, either through the LMPs or with a Make Whole Payment. If the LMPs do not adequately compensate the units over the commitment period, then MISO will provide a Make Whole Payment to the unit through the Day Ahead or Real Time Revenue Sufficiency Guarantee Make Whole Payment charge types. Additionally, if market conditions erode the margin that would have been earned in the Day Ahead Market due to a lower dispatch in the real time, the units might be eligible for a Price Volatility Make Whole Payment in the real time.

E. Capital Revenue Requirements

Capital Revenue Requirements is a financial estimate of the total amount of money Minnesota Power must collect from customers to pay all costs including a reasonable return on investment in the assets. The revenue requirement for Boswell Units 3 and 4 is based on the capital investment in the facility and the financial metrics of the company such as debt rate, return on equity, taxes, and depreciation. The estimated Capital Revenue Requirements for Boswell Units 3 and 4 as of December 31, 2021

were **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]** respectively.

F. Average Heat Rate

Table 6 below shows the average heat rate at economic minimum and average heat rate at economic maximum for Boswell Units 3 and 4.

Table 6: Average Heat Rates

	Average Heat Rate at Economic Minimum (Btu/kWh)	Average Heat Rate at Economic Maximum (Btu/kWh)
	[TRADE SECRET DATA BEGINS	
Boswell Unit 3	[redacted]	[redacted]
Boswell Unit 4	[redacted]	[redacted]
		TRADE SECRET DATA ENDS]

G. Operation and Maintenance Costs

Fixed Operations and Maintenance

Fixed Operations and Maintenance ("O&M") costs are defined as direct O&M expenses not related to fuel, reagents, fuel handling equipment, incremental wear-and-tear, and ash handling costs. Table 7 below shows the fixed O&M costs attributed to Boswell Units 3 and 4.

Table 7: Fixed O&M

	Boswell Unit 3	Boswell Unit 4
	[TRADE SECRET DATA BEGINS	
January 2021	[redacted]	[redacted]
February 2021		
March 2021		
April 2021		
May 2021		
June 2021		
July 2021		
August 2021		
September 2021		
October 2021		
November 2021		
December 2021		
2021 Fixed O&M Cost	[redacted]	[redacted]
		TRADE SECRET DATA ENDS]

Variable O&M

Minnesota Power defines variable O&M as the changes in reagents, fuel handling equipment and incremental wear-and-tear, and ash handling costs minus fly ash sales revenue. These costs will increase or decrease depending on the production level of the generating unit. Below are the variable O&M costs in $/MWh we use in our offer into the MISO Energy Market during 2021.

Table 8: Dispatch Variable O&M ($/MWh)

	1/1/2021-4/1/2021	4/2/2021-12/31/2021
	[TRADE SECRET DATA BEGINS	
Boswell Unit 3	[redacted]	[redacted]
Boswell Unit 4	[redacted]	[redacted]
		TRADE SECRET DATA ENDS]

Preventative Maintenance

Minnesota Power does not track generation maintenance costs by predictive, preventative, or corrective maintenance. Instead, the accounting for generation maintenance costs is tracked consistent with FERC accounting rules.

In order to comply with Order Point 5.d of the January 2021 Order, the preventative maintenance data included in Attachments 1 and 2 is the best information the Company was able to obtain utilizing its accounting and budget system. However, is not inclusive of all preventative maintenance and could include predictive maintenance costs as well. Minnesota Power does not track generation maintenance costs by predictive, preventative, or corrective maintenance. Instead the accounting for generation maintenance costs is tracked consistent with FERC requirements. The methodology Minnesota Power used to determine the hourly rate was based on actual costs available divided by generation output. Costs on a $/MWh basis vary greatly based on production, outages, and shared resources.

It is also important to note that preventative maintenance is not utilized in the MISO offer curve.

Table 9: Estimated Preventative Maintenance ($/MWh)

	[TRADE SECRET DATA BEGINS
Boswell Unit 3	[redacted]
Boswell Unit 4	[redacted]
	TRADE SECRET DATA ENDS]

Preventative maintenance is a runtime or calendar based activity recommended by the manufacturer or by experience where a maintenance technician has hands-on activity with the piece of equipment. This would include inspections, tests, repairs and replacement of components in critical equipment. It may also include lubrications and minor adjustments. If inspection turns into repair or replacement, it becomes a corrective work order. Preventative maintenance costs also fluctuate from year to year based on outage schedules.

