414 Nicollet Mall
Minneapolis, Minnesota 55401

October 29, 2018

VIA ELECTRONIC FILING

Daniel P. Wolf
Executive Secretary
Minnesota Public Utilities Commission
121 7th Place East, Suite 350
St. Paul, MN 55101-2147

RE: REPLY COMMENTS
2017 ANNUAL AUTOMATIC ADJUSTMENT OF CHARGES REPORT - ELECTRIC
DOCKET NO. E999/AA-17-492

Dear Mr. Wolf:

Northern States Power Company, doing business as Xcel Energy, submits these Reply Comments in response to the October 19, 2018 Comments of the Department of Commerce, Division of Energy Resources.

We have electronically filed this document with the Minnesota Public Utilities Commission, and copies have been served on the parties on the attached service list. Please contact Rebecca Eilers at rebecca.d.eilers@xcelenergy.com or 612-330-5570 or me at amy.a.liberkowski@xcelenergy.com or 612-330-6613 if you have any questions regarding this filing.

SINCERELY,

/s/

AMY A. LIBERKOWSKI
DIRECTOR, REGULATORY PRICING & PLANNING

c: Service List

STATE OF MINNESOTA
BEFORE THE
MINNESOTA PUBLIC UTILITIES COMMISSION

Nancy Lange	Chair
Dan Lipschultz	Commissioner
Matthew Schuerger	Commissioner
Katie Sieben	Commissioner
John Tuma	Commissioner

IN THE MATTER OF NORTHERN STATES POWER COMPANY, REVIEW OF 2016-2017 ANNUAL AUTOMATIC ADJUSTMENT REPORT FOR ITS ELECTRIC OPERATION

DOCKET NO. E999/AA-17-492

REPLY COMMENTS

OVERVIEW

Northern States Power Company, doing business as Xcel Energy, submits this Reply to the Minnesota Department of Commerce - Division of Energy Resources' October, 19, 2018 review of our Annual Automatic Adjustment of Charges (AAA) Report for 2016-2017.

We appreciate the Department's thorough review of the Company's 2017 AAA filing and its recommendation that the Commission accept many of the Company's compliance items. In this Reply, we provide additional information as requested by the Department.

REPLY

A. Transformer Backup Strategy and Transformer Maintenance Policy

The Department noted that the Company did not provide information regarding backup strategies for transformers or our policy for transformer maintenance as required by the Commission's August 16, 2013 ORDER ACTING ON ELECTRIC UTILITIES' ANNUAL REPORTS, REQUIRING REFUND OF CERTAIN CURTAILMENT COSTS, AND REQUIRING ADDITIONAL FILINGS in Docket No. E999/AA-11-792, the 2011 AAA report docket. We provide additional information below.

1. Transformer Backup Strategy

Xcel Energy's transformer backup strategy is a three-pronged approach consisting of our Spare Transformer Fleet designed to meet the needs of our back-up requirements, and participation in two industry programs. Each is discussed in turn below.

Xcel Energy maintains an independent fleet of spare transmission transformers in each Operating Area, including the Northern States Power Company region consisting of NSPM and NSPW.[1] Each fleet is designed based on two main concerns: operational failure rates and non-traditional threats (such as geomagnetic disturbance, electromagnetic pulse, and physical attack). More specifically, the Spare Transformer Fleets are first designed based on the population of transformers in service in each voltage class and historical failure rates for those transformers. This design principle results in at least one spare transformer for most voltage classes. Each fleet is then supplemented with additional spare transformers in the voltage classes identified in critical substations. With the current Spare Transformer Fleet design, each Operating Area is able to recover the system for two, and sometimes three, substation complete loss events. For planning and normal operational purposes, each Operating Area's spare fleet is separate and independent. In an extreme emergency, spare transformers could be used throughout the Xcel Energy System as necessary and appropriate.

Xcel Energy also participates in two industry transformer programs. Spare Transformer Equipment Program (STEP) is a voluntary program managed by Edison Electric Institute (EEI). Participation in STEP comes with binding obligations, where a participating utility has legal "call rights" to purchased transformers of other participating utilities in the event of a triggering event, which must be terrorism-related. There are currently more than 50 participating utilities, including most of the investor owned utilities in the United States. Xcel Energy also participates in SpareConnect, another voluntary program managed by EEI. SpareConnect matches utilities that have a transformer need with utilities that have similar equipment. There are currently more than 100 participating utilities in the United States and Canada.

The Company believes that it maintains a reasonable level of transformers in inventory in order to: (1) maintain the reliability of the system; (2) remain consistent with North American Electric Reliability Corporation (NERC) reliability criteria; and

[1] In Part H, Section 4 of our initial AAA report, we provided a list of the NSP System spare transmission transformer inventory and planned deliveries.

(3) balance the economic benefit to ratepayers. Participation in these voluntary programs provides added assurance to support our spare transformer inventory.

2. Transformer Maintenance Policy

We provided in the initial AAA report the Company's policy regarding the maintenance program for power transformers and load tap changers on the bulk electric system as Part K, Section 5, Schedule 3. For the Department's convenience, we have re-submitted the policy document with these Reply Comments as Attachment A.

B. Asset-Based Margins

The Department requested that the Company explain the increase in asset-based margins from $4.0 million in FYE16 to $18.3 million in FYE17. The increase in asset-based margins was primarily driven by the addition of three new wind resources in FYE17 with no fuel cost (Odell Wind Farm, Courtenay Wind Farm, and Border Winds) and the resultant increase in sales to the MISO market (as opposed to a material increase in Ancillary Services margins or margins from sales to wholesale customers). These units that we bid into the MISO Day Ahead market increased the Company's opportunities to offer energy from our generation fleet into the short term market after the system native requirements have been met.

In conjunction with higher sales, MISO LMPs create higher margins. LMPs in NSP were generally higher in FYE17 than in FYE16. With the addition of 550 MW of wind capacity in FYE17, NSP was able to offer and sell its additional excess resources to MISO at higher prices. The weighted average day-ahead sales price in FYE17 was $2.39/MWh greater than FYE16.

C. Increase in Real Time Non Excessive Energy Amount – System Charges

The Company's response to Information Request No. DOC-29(d) explained that the total Real Time Non Excessive Energy Amount of $2,357,643 in July 2016 is a net value comprising approximately $200 million in gross sales and buybacks. The Real Time sale to buyback ratio increased slightly from this perspective when compared to July 2015. The Company's response attributed the slight increase to a single unit that tripped offline on three different days in August 2016. The Department requested that the Company discuss the unit that tripped offline on our Reply.

When examining the data to respond to the Department's current request, we discovered that the three outages at one plant referenced in our response to IR No.