Predictive maintenance is a program that uses diagnostic and performance data, maintenance histories, design data and operating history to determine the condition of equipment. It utilizes the latest in technology such as vibration, thermography, motor testing to monitor equipment while it is operating. These activities do not significantly change based on incremental changes in production.

H. Unit Fuel Cost

Fuel as used in the offer curve for dispatch in the MISO energy market is defined as the actual monthly average cost of inventory on hand for the generating station.

I. Carbon Dioxide Emissions

In accordance with Order Point 8.a. of the December 2021 Order, the Carbon Dioxide Emissions for Boswell Units 3 and 4 for 2021 were 2,543,828 short tons and 2,636,159 short tons, respectively.

J. Equivalent Forced Outage Rate

In accordance with Order Point 8.d. of the December 2021 Order, the Equivalent Forced Outage Rate for Boswell Units 3 and 4 for 2021 were **[TRADE SECRET BEGINS** [redacted] **TRADE SECRET ENDS]**, respectively.

III. ECONOMIC DISPATCH

The Company successfully transitioned Boswell Unit 3 to economic dispatch on July 20, 2021. Since the transition Boswell Unit 3 has been consistently dispatched by MISO. However, due to the barriers identified in this filing with regard to Boswell Unit 4

and the higher energy price outlook consistently dispatching the unit, the Company is not recommending a transition of Boswell Unit 4 to economic dispatch in 2022. For 2023 and forward, the Company will continue to review the operations, energy price forecast, and timeline to transition the unit to economic dispatch, with an update provided in next year's filing.

Minnesota Power evaluated the future impacts of shifting Boswell Unit 4 self-commitment status to economic dispatch operations over a time period of January 1, 2022 through December 31, 2024. Two operational scenarios were analyzed. In the first scenario Minnesota Power analyzed a "worst case" scenario where Boswell Unit 4 was set to must run all year. The second scenario analyzed a "best case" scenario were Boswell Unit 4 was set to must run during the winter months as the need for supplemental heat is a critical component of operations and economic for all other months.

Table 4: Operational Scenarios	
	Boswell Unit 4
First Scenario	Must Run Status
Second Scenario	2022: Economic Dispatch (Apr-Oct) 2023: Economic Dispatch (Apr-Oct) 2024: Economic Dispatch (Apr-Dec)

Using a production cost model, the company expects to see no customer economic benefit in 2022 and 2023 by shifting Boswell Unit 4 to economic dispatch. With forecast showing higher market prices and higher natural gas prices, the modeling supports operating Boswell Unit 4 in must run operations in 2022. A comparison of the second scenario to the first scenario provided an annual power supply cost savings of approximately **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]** in 2024. The projected savings in 2024 is due to the forecast showing a decline in market energy prices and natural gas prices. Minnesota Power will continue to monitor energy and natural gas prices and how it impacts Boswell Unit 4 operations.

The Company has made significant progress in addressing the various milestones identified in the 2021 filing that need to be reached in order to transition Boswell Unit 4 to economic operations. These milestones and associated cost, discussed below, were

not taken into consideration in the analysis above. If the potential cost of meeting these milestones were incorporated into the analysis, it would have an impact on the results.

Economic Dispatch Milestones

A. Market Readiness

The ability of MISO market tools to properly evaluate the need and duration of baseload generation facilities is a key component of being ready to transition Boswell Unit 4 to economic dispatch. Currently MISO's existing Day Ahead commitment process does not provide assurance that the units will be operated economically across multiple days. In particular, while the economics of a single day may not indicate economic dispatch for the Boswell units (which have relatively high startup costs and a relatively long lead time), the economics over two or more days are more likely to favor commitment. This leaves the individual utilities in a position of having to actively manage and create additional internal procedures for operating the units in the MISO market environment when MISO is determining whether to commit the units.