DOC-29(d) occurred in August 2016 instead of July 2016. The increase between July 2015 and July 2016 Real Time Non Excessive Energy Amount can be attributed to generating unit outages at various plants in July 2016, not to three outages at a single unit. As shown in the outage report for this period, included in the AAA report as Part K, Section 4, Schedule 2, there were several units that experienced outages in July 2016, though King Unit 1 experienced more outages that month than other units. We provide as Attachment B a condensed version of the outage report comparing July 2015 outages to July 2016 outages. More unit outages occurred in July 2016 than July 2015, which led to higher Real Time Non Excessive charges in July 2016.

D. Day-Ahead Ramp Capability Amount and Real-Time Ramp Capability Amount

The Commission's March 16, 2018 Order in Docket No. E999/AA-16-523 requires the Company to include separate line items for two new MISO charge types (Day-Ahead Ramp Capability Amount and Real-Time Ramp Capability Amount) in the existing ASM Day-Ahead Regulation Amount and Real-Time Regulation Amount. As the Department's review notes, this order was issued after the Company's 2017 AAA Report was submitted on September 1, 2017, and therefore the report did not separate the two charge types. At the Department's request, Attachment C to this Reply is an updated Part J, Section 5, Schedule 14 that shows the separate line item amounts for these two new charge types for the 2016-2017 AAA report period. We note that the two new charge types are shown on separate line items in Attachment 2, page 8 of our monthly fuel clause reports beginning with the February 28, 2018 fuel clause filing in Docket No. E002/AA-18-176. Our 2018 AAA Report filed on August 31, 2018 in Docket No. E999/AA-18-373 also shows these charge types on separate line items.

CONCLUSION

The Company appreciates this opportunity to submit its Reply to the Department's review. Through this Reply, we have provided additional information in response to the questions raised by the Department. We respectfully request that the Commission accept and approve Xcel Energy's FYE17 Electric AAA Report as supplemented by this Reply.

Dated: October 29, 2018

Northern States Power Company

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1.0 PURPOSE

- Define the time-condition-event based prioritization system to be utilized to predict the need for inspection and maintenance.
- Define the maintenance and diagnostic testing plans.
- Define the specific maintenance and diagnostic testing procedures for power transformers and load tap changers (LTCs).
- Document the required data to plan and schedule maintenance and diagnostic testing activities.
- Document the required data to be collected during the substation inspections, diagnostic testing, and maintenance of the power transformers and LTCs.

2.0 APPLICABILITY AND RESPONSIBILITIES

- To define a consistent and common plan and procedures for all Xcel Energy Operating Companies for the maintenance of transmission and distribution substation power transformers and LTCs.

3.0 APPROVERS

Name	Title
Dave Cenedella	Director, System Sustainability
Greg Bennett	Director, Substation CO&M
Philippa Narog	Director, Transmission Business Operations

4.0 VERSION HISTORY

Effective Date	Version Number	Supercedes	Change
11/25/2014	1.0	n/a	Initial version

Transmission System Policy	
Xcel Energy	
Maintenance Plan for Transmission & Distribution Power Transformers and Load Tap Changers	**VERSION: 1.0**
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Document Structure and Governance Process

THIS SECTION IS THE SAME FOR ALL SUBSTATION MAINTENANCE PLAN/PROCEDURE DOCUMENTS

This document is part of a set of documents describing Xcel Energy's overall Substation Maintenance Plan/Procedures. These documents define the Substation Maintenance philosophy, policy, plans and procedures for all operating companies.

Substation Maintenance Plan and Procedures
For
Power Transformers and Load Tap Changers

Purpose

Background

This document has been developed to define a consistent plan and procedure for all Xcel Energy Operating Companies for the maintenance of transmission and distribution substation transformers and on-load tap changers[1] (this document uses LTC specifically for the on-load tap changer). Transformers in this procedure include power transformers, grounding banks, and include all transformers where it is possible to take an oil sample without removing the transformer from service. Proper and appropriate maintenance and diagnostic testing of transformers that may or may not have a LTC to manage voltage is essential to system reliability and operations; failure of transformers of any type is expensive, requiring extensive effort to repair and or install a new unit and may adversely affect thousands of customers and reliability statistics.

The overall plan and specific procedures establish requirements for:

- Annual or quarterly ***DGA Testing*** of oil filled transformer compartments including the main tank and the LTC compartment or compartments (i.e. independent selector switch compartments) to evaluate the condition of the asset including the transformer windings, water, dissolved gases, LTC contact condition, etc. The frequency of the DGA test is dependent upon:
    - o Initial installation testing of new or rebuilt transformers
    - o Voltage and size of the transformer
    - o Previous DGA testing that had shown any issues in the transformer
- Annual ***Infrared Inspection*** of the transformer including the on-load LTC and no-load tap changer[2] compartments.
- Annual ***Comprehensive Oil Testing*** of samples taken from every transformer compartment including the main tank and the LTC compartment or compartments (i.e. independent selector switch compartments) to evaluate the condition of the asset through oil condition including the transformer windings, water, furans, LTC contact condition, etc.
- Periodic complete diagnostic inspection and testing of ***Ancillary Transformer Equipment*** based on the transformer cooling design and the size of the transformer.

The purpose of this plan and procedure is to:

- Define the periodic transformer diagnostic inspection plan: dissolved gas analysis, complete oil analysis, and infrared inspection.
- Define the annual on-load LTC diagnostic inspection plan: dissolved gas analysis, complete oil analysis, and infrared inspection.

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[1] On-load tap changers are capable of making adjustments to the transformer turns ratio while energized and carrying load.

[2] Transformers are often equipped with a no load tap changer that is set to the proper turns ratio (voltage ratio of high side and low side of the transformer) before the transformer is energized.

- Define the diagnostic testing plan of the peripheral (ancillary) apparatus portion of the transformer[3] based on a Maintenance number formula that ties the transformer cooling system, MVA size, overall condition and the value of the asset to the Xcel system and time since the previous ancillary diagnostic inspection to the scheduling of the work.
- Document the required data to plan, schedule and record maintenance and diagnostic testing activities.
- Document the required data to be collected during the substation inspections, DGA, diagnostic oil testing, infrared scanning and maintenance of the peripheral portions of the transformer.
- Document the storage of data for easy retrieval and reference for future inspections.

Scope

The Transmission and Distribution Transformer and LTC plan establishes the maintenance drivers and minimum required periodic visual inspection, quarterly and annual diagnostic testing, evaluation of the test results, and diagnostics of the transformer ancillary assets. No internal inspections are scheduled based on time or the Maintenance number for either the main transformer tank or the integral LTC. The goal of the plan is to monitor key diagnostic tools that predict the need for further investigations and possible repairs. This document describes the maintenance plan established to achieve this goal and the procedures used to accomplish it.