MISO has improved tools such as the Multi-Day Operating Margin and Maintenance Margin reports, which provide some insight into the balance of supply and demand in MISO that may help Market Participants forecast the market economics of their long-lead units across multiple days. The tools may assist Market Participants in determining whether to Must Run their units, making the units available for MISO dispatch across multiple days, but forecasts cannot provide assurance that the decision to Must Run or not will maximize the units economics. Minnesota Power continues to advocate as a MISO stakeholder for operating alternatives within the current market construct such as a multi-day commitment mechanism that is financially binding for long lead time generators; and we are actively participating in the stakeholder process regarding the Enhancements for Long-Lead Units and Self-Commitments (formerly known as Exploration of a Forward Market Mechanism IR085).

The company has developed a short-term forecasting tool in addition to internal processes to aid in the management of Boswell Unit 3 in the MISO market under an economic dispatch in 2021. The Company successfully transitioned Boswell Unit 3 to economic dispatch on July 20, 2021; however, with the strong market prices in 2021,

the unit was committed by MISO continuously and the Company is still learning how to manage the unit under this commit status. The Company would utilize the same processes and procedures to offer Boswell Unit 4 into the MISO market under economic dispatch; however, having two units at the same site under economic dispatch adds additional layers of complexity that are still being evaluated and analyzed. Therefore, additional processes need to be established if both units dispatch economically as there are constraints to start the units at the same time.

In addition, the Company will continue to refine its processes and procedures for working with the market when the unit cycles on and offline more often due to economics. The experience being gained on the Boswell Unit 3 transition, although limited at this time, will aid in the future transition for Boswell Unit 4. The Company works closely with MISO to manage the economic dispatch of Boswell Unit 3 on a daily basis; and based on daily operating and facility conditions, may need to move in and out of economic commitment status to manage all aspects of the plant.

Minnesota Power will continue to use its current planning process to help predict and plan expected mid-term and longer-term energy production at the facility. These projections help inform the Company regarding how these units are expected to operate for the upcoming year. The projections are also used to inform the Company's fuel procurement strategy and procurement of materials, such as reagents for the environmental controls. Outputs from the evaluation are then used to track and forecast Boswell Units 3 and 4 generation production.

B. Joint Ownership

The terms of the Operations, Ownership and Power Sales Agreement between Minnesota Power and WPPI states, **[TRADE SECRET DATA BEGINS** [redacted] **TRADE**

SECRET DATA ENDS] The Company is advancing work with co-owner, WPPI, on an economic dispatch plan for Boswell Unit 4.

One of the main areas the Company and WPPI continue to try to understand is market coordination and customer impact for a jointly owned unit. In the MISO Market, Boswell Unit 4 is modeled as two individual, distinct generators and each ownership share has its own generator node. Under a Must Run dispatch, Minnesota Power coordinates with WPPI on the energy market parameters to ensure a consistent dispatch of Boswell Unit 4 that optimizes the unit's economics. Under economic dispatch, there is a potential for only one generator node (either Minnesota Power or WPPI) to be dispatched. Minnesota Power has identified several MISO market items that will need to be addressed further with WPPI, including changes to the offer strategy, changes to how Boswell Unit 4 is modeled in the MISO energy market and decide if re-registration is needed, and determine whether new MISO market coordination agreements will be needed between Minnesota Power and WPPI. Minnesota Power will continuing to advance this work with WPPI in 2022.

C. Transmission Reliability

Currently Boswell provides essential reliability services that give the operational flexibility needed to ensure continuous reliable operations of the power system and energy supply to a unique geographic area. The energy and reliability needs of this area include both energy intensive large industrial loads and sprawling rural community areas. These two very different types of customers must be served while also balancing bulk regional power transfer impacts, particularly as regional renewable energy production varies on a minute-by-minute basis and the transmission grid operates with facilities coming in and out of service due to maintenance, storms and unexpected events. There are two main areas of concern for transmission system reliability that stem from the transition of the Boswell units to economic dispatch: (1) voltage support and system strength; and (2) regional voltage stability. The first concern, voltage support and system strength, is primarily related to whether or not there is at least one Boswell unit online at any given time. The second concern, regional voltage stability, is primarily related to how much power is being produced by the Boswell units at any

given time and the surrounding system conditions at the time. An overview of each of these concerns is provided briefly below[2].