This document does not include the routine substation and equipment inspection procedures but does list the required visual inspections of the transformers.

For the purposes of this plan all oil filled substation transformers and the associated LTC within the substation fence will be included. For Xcel Energy substations, this includes looking at the two types of assets (transformers and LTC's), documenting their maintenance requirements and procedures and then defining how the two asset categories, will be inspected and diagnostically tested to minimize the required effort while maximizing the assets' life and preventing preventable failures. The following is a brief description of the two categories:

- *Power Transformer (XFMR)* - A static device consisting of a winding and two or more coupled windings, with a magnetic core for introducing mutual coupling between electric circuits. Transformers are extensively used in electric power systems to transfer power by electromagnetic induction between circuits at the same frequency, usually with changed values of voltage and current.

- *On-Load Tap Changer (LTC)* - A controlled device used to automatically or manually change the primary or secondary voltage level of a transformer while under load (effectively the turns ratio)normally up to 10% to maintain the voltage in a preset bandwidth suitable for the downstream users of the energy. There are many applications:

[3] Peripherals include items such as temperature gauges, LTC drag hands, fans and pumps, etc.

- o Transmission system where under heavy loads the voltage may sag, the LTC can be used to maintain the transmission voltage at acceptable levels.
- o Distribution system to maintain the distribution substation bus voltage at acceptable levels to maintain the voltage level on individual circuits (aka feeders).
- o The LTC on a smaller transformer may be used for individual feeder voltage control.
- o The LTC may be used to re-direct the flow of VARs on the transmission system.
- o System ties, where the voltage between electrical systems may vary and LTC's may be used to correct the voltage levels.

Equipment types included in this procedure include all transformer winding configurations; and are categorized according to the various cooling methods, oil preservation sealing system, size and voltage. LTC's have been similarly categorized according to the various technologies used to facilitate the ability to change the voltage while in service and under load and if an identifiable oil sample can be obtained to determine the LTC condition. On LTCs, where oil sampling is not possible, the Xcel Energy procedures development team has analyzed the alternatives and recommends that necessary modifications be made to the transformer to facilitate sampling. Until such changes are installed, those transformers will be removed from service to allow for LTC DGA and oil sampling to determine the LTC's condition and any need for maintenance.

Transformers: the following types of transformers are included in this plan for voltages from 4kV up to 500kV for all MVA ratings. A key factor in the maintenance and inspection of transformers, is to prevent the overheating of the insulating medium including the core and coils with load management and adequate operating cooling, fans, and if so designed oil pumps to assist natural convection. Xcel Energy's plan is based on operating transformers in the designed range of load and temperature to maximize life; a major maintenance driver is the type of designed cooling and is used here to sort the various transformer categories.

The Maintenance number formula used to schedule the complete diagnostic inspection of the transformer ancillary equipment includes an Apparatus Condition (APK) factor ranging from 1 – 5, with 5 having the least amount of ancillary cooling equipment. For transformers, the factors are based on cooling equipment regardless of arrangement. They are:

- APK = 5 is not presently used.
- APK = 4 for transformers that are self-cooled.
- APK = 3 for transformers that use fans to cool the transformer.
- APK = 2 for transformers that use both fans and oil pumps to cool the transformer.
- APK = 2 for transformers that are water cooled.
- APK = 1 is not presently used.

The cooling design for each transformer can be found on the name plate and is designated with standard letter configurations. Key to determining the APK are the IEEE designations indicating air cooling, forced air, and forced oil.

In addition the transformer Maintenance number formula uses a service constant (SK) used as a prioritizing factor in the Maintenance number formulas; the Maintenance number grows at different rates depending on how important, as expressed by the SK, each transformer is to the operation of the Xcel Energy system. Service constants are assigned and used on both the transmission and distribution transformers; the specific SK values depend on the operating voltage class of the transformer.

Service constants used in Xcel Energy's Maintenance number formulas for transformers range in value from 1 to 5, with 5 being a transformer that has the greatest consequence of failure. An asset with a service constant of 5 would be subject to ancillary diagnostics sooner than equipment with the same oil cooling methodology but with a lower service constant. For transformers, the factors are based on the MVA size of the transformers:

- SK = 5 for transformers with EHV primary voltage and larger than 200 MVA.
- SK = 4 for transformer larger than 200 MVA.
- SK = 3 for transformers 20 MVA but less than 200 MVA.
- SK = 2 for transformers 5 MVA but less than 20 MVA.
- SK = 1 is a transformer less than 5 MVA.

On-Load Tap Changers: LTCs used at Xcel Energy include units based on resistive, reactive, and vacuum switching arrangements. They are applied to power transformers that have a variable load. When a transformer's load increases the transformer impedance causes the voltage to drop. When the load decreases the voltage rises. The LTC control senses the change in voltage and adjusts/regulates the LTC to keep the voltage within acceptable limits. LTCs are mechanical devices that vary the turns-ratio of a transformer. It performs this function without opening or disconnecting the power that is flowing through the transformer. The LTC's contacts are connected to the taps of a regulating winding. The mechanical drive mechanism physically moves the position of electrical contacts to select the appropriate ratio taps of the regulating winding. Resistors or reactors are used to limit the amount of circulating current during the switching transition from tap to tap.

Differences in voltage between the tap positions cause arcing to take place as the electrical contacts connect and part. This in turn causes burning of the contacts and degradation of the insulating fluid; both can be detected in dissolved gas analysis to evaluate the LTC condition.
Vacuum bottle tap changers are not designed to cause arcing in oil, and use a Vacuum Protection system to detect issues with the vacuum interrupters.

Most Xcel Energy substation regulating transformers have a 10% tap winding with higher or lower ranges for special applications. The tap winding typically varies the transformers ratio in .625% increments for a total of 16 steps. The polarity of the tap winding can be reversed under load. This gives the transformer the ability to lower or raise the voltage ratio by 10% above or below the nominal voltage rating. Details of LTC types and operation can be found in the equipment section below.

General

Diagnostic testing, careful analysis of the results, and when required proper maintenance activities including complete diagnostic of the transformer[4] is essential to system reliability and operations. Following the plan and procedures in this document, will ensure equipment performance and system reliability, and reduce the probability of unplanned failures. To ensure the proper implementation of these guidelines, maintenance personnel shall have a thorough understanding of the apparatus in their area of responsibility; be able to perform all required DGA and oil sampling, perform diagnostic tests, adjustments, repairs, inspections, and collect and record the correct performance and evaluation data for each asset. Test reports and other information collected during the diagnostic and laboratory testing, must be accurately interpreted and correct prompt actions taken when required, based on an understanding of the implications. All employees and Xcel Energy mutually share the responsibility to develop training, work as a team to stay current on procedures and equipment, and to recognize areas requiring additional focus.