As the last remaining baseload generators operating in Northern Minnesota, the Boswell units provide voltage support and system strength on a continuous basis that support consistent and predictable system operations and properly functioning protection systems. Without the Boswell units online, the Northern Minnesota transmission system would operate for extended periods of time without any local generators online providing fault current and voltage regulation. This mode of operation would be unprecedented in the modern history of the Northern Minnesota transmission system and, if not adequately assessed and mitigated, would lead to a great deal of uncertainty and potential mis-operation in the transmission system and the lower-voltage distribution systems connected to it. Minnesota Power has undertaken several different types of analysis to understand the significance, complexity, and inter-relationships of voltage support and system strength impacts. Minnesota Power's analysis, including short circuit analysis, will be summarized in a forthcoming System Strength Report to be provided at a later date pursuant to Order Point 6 of the December 2021 Order.

Several Minnesota Power and MISO studies have also identified that there is a regional voltage stability concern associated with one or both Boswell units being offline under certain combinations of transmission system conditions. Minnesota Power continues to work with MISO to ensure that this voltage stability issue is understood, monitored, and managed effectively in MISO real-time operations, as well as being evaluated and planned for in MISO long-range transmission planning studies. At this time, MISO understands the issue, and both MISO and Minnesota Power are monitoring and responding to real-time indicators associated with the voltage stability issue. Over time, additional tools and improvements may be developed to increase operational awareness and management of the issue. It is also important to note that the voltage stability concerns are primarily associated with system conditions that typically occur during winter months. With at least one Boswell unit expected to be running through the winter months in the near future, the near-term risk of encountering voltage stability

[2] For additional information, please see Appendix F in Minnesota Power's Application for Approval of its 2021-20235 Integrated Resource Plan in Docket No. E015/RP-21-33.

issues is lessened. Therefore, for the time being, regional voltage stability concerns are not an obstacle for transitioning one or both Boswell units to economic dispatch, assuming that at least one unit continues to be available for dispatch to support transmission reliability through the winter months.

D. Environmental Emission Compliance

Boswell deploys advanced air quality control technology equipment on both Boswell Units 3 and 4 which is designed to significantly reduce pollutant emissions to ultra-low levels of nitrogen oxides, sulfur dioxide, particulate matter, and mercury. To meet the required permit limits under economic dispatch operations, emission controls need to normalize over an operating period, as start-up and shut down cycling can lead to higher emission rates than baseload operation and ultimately impact flexibility to respond while operating within allowed permit limits.

In order to operate within permit levels, Boswell Units 3 and 4 may periodically need to be offered using the Must Run dispatch status for approximately three to five days to ensure that proper margin to emission limits can be maintained for the next shut down/start-up cycle. Shorter runs could be accommodated; however, every third to fifth start-up may require a longer run time to maintain margin to comply with permit requirements.

With Boswell Unit 3 being consistently dispatched by MISO since its transition to economic dispatch, similar to a must run unit, Minnesota Power has not gained operational experience on emission impacts. However, the Company will continue to closely monitor emissions impacts due to economic dispatch and adjust offer parameters to optimize flexibility and emission margin.

E. Generating Facility Impacts

Boswell Units 3 and 4 have been designed for consistent, round the clock operation at full load. The use of these Units for cycling can lead to component damage and reliability problems. According to EPRI (“Electric Power Research Institute”) these reliability impacts have been seen in the form of accelerated damage to boilers from corrosion and thermal fatigue and turbine problems associated with water chemistry. Corrosion and thermal fatigue develops over long periods of time and cycling increases

the rate at which this occurs. There are methods to minimize the rate at which thermal fatigue occurs such as decreasing the ramp rate of the unit and maximizing the warm up period during start-up. There is also chemistry additions, such as anodamine, that can be injected into the boiler to reduce corrosion fatigue. Anodamine is a proprietary filming amine, was selected as a candidate to inhibit the corrosion of low pressure steam turbine steels. Minnesota Power is injecting anodamine on Boswell Unit 3 and has begun to inject anodamine on Boswell Unit 4 prior to any planned outages. Boiler chemistry is also a component impacted by unit cycling. This impact can be seen in the form of generation holds until adequate boiler chemistry can be achieved or negative impacts to turbine components. There are ways to minimize the generation holds related to boiler chemistry through the use of a polisher. A polisher is a device used to filter water condensed from steam as part of the steam cycle. It is frequently filled with polymer resins which are used to remove or exchange ions such that the purity of the condensate is maintained at acceptable levels. Unit 4 has a polisher available for its operation as needed and with increased use, the cost to operate and maintain the polisher will increase.