Planning and Scheduling Transformer and LTC Diagnostics and Maintenance

Xcel Energy utilizes both time and a common planning and scheduling tool across the transmission and distribution asset[5] fleet, including the transmission and distribution transformers and LTCs based on a combination of factors including time, condition of the asset, the importance of the asset to the system and events that occur, such as fault operations while the equipment is in service. This Xcel Energy methodology, called Adaptable Reliability Centered Maintenance (ARCM) utilizes traditional diagnostic testing as well as modern diagnostic techniques such as transformer and LTC dissolved gas analysis (DGA), comprehensive oil testing, infrared scanning and periodic ancillary transformer diagnostics, as well as periodic visual inspections. If there is a need to perform further tests, make repairs, or order a transformer off-line to make repairs these tools and diagnostics provide the information required to make timely decisions. The goal, to increase reliability, requires Xcel Energy to perform all diagnostic testing the right way at the right time. Both on-site diagnostics and laboratory investigations will be used to determine the condition and if there is a need for further tests or actions on the transformer and/or the LTC if present.

While DGA, oil testing and infrared is done on a periodic (time based) schedule, each transformer and LTC in the system is represented by an algorithm[6] that grows the need for the ancillary diagnostic inspection either faster or slower depending on several factors such as previous diagnostic inspections and results. The algorithm for transformers is based on the type of construction and cooling of the unit (air only, fans, forced oil, or water cooling) to determine the apparatus constant (APK), the Service Constant (SK) based on the size of the unit in MVA to determine the value to the company (reliability, cost, risk, etc.). In addition the current and previous DGA tests, complete oil testing, and infrared results will all be used to evaluate the health of a transformer and the appropriate activities to ensure continued reliable operation of the unit. The

[4] Transformers will be used generically in the general text to indicate transformers and on-line tap changers - LTCs
[5] **Asset:** An item with an independent physical and functional identity and age, within a facility (e.g. transformer, circuit breaker, pole, tower).
[6] Several algorithms are required for the complete fleet of substation assets assigned major grouping such as breakers, transformers, LTCs, etc. to generate the correct indication for maintenance activity.

Maintenance number for transformers triggers a diagnostic for the ancillary transformer equipment (temperature gauge, fans, pumps, etc.). Diagnostic testing of the transformer and LTC is as follows:

- DGA sampling and laboratory analysis: Every 12 months for all transformers and LTCs with the following exceptions:
  - Transformers operating at 345 kV or greater and larger than 200 MVA in size will have a DGA sample drawn and analyzed every 3 months unless continually monitored, then annually.
  - New transformers and repaired transformers when initially energized will have a DGA sample at 1 day, 1 week, and 1 month, unless required more often by warranty. Depending on voltage and size, the transformer will then be scheduled on either a quarterly or annual basis.
  - Transformers indicating internal issues and/or potential failures will have testing done, depending on the severity, often enough to monitor the rate of gassing and the total combustibles.

- Complete Oil Analysis by laboratory: Every 12 months for all transformers and LTCs

- Infrared Scanning and Analysis: Every 12 months for all transformers and LTCs

- Diagnostic of ancillary equipment such as gauges, pumps, fans, etc. is scheduled based on the apparatus condition and overall importance to the Xcel Energy system using the Maintenance number methodology and the formula. The formula generates a Maintenance Number (or MN_{TA}) that can be used to plan and schedule the ancillary diagnostic inspection. The formula is:

$$MN_{TA} = \left(1 + \frac{SK}{APK}\right) x \left(\frac{250xTAE}{TK}\right)$$

Definitions of the terms:

MN_{TA} is the Maintenance number indicating the need for an ancillary equipment diagnostic
SK is a service constant 1-5 where 5 is the most important asset
APK is an apparatus constant 1-5 where 5 is the best condition
TAE is the time since there was an ancillary equipment diagnostic done
TK is a time constant (unit is years). Xcel Energy's TK is initially set at 8 years

Note: The LTC is similarly tested at the same time and intervals as the transformer.

Requirements

Documentation

A comprehensive maintenance history for each transformer and LTC as installed and operating, is essential in developing an effective maintenance strategy and adapting the plan to improve reliability based on the actual field condition of the transformers. This information is also important when addressing failure trends and understanding cause and effect analysis. Consequently **all** diagnostic inspections, LTC voltage control operations, factory tests, repairs, adjustments, and failures must be clearly documented and said information securely and permanently stored in an easily retrievable and useable format. Life expectancy of transformers is greater than 75 years and records will be required for the entire service period.

In addition, a summary of the DGA, comprehensive oil tests, infrared inspections and peripheral diagnostic inspections and maintenance activities will be kept in a transformer assessment folder. The date, name of personnel, and brief description of the work performed, tests made, and counter readings shall be recorded. In addition, **all** work performed, required follow-on quantitative test results, transformer or LTC condition reports will be documented in Xcel Energy's PassPort™ Work Management System or other designated systems of record.

A comprehensive inspection, operation, diagnostic and maintenance history of each substation transformer, LTC, and peripheral equipment must be maintained. This is essential for establishing not only the "health" of the individual piece of equipment, but also other transformers in the fleet of the same model or class (sister units). This information is essential when addressing failure trends and understanding cause and effect analysis, establishing schedules, diagnostic, and maintenance requirements. It is critical to the success of the overall maintenance plan objectives to maintain the appropriate documentation and data for each piece of equipment.

Maintenance and Inspection Plans

The transformer inspection, diagnostic and maintenance plan consists of three basic inspection and diagnostic procedures. A fourth procedure, an internal inspection of the core and coils, bushing connections, LTC, etc. may be required based on the diagnostic testing of the assets, but is not specifically scheduled or planned. This procedure is not intended to establish the Substation Inspection Program and Procedures which are contained in a separate document. A brief overview of the Inspection requirements that provide data and input into the Transformer and LTC Plan and Procedures is included for completeness.

Transformer Visual Inspections:

The visual transformer inspection will be performed each time a station inspection is performed and appropriate data collected in the electronic device used for inspections and later transferred to the system of record. Included in this inspection are all external gauges such as top oil temperature, hot spot temperature, oil level, LTC drag hands, LTC counter, pressure relief indicator, etc. In addition the fans and pumps if present should be activated to insure they are operational (oil pumps flow indicator should be verified), and any oil leaks or other issues reported.

Annual DGA, Comprehensive Oil and Infrared Inspection:

Dissolved Gas Analysis (DGA): As discussed above, every transformer will have a unique sample drawn from each separate compartment for dissolved gas testing as a health index of the transformer and LTC apparatus condition.

Transformer oils perform four functions for the transformer and load tap changer. The first three are to provide insulation, provide cooling, and help extinguish arcs. In addition oil retains dissolved elements generated by:

- Oil degradation
- Moisture in the transformer paper insulation and oil
- Cellulose insulation
- Deterioration of the core and tank metals

Close observation of dissolved gases in the oil and other oil properties; provide the most valuable information about transformer health. It is important to note that while unusual, a buildup of combustible gas and failure events can occur very quickly. Through-faults, high moisture levels in a transformer, or air bubbles trapped in the windings are some of the possible causes.

The analysis of the DGA and comprehensive oil tests looks for trends by comparing information of the present laboratory results to previous DGAs from the same asset compartment (transformer or LTC), and understanding their meaning. Two specific IEEE combustible tables are used in this analysis; the total combustible gas levels and the acceptable rate of rise per day of combustible gas. The laboratory will issue consistent condition reports as to the status of the various transformers.

Xcel Energy will use DGA analysis for all substation transformers on annual or quarterly basis after being placed in service and the transformer's initial energized period where DGA samples will be taken more frequently to establish a base line and trend if any gases are forming typically after 1 day, 1 week, and 1 month. Transformers operating at 345kV or greater and 200 MVA or larger will be DGA tested quarterly, unless continually monitored, and then yearly. This is by far the most important tool for determining the health of a transformer and LTC.

After results are determined for each of the samples, the laboratory will compare the current gas levels and prior DGAs, so that trends can be recognized and rates of gas generation established. Transformers are very complex; aging, chemical actions and reactions, electric fields, magnetic fields, thermal contraction and expansion, load variations, gravity, and other forces all interact inside the tank. Externally, through-faults, voltage surges, wide ambient temperature changes, and other forces such as the earth's magnetic field and gravity affect the transformer. There are few, if any, "cut and dried" DGA interpretations; keeping accurate records of each individual transformer's operating history is paramount.

Xcel Energy will depend on the expertise of the laboratory to analyze the oil samples and rank the condition of the transformer using a pre-defined scale, indicating if there is any issue with the transformer, if a re-test is warranted, or if serious problems are found in the transformer.

DGA is also used for the LTC compartments to determine the condition of the insulating oil (gases and carbon levels), the wear on the contacts, and the remaining useful life of the LTC.

The laboratory will analyze the types of metals found in the oil samples to determine the source of the particulates and the changes in concentrations since the last testing.

Comprehensive Oil Analysis: In addition to the DGA tests, transformers and LTCs (all separate compartments) will have an annual comprehensive oil analysis, which will include:

- **Dielectric Strength of the Oil** – this test is done to see at what voltage the oil electrically breaks down which affords a good indication of the contaminants in the oil such as water and oxidation particles. The IEEE standard C57.106 sets the minimum breakdown voltages for transformer oil and the specified test methodologies. Oil not meeting the standard must be reclaimed or replaced.

- **Interfacial Tension (IFT)** - used to determine the interfacial tension between the oil sample and distilled water. As the oil ages, it is contaminated by tiny particles (oxidation products) of the oil and paper insulation. The more particles, the weaker the interfacial tension and the lower the IFT number. The IFT and acid numbers together are an excellent indication of when the oil needs to be reclaimed.

- **Acid Number** – this number (acidity) is the amount of potassium hydroxide (KOH) in milligrams (mg) that it takes to neutralize the acid in 1 gram (gm) of transformer oil. The higher the acid number, the more acid is in the oil. New transformer oils contain practically no acid.

- **Oxygen Inhibitor** - Oxygen inhibitor is a key to extending the life of transformers. The oxygen attacks the inhibitor instead of the cellulose insulation. As this occurs and the transformer ages, the inhibitor is used up and needs to be replaced. The ideal amount of inhibitor recommended by the manufacturer shall be followed but generally 0.3% by total weight of the oil (ASTM D-3487). The test is usually done at intervals of no more than 3-4 years.

- **Power Factor -** This measurement indicates the dielectric loss (leakage current) of the oil. This test may be done by the DGA laboratories or using field testing equipment such as Doble™ testing equipment or other power factor test sets. A high power factor indicates deterioration and/or contamination by-products such as water, carbon, or other conducting particles; metal soaps caused by acids (formed as mentioned above), attacking transformer metals, and products of oxidation. The DGA labs normally test the power factor at 25 °C and 100 °C. Current information indicates the in-service limit for power factor is less than 0.5% at 25 °C. If the power factor is greater than 0.5% and less than 1.0%, further investigation is required; the oil may require replacement or reclamation by some method. If the power factor is greater than 1.0% at 25 °C, the oil may cause failure of the transformer; replacement or reclaiming is required. Above 2%, the oil should be removed from service and reclaimed or replaced because equipment failure is a high probability.

- **Furans -** Furans are a family of organic compounds which are formed by degradation of paper insulation (ASTM D-5837). Overheating, oxidation, and degradation contribute to the destruction of insulation and form furanic compounds. Changes in furans between DGA tests are just as important as individual numbers. The same is true for dissolved gases. Transformers with a degree of polymerization lower than 250 should be investigated because paper insulation is being degraded. Also reexamine both the IFT and acid number. Furan testing will be done in conjunction with the ancillary diagnostic.

Infrared Inspection

The annual inspection of the power transformers and the LTC shall include a comprehensive infrared inspection to verify that there is no unusual heating of the tank and LTC as well as the connections to the bushings, etc. The inspection will include verifying the temperature of the transformer oil versus the top oil temperature gauge and also the level of the oil versus the transformer's oil level gauge.

Ancillary Diagnostic Inspection

Based on the type of transformer, specific diagnostic tests will be periodically performed based on the Maintenance number generator discussed above. At this time, the transformer will be inspected for any gauge or mechanism that can be examined safely without the transformer being de-energized.