When loads change or units are cycled on and off the consequences are numerous with pulverizers going off and on, fans speeds going up and down, furnace temperatures and heat profiles are altered, pollution control requirements changes, steam and flue gas velocities vary and so on. All of these changes create stresses and systems can be unsteady resulting in reliability impacts. In order to manage units effectively, it's important to understand the critical risks, such as higher costs, increased probability of failure, and rate of equipment degradation. Past research done by EPRI has demonstrated that the detrimental effects of cycling operation might not show up in the short term and that unique unit characteristics (age, design, metallurgy, etc.) and operational regimes make it difficult to accurately quantify and predict cycling impacts. Plant design, cycling regime, equipment condition, changes in operating practices, and changes in fuel all make it unlikely that a one-time assessment will produce an accurate result that can be used in the long run. Continued, longer term evaluation of components and systems needs to be done to fully recognize and minimize these reliability impacts.

Auxiliary Heat

During winter operations and after the retirement of Boswell Units 1 and 2 in 2018, Boswell Unit 3 and/or Unit 4 provide heating steam and process steam (e.g. air preheating steam) to the entire Boswell facility. In order to ensure the Boswell facility maintains a protected temperature, currently, at least one of the Boswell units needs to be operating during the cold winter months. The heating season in Northern Minnesota runs from September through May with the critical heating months being December through February. Loss of heating steam for any reason in the December through February range needs to be corrected within 72 hours to prevent the plant from freezing.

The Company currently has several options available to address the plant heating, including, continuing to seasonally Must Run one of the Boswell units during cold weather months, or investing in a backup heat source.

A backup heat source at Boswell, consisting of two natural gas fired heating boilers and balance of plant systems and structures requires a three-year schedule for permitting, design, procurement, and construction. The Company is nearing the end of the study phase and expects the backup heat source to be available for the 2024-2025 heating season if deemed the best option.

Operating a backup heat source in the form of natural gas heating boilers will also change the Company's fuel procurement strategy and commitment for natural gas firm capacity. As Boswell Units 3 and 4 move to economic dispatch there would be an incremental cost to purchase firm natural gas transportation capacity. This would apply to both fuel for the heating boilers as well as fuel for start-up of the power boilers on a more frequent basis.

Boiler Chemistry

Boiler cycle water chemistry programs are designed to protect the boilers and turbines from deposits due to impurities in the feedwater and steam systems. By moving to economic dispatch, it is very likely that each of the Boswell units may experience more frequent starts, resulting in the inability to stabilize boiler chemistry before the unit is shut down. This could increase the level of deposits and shorten the interval between

required boiler cleanings. The estimated cost of boiler cleaning including disposal is $1.5 million per boiler. Minnesota Power has implemented preventative chemical treatments on Boswell Unit 3 to maximize the time between boiler cleaning cycles.

Cycle chemistry holds may be a barrier to quickly and reliably return a unit to service. The more impurities that are present in the feedwater and steam systems, the longer the water lab holds take, and the longer it takes to get the unit to a dispatchable load range during a start-up. A potential solution is to evaluate re-piping Unit 3 to the Unit 4 polisher, which would likely be in the range of $1 million. At this time Minnesota Power has been unable to determine the need for this solution, given Unit 3 has been operating similar to a must run unit since its change to economic dispatch.

A sustainable boiler chemistry program is necessary so the units are flexible to meet the changing market demand and protect the asset from physical degradation and loss of reliability that would jeopardize their ability to come on-line for either a hot or cold start.