Unit	Outage Category	Primary Reason for outage	Outage Dates Start	End	Q1. Equipment that resulted in the forced outage	Q2. Description of Equipment Failure
JULY 2015						
Allen S. King 1	Derate	Feedwater Pump	07/14/2015	07/31/2015	12 Boiler Feed Pump	12 Boiler Feed Pump removed from service due to high vibrations and temperatures of outboard bearing. Electric driven 11 boiler feed water pump has a smaller capacity resulting in derate. The inlet volute is internal to the pump, guiding the inlet water source through the first of 5 stages of impellers within the pump.
JULY 2016						
King_G1	Forced	Forced Draft Fans	07/05/2016	07/08/2016	11 Forced Draft Fan	A failed inlet damper control ring allowed partial closure on the inboard side damper of the 11 FD Fan resulting in excessive thrust loading towards the 11 FD fan motor. This thrust loading was enough to cause premature wear on the fan side thrust pad of the inboard bearing which ultimately resulted in damage to the integral thrust collar.
King_G1	Forced	Forced Draft Fans	07/11/2016	07/14/2016	11 Forced Draft Fan	A failed inlet damper control ring allowed partial closure on the inboard side damper of the 11 FD Fan resulting in excessive thrust loading towards the 11 FD fan motor. This thrust loading was enough to cause premature wear on the fan side thrust pad of the inboard bearing which ultimately resulted in damage to the integral thrust collar.
King_G1	Forced	High Pressure Heater Tube Leaks	07/14/2016	07/15/2016	16B Feedwater Heater	Tube leaks were discovered in three FWH tubes in the outlet pass of the desuperheating zone of the Feedwater Heater.
SHERC3	Forced	Other Pulverizer Problems	07/03/2016	07/06/2016	303 Mill and 306 Mill	307 was out for scheduled mill major overhaul, 303 was out of service from 6/25-7/13 due to high stator temps requiring motor replacement. Loss of 303 eliminated our normal redundant configuration of mills. The loss of 306 mill due to the rotating throat segment coming loose as the result of two of the three hold-down bolts breaking caused a derate when combined with loss of our normal redundant mill 303.
SHERC3	Forced	Other Pulverizer Problems	07/07/2016	07/08/2016	303 Mill and 310 Mill	307 was out for scheduled mill major overhaul, 303 was out of service from 6/25-7/13 due to high stator temps requiring motor replacement. Loss of 303 eliminated our normal redundant configuration of mills. The loss of 310 mill due to internal damage to metal fenders, tile and pyrite scraper caused a derate when combined with loss of our normal redundant mill 303.
Anson_G2	Forced	Gas Turbine - Cooling Water System	07/22/2016	07/25/2016	Water Injection Pump	Motor failure
Anson_G4	Forced	Main Transformer	07/01/2016	08/01/2016	Main Transformer	Shorted winding
King_G1	Forced	Forced Draft Fans	07/08/2016	07/11/2016	11 Forced Draft Fan	A failed inlet damper control ring allowed partial closure on the inboard side damper of the 11 FD Fan resulting in excessive thrust loading towards the 11 FD fan motor. This thrust loading was enough to cause premature wear on the fan side thrust pad of the inboard bearing which ultimately resulted in damage to the integral thrust collar.
King_G1	Forced	High Pressure Heater Tube Leaks	07/15/2016	07/18/2016	16B Feedwater Heater	Tube leaks were discovered in three FWH tubes in the outlet pass of the desuperheating zone of the Feedwater Heater.
King_G1	Forced	Bottom Ash Hoppers (including Gates)	07/30/2016	08/01/2016	Bottom Ash Slag Tank	Unable to sluice bottom ash from tank. Contributing factors included degraded coal grind, lower load operation and a sluicing assist process change.
Redwing_1	Forced	First Superheater Leaks	07/13/2016	07/16/2016	Boiler	Superheater Tube Leak
Redwing_1	Forced	First Superheater Leaks	07/18/2016	07/21/2016	Boiler	Superheater Tube Leak