Auxiliary Equipment

Auxiliary equipment such as large electric motors, coal pulverizers, large fans, boiler feed pumps and boiler circulating water pumps were designed to be operated in a baseload manner. During economic dispatch the equipment will very likely experience more frequent starts and stops. The Company will train operators for the frequent starts and stops and adjust Preventative Maintenance and Predictive Maintenance programs accordingly.

Published data from plants that have moved from baseload operation to economic commitment on a seasonal or annual basis have experienced widely variable effects to their operations. The variability is related to frequency and number of starts, operating time while running, size and operating temperature/pressure. At this time, the Company is unable to know definitively what the effect of economic dispatch will have on operating costs.

To maintain reliable operations, the Company will re-evaluate capital and O&M expenses based on experience with a new operating profile. At this time, no changes

have occurred related to maintenance practices, since the units continue to be operating similar to a Must Run unit.

F. Staffing

Offering Boswell Unit 4 as an economic dispatch unit is not anticipated to have any impact on planned staffing levels at Boswell. The Company's current staffing methodology is to share human resources between Boswell Units 3 and 4 and Boswell headcount has been determined for both units operating simultaneously. There may be times when a specific position will not need to be replaced in the event of one or both units not being dispatched and a scheduled employee is ill or requests vacation. The determination of filling that vacated position for that day will be made at the time of the occurrence and dependent on other planned work for that day.

G. Fuel Procurement and Fuel Operations

The Company's fuel procurement process consists of three components: coal procurement, rail transportation, and inventory management. Current coal procurement practices are a key attribute to ensuring low cost energy for Minnesota Power customers. The following outlines the considerations and consequences, regarding coal procurement practices, under a significant change in Boswell Energy Center operations.

Coal Commodity Impact

Minnesota Power has coal commitments under contract until **[TRADE SECRET DATA BEGINS [redacted] TRADE SECRET DATA ENDS]** as part of layered purchase strategy designed to secure competitive pricing as well as guarantee a portion of forecasted need per year in supply availability.

Even with a reasonable preparation period, procuring competitively priced coal becomes challenging under the conditions of economic/seasonal operations. Volume requirement uncertainty requires a conservative procurement approach in an effort to avoid potential liquidated damages due to over-commitment. Competitive commodity pricing is often directly proportional to higher volume commitments so, in turn, a conservative volume approach would likely cause pricing to be in line with higher market pricing versus a volume incentivized price point. There is also risk that coal mines will already be fully committed and no longer have immediately available supply by the time

Minnesota Power is ready to enter into additional contracts, leaving the options of no supply, alternate mines with lower quality, and/or higher pricing, particularly if additional tonnages are needed within a current calendar year. The risk of limited coal supply and high commodity pricing for coal-burning utilities came to fruition in 2021 as energy market demand increased dramatically above economic dispatch operation expectations. Additional information on Minnesota Power's coal conservation efforts is discussed below.

Rail Transportation Impact

Minnesota Power is a captive shipper on the BNSF railroad, which means that no other rail transportation provider has the ability to deliver coal to the Boswell Energy Center. Minnesota Power's rail transportation binding tonnage nomination is due several months prior to each effective contract year. Transportation needs can be a challenge to determine accurately with economic/seasonal operations, especially during a period of volatile energy markets. Generation forecast error could result in significant liquidated damages due to over-commitment. Conversely, under-commitment would result in low inventory levels requiring potential unit idling during strong energy price periods and ultimately purchasing energy at a higher cost within the energy market. Reducing transportation tonnage commitments in preparation for economic/seasonal dispatch would also negatively impact transportation contract price negotiation as economies of scale will be lost.

Tariff rail transportation rates are an alternative to binding contract tonnages but, with respect to customers, is not a financially responsible option as tariff rates are **[TRADE SECRET DATA BEGINS** [redacted] **TRADE SECRET DATA ENDS]** than negotiated contracted rates and also does not provide delivery performance certainty from the railroad. As a captive shipper, there is no substitute transportation supplier available to mitigate current rail transportation disruption risk.

Inventory and Fuel Operation Impacts

The rail transportation contract has an obligation of ratable deliveries throughout the year. Economic/seasonal operations will lead to wide physical inventory fluctuations by accepting deliveries when the units are at a low/no generation level and failing to deliver

enough coal to keep inventory levels constant during high generation demand. Physical inventory levels would likely need to be maintained at a higher volume than current to handle generation volatility which equates to higher carrying costs and expense.

Inconsistent inventory levels translates to higher O&M costs for Fuel Operations by having to either push coal to or from the stockpile versus maintaining a consistent inventory level. Inventory management practices will need to be revised to ensure proper staffing and dozer capabilities to effectively mitigate increased operational costs of controlling wide inventory fluctuations.

Balancing coal commodity, rail transportation, coal inventory and operational risks are all challenges Minnesota Power is currently navigating with Boswell Unit 3 on economic dispatch.

H. Fuel Adjustment Clause Impacts

Minnesota Power would like to bring awareness that a move to economic dispatch at both Boswell units could result in additional Fuel Adjustment Clause ("FAC") volatility. The Company has identified that procurement of coal can be a challenge when the energy markets change significantly throughout the year. With higher than expected energy prices, Boswell Units 3 produced more energy than anticipated when procuring coal for 2021. Due to the increased demand in generation at both Boswell Units, Minnesota Power implemented coal conservation measures beginning in September 2021 to ensure Boswell maintained an adequate fuel supply for the winter season. Those measures included the testing of alternative fuels at Boswell, working with the MISO Independent Market Monitor to develop an effective offer structure to ensure the units were offered appropriately into the market, and utilization of the bilateral market to purchase replacement energy to minimize customer exposure to the higher priced market. In addition, the Company was able to secure additional coal in the short-term markets late in 2021 after working with its rail transportation provider to deliver volumes over its binding nomination in an effort to keep a consistent number of train deliveries through the remainder of 2021 and into the 2022 winter season. Minnesota Power does

not know if 2021 will be an abnormal year, but it is helpful to analyze how operational strategies at a coal plant can impact customer cost in a real world application.

IV. OPERATING PROCEDURES AND PHYSICAL MODIFICATIONS TO UNITS

Minnesota Power has made substantial progress with economic dispatch operating procedures in 2021. New start-up and shutdown procedures have been developed. Maintenance procedures provide guidance on when work can occur on the unit and what equipment will be laid-up in the event of a Reserve Shutdown. New internal communication processes are in place to adjust to day-to-day changes from economically dispatching the unit. In addition, an open valve start-up procedure was developed, which allows Boswell Unit 3 to be dispatchable within 24 hours.

Minnesota Power invested $4.0 million into Boswell Unit 3 to significantly reduce the operational minimums of the unit from 175 MW to 75 MW, creating considerably more flexibility for the unit in its daily dispatch. This project was completed in November 2021.

In 2018, Minnesota Power reduced the operational minimums for Boswell Unit 4 from approximately 300 MW to 210 MW. In December 2021, Boswell Unit 4 was able to lower the Emergency Minimums from 210 MW to 185 MW. At this time there have been no other projects identified; however, Minnesota Power will continue to explore other opportunities.

V. COAL OPERATIONS

On February 1, 2021, Minnesota Power submitted its 2021-2035 Integrated Resource Plan[3] which announced its vision to deliver 100 percent carbon-free energy to customers by 2050. As part of this vision, Boswell Unit 3 will retire by 2030 and Boswell Unit 4 will cease coal operations by 2035.

[3] Docket No. E015/RP-21-33

VI. CONCLUSION

During 2021 Minnesota Power successfully transitioned Boswell Unit 3 to economic dispatch and decreased its operational minimums to 75 MW. Although the Company does not have a firm date at this time for when Boswell Unit 4 will transition to economic dispatch, Minnesota Power continues to address the remaining milestones, monitor energy markets and customer impacts, and learn from the transition at Boswell Unit 3.

Dated: March 1, 2022

Respectfully Submitted,

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STATE OF MINNESOTA	)	AFFIDAVIT OF SERVICE VIA
	) ss	ELECTRONIC FILING
COUNTY OF ST. LOUIS	)	

Tiana Heger of the City of Duluth, County of St. Louis, State of Minnesota, says that on the 1st day of March, 2022, she served Minnesota Power's Annual Compliance Filing in **Docket No. E999/CI-19-704** 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