Internal Order Description	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	2017 AAA Total
NSPM MISO NSPP DA_ASSET_EN Alloc	7,641,678.27	10,575,362.19	8,535,951.98	10148264.66	8,506,782.22	18,160,285.49	16,167,432.00	8,626,409.49	12,499,060.40	4,531,659.80	10062469.21	7,729,168.86	123,184,524.57
NSPM MISO NSPP RT_ASSET_EN Alloc	1,789,068.86	1,812,075.88	2,423,117.66	2018914.28	2,789,312.91	3,412,197.85	1,824,352.43	2,658,223.29	2,544,632.09	1,827,133.67	1732008.94	1,200,676.94	26,031,714.80
NSPM MISO NSPP DA_ADMIN Alloc	(23,136.95)	(25,231.27)	(34,946.87)	-32841.29	(33,574.31)	(58,166.96)	(40,268.08)	(29,852.49)	(51,120.69)	(16,364.60)	-33045.75	(23,849.05)	(402,398.31)
NSPM MISO NSPP RT_ADMIN Alloc	(4,832.27)	(3,907.43)	(10,421.40)	-7357.77	(12,736.77)	(11,091.31)	(6,124.05)	(9,375.97)	(13,903.01)	(7,175.30)	-7221.12	(4,334.74)	(98,481.14)
NSPM MISO NSPP RT_RSG_MWP Alloc	218,481.50	64,889.95	33,234.35	8123.61	25,153.99	187,176.93	(42,462.30)	(11,394.58)	27,258.12	(2,945.29)	22612.8	24,212.07	554,341.15
NSPM MISO NSPP RT_PV_MWP Alloc	6,073.15	29,829.05	36,784.83	43105.33	58,156.79	76,212.85	54,061.20	28,432.26	18,269.85	17,609.47	89750.67	(40,306.72)	417,978.73
NSPM MISO NSPP DA_RSG_MWP Alloc	10,205.57	20,534.79	62,697.62	84007.66	80,577.19	91,550.83	(62,719.05)	(1,673.21)	19,142.44	12,045.72	35027.48	7,165.33	358,562.37
NSPM MISO NSPP DA_SCHD_24_ALC Alloc	(3,630.43)	(4,705.10)	(5,802.96)	-6406.91	(6,404.74)	(9,988.95)	(7,216.44)	(5,836.75)	(7,461.16)	(2,834.62)	-5586.39	(3,596.22)	(69,470.67)
NSPM MISO NSPP RT_SCHD_24_ALC Alloc	(759.14)	(754.43)	(1,754.01)	-1464.76	(2,420.45)	(1,890.91)	(1,105.18)	(1,814.30)	(2,097.90)	(1,238.41)	-1220.43	(649.06)	(17,168.98)
NSPM MISO NSPP RT_RAA Alloc	56,150.21	56,150.61	54,339.30	-46377.24	156,867.03	56,150.61	56,150.61	50,716.80	56,150.61	54,339.30	56150.61	14,400.00	621,188.45
NSPM MISO NSPP RT_MVP_DIST Alloc	(48,887.37)	35,607.48	15,406.22	37915.19	17,445.05	30,253.66	28,881.75	29,330.47	25,824.53	1,440.64	14173.15	13,783.27	201,174.04
NSPM MISO NSPP ASM_REG Alloc	159,962.82	111,869.06	85,444.70	134717.46	29,242.56	67,109.78	28,888.65	16,200.02	77,165.84	106,108.10	123921.02	91,874.20	1,032,504.21
NSPM MISO NSPP ASM_SPIN Alloc	189,401.90	187,943.89	366,160.10	123391.76	192,356.25	79,021.71	56,904.94	65,615.84	109,763.99	116,377.74	236244.96	142,962.09	1,866,145.17
NSPM MISO NSPP ASM_SUPP Alloc	4,310.11	2,886.46	3,616.42	6147.11	(255.72)	1,649.56	3,446.57	(884.74)	2,474.74	6,004.41	7492.05	1,897.01	38,783.98
NSPM MISO NSPP RT_ASM_CRDFC Alloc	408.74				408.74				(319.82)			-	497.66
NSPM MISO NSPP RT_ASM_EXE_DFE_DEP Alloc	(46,911.99)	(61,351.50)	(37,104.77)	-17743.96	-44283.92	(52,177.81)	(20,782.14)	-19700.66	(48,360.31)	(31,184.30)	-51103.57	(50,973.39)	(481,678.32)
NSPM MISO NSPP RT_ASM_NRGA Alloc	(9,223.81)	(6,326.83)	(4,263.27)	9577.27	270.12	(7,417.15)	(3,901.46)	1842.15	6,239.25	6,522.21	-1717.6	2,571.05	(5,828.07)
NSPM MISO NSPP RT_SCHD_24_DIST Alloc	146,913.50	123,496.22	119,325.10	129907.38	98191.8	94,657.63	126,782.27	96543.42	85,538.91	127,817.27	103395.06	118,795.65	1,371,364.21
NSPM MISO NSPP DA_ASSET_EN	14,751,852.20	4,679,465.44	5,635,363.80	2297652.46	(7,661.18)	(8,726,387.36)	(7,165,551.57)	-1735924.48	(3,986,679.13)	8,943,497.22	4750223.13	6,023,192.03	25,459,042.56
NSPM MISO NSPP DA_ASSET_EN_CG	6,693,773.94	9,162,977.08	804,947.51	-235114.55	1,041,169.43	3,445,808.29	1,113,211.80	199791.15	764,658.21	617,319.34	634446.81	692,477.42	24,935,466.43
NSPM MISO NSPP DA_ASSET_EN_LS	2,637,572.44	3,011,387.22	2,246,565.83	2199280.18	2,273,435.78	4,426,568.47	4,009,830.07	2,523,307.46	2,733,978.19	1,802,195.73	1731852.28	1,954,979.69	31,550,953.34
NSPM MISO NSPP DA_GFACO_RBT_CG	12,653.88	4,691.40	22,661.42	28826.73	7,389.41	13,752.42	1,791.59	7,617.44	(2,509.88)	2,890.88	5.88	550.32	100,321.49
NSPM MISO NSPP DA_FIN_LS	(4,115.25)	(1,282.04)	(4,943.79)	-5454.82	(350.42)	275.39	3,497.26	590.24	(345.72)	(1,878.50)	-631.65	(2,188.53)	(16,827.83)
NSPM MISO NSPP DA_FIN_CG	(12,653.88)	(4,691.40)	(22,661.42)	-28826.73	(7,389.41)	(13,752.42)	(1,791.59)	(7,617.44)	2,509.88	(2,890.88)	-5.88	(550.32)	(100,321.49)
NSPM MISO NSPP DA_GFACO_RBT_LS	4,115.25	1,282.04	4,943.79	5454.82	350.42	(275.39)	(3,497.26)	(590.24)	345.72	1,878.50	631.65	2,188.53	16,827.83
NSPM MISO NSPP DA_GFAOB_RBT_LS	-												-
NSPM MISO NSPP DA_RSG_DIST	88413.54	101546.43	140755.17	212504.71	(42,553.24)	149,113.65	52,462.56	30,228.41	151,220.36	63,980.90	159086.76	42,276.99	1,149,036.24
NSPM MISO NSPP DA_RSG_MWP	-26345.38	-27314.08	-138089.08	-170329.88	(223,693.48)	(110,242.83)	(21,715.03)	(48,527.36)	(80,092.60)	(56,414.91)	-83526.34	(43,329.19)	(1,029,620.16)
NSPM MISO NSPP DA_VIRT_EN													-
NSPM MISO NSPP DA_NASSET_EN	(13,021,473.40)	(12,031,894.42)	(11,617,366.18)	-11010270.82	(6,682,039.04)	(8,738,190.78)	(8,201,636.26)	(6,286,966.14)	(8,185,863.68)	(7,929,213.87)	-10848760.73	(11,186,274.72)	(115,739,950.04)
NSPM MISO NSPP DA_NASSET_EN_CG	1681442.69	1635050.27	2767318.76	2290978.4	895,301.93	1,628,179.16	525,988.22	718,406.43	1,281,429.07	1,104,103.63	2452897.05	1897670.89	18,878,766.50
NSPM MISO NSPP DA_NASSET_EN_LS	1,802,574.91	1,494,597.03	1,685,470.12	1315206.4	690,755.74	820,238.01	505,601.38	614,684.34	802,981.04	960,734.67	1181928.5	1,125,362.40	13,000,134.54
NSPM MISO NSPP DA_ASM_REG	-203253.49	-211030.49	-210250.11	-372539.67	(218,835.36)	(260,027.78)	(150,242.01)	(85,401.29)	(253,646.51)	(309,297.78)	-247294.97	(165,757.16)	(2,687,576.62)
NSPM MISO NSPP DA_ASM_SPIN	(389,637.08)	(312,265.86)	(350,641.19)	-388116.87	(254,924.70)	(184,204.82)	(125,045.23)	(99,367.94)	(184,965.18)	(314,061.33)	-330087.19	(183,520.88)	(3,116,838.27)
NSPM MISO NSPP DA_ASM_SUPP	(128,112.49)	(104,166.58)	(79,036.23)	-74001.48	(35,474.11)	(52,166.14)	(45,283.28)	(25,239.60)	(58,854.88)	(58,851.04)	-120291.28	(28,503.25)	(809,980.36)
NSPM MISO NSPP RT_GFACO_RBT_CG													-
NSPM MISO NSPP RT_LOSS_DIST	(2,855,796.74)	(1,557,284.72)	(1,083,039.53)	-943560.52	(752,139.68)	(1,384,208.66)	(1,444,450.98)	(781,626.16)	(579,514.70)	(557,907.40)	-458282.41	(786,799.19)	(13,184,610.69)
NSPM MISO NSPP RT_FIN_LS													-
NSPM MISO NSPP RT_FIN_CG													-
NSPM MISO NSPP RT_GFACO_RBT_LS													-
NSPM MISO NSPP RT_MISC	88,512.44	152,049.08	88,603.51	112179.21	93347.4	91,346.47	479,018.87	(97,050.54)	485,323.46	158,391.31	156119.12	101,543.73	1,909,384.06
NSPM MISO NSPP RT_NI_DIST	(905,844.50)	(254,345.91)	110,072.99	382324.62	166851.4	42,338.73	29,306.50	33,342.99	213,278.40	22,885.49	57278.8	50,461.87	(52,048.62)
NSPM MISO NSPP RT_RSG_DIST1	315,992.23	372,098.76	340,232.69	154590.98	92564.14	242,110.81	161,443.72	5,442.26	116,523.07	211,887.74	140388.4	190,404.27	2,343,679.07
NSPM MISO NSPP RT_RSG_MWP	-364259.72	-131572.28	-112849.1	-101807.53	-40154.78	(249,062.96)	(33,064.72)	4.85	(50,870.00)	(4,636.12)	-31357.47	(32,253.36)	(1,151,883.19)
NSPM MISO NSPP RT_RNU	1,335,881.88	1,047,875.60	(98,074.48)	661604.99	467965.97	299,374.04	67,209.06	1,422,404.14	318,206.81	822,591.68	342761.45	570,998.21	7,258,799.35
NSPM MISO NSPP RT_PV_MWP	-225785.91	-408906.14	-270619.24	-329598.35	(500,635.71)	(300,602.11)	(237,896.77)	(99,395.27)	(121,293.01)	(111,132.69)	-659800.73	(334,962.57)	(3,600,628.50)
NSPM MISO NSPP RT_NASSET_EN	-87312.34	22008.37	25806.09	53572.36	-3601.38	43.68	-	15,322.41	70,401.75	366.62	73716.52	9,357.28	179,681.36
NSPM MISO NSPP RT_NASSET_EN_CG	40600.7	158.2	-19688.79	-37987.58	916.82	(36.28)	-	220.88	2,155.31	(13.29)	4078.17	(735.96)	(10,331.82)
NSPM MISO NSPP RT_NASSET_EN_LS	16,457.34	192.41	(6,117.29)	-15573.91	1,692.43	(7.40)	-	(275.90)	(3,509.43)	26.34	-5805.26	(1,223.10)	(14,143.77)
NSPM MISO NSPP RT_ASM_CRDFC	(408.74)			675.77	(408.74)	41.82	-	320.26	4,041.87				4,262.24
NSPM MISO NSPP RT_ASM_EXE_DFE_DEP	117,233.20	86,407.95	57,096.42	84714.53	63791.62	95,714.74	110,846.27	43,817.63	108,430.61	158,209.09	170603	110,957.07	1,207,822.13
NSPM MISO NSPP RT_ASM_NRGA	11,738.49	17,575.14	1,756.17	-15395.62	5,821.80	8,491.08	7,943.31	-4847.38	(7,683.10)	(15,677.67)	13433.65	(4,688.34)	18,467.53
NSPM MISO NSPP RT_ASM_REG	(86,566.96)	(31,752.22)	44,782.90	33941.33	73,530.49	87,100.06	(3,470.78)	-465.55	28,731.03	27,984.07	-17348.94	(39,876.67)	116,588.76
NSPM MISO NSPP RT_ASM_REG_DIST	123,289.44	124,255.05	108,778.94	137021.63	117728.16	130,720.51	142,259.27	125656.06	130,795.98	155,608.83	159876.25	154,481.76	1,610,471.88
NSPM MISO NSPP RT_ASM_SPIN	(27,838.72)	16,612.93	(95,210.49)	15897.82	(25,356.04)	10,648.39	(10,468.96)	-31146.43	(11,897.85)	69,082.08	-56185.35	(43,688.54)	(189,551.16)
NSPM MISO NSPP RT_ASM_SPIN_DIST	238,067.59	173,598.67	127,771.51	187097.05	128175.31	123,759.66	112,319.76	93638.12	147,325.12	221,553.67	227740.14	192,684.30	1,973,730.90
NSPM MISO NSPP RT_ASM_SUPP	35,451.00	19,387.71	11,908.79	371.4	178.76	994.94	111.58	28.01	3,694.36	2,507.18	-6325.59	579.15	68,887.29
NSPM MISO NSPP RT_ASM_SUPP_DIST	167503.22	115305.55	74043.79	69961.08	46,724.18	67,034.46	46,498.28	26168.95	55,602.26	55,032.47	112904.58	29,387.92	866,166.74
NSPM MISO NSPP RT_ASM_EXE	(45,225.24)	(47,178.90)	173,790.85	94582.82	(10,205.87)	298,145.86	50,986.22	4668.67	2,665.58	13,415.57	20530.84	49,816.84	605,993.24
NSPM MISO NSPP RT_ASM_NXE	2,357,643.07	3,644,189.71	1,398,367.97	-85655.44	(1,559,001.94)	(356,627.24)	850,936.44	(362,952.53)	(731,947.73)	(1,128,894.28)	1642398.77	2,373,003.64	8,041,460.44
NSPM MISO NSPP RT_ASM_NXE_CG	(221,566.25)	(145,346.27)	(54,193.66)	-50253.92	(27,497.27)	(198,936.28)	35,457.76	-102060.22	43,776.56	(255,503.77)	-221968.95	(445,709.10)	(1,643,801.37)
NSPM MISO NSPP RT_ASM_NXE_LS	(7,871.36)	(91,100.46)	3,955.41	69462.82	72,002.52	5,157.77	79,009.30	-40432.63	100,987.08	129,457.95	-186046.73	(83,842.45)	50,739.22
NSPM MISO NSPP RT_ASSET_EN	213,728.78	349,451.38	(582,243.58)	-151077.15	-18938.39	431,819.46	(71,054.97)	(876,327.90)	(364,062.19)	(1,422,100.49)	-2118816.93	(1,052,059.76)	(5,661,681.74)
NSPM MISO NSPP RT_ASSET_EN_CG	30,079.22	250,963.33	134,755.67	71258.6	-16456.74	41,770.07	(34,314.84)	100,975.13	63,072.26	126,136.01	209150.13	381,637.83	1,359,026.67
NSPM MISO NSPP RT_ASSET_EN_LS	56,601.47	126,737.41	54,962.67	-4971.11	3,612.06	1,708.83	(135.06)	46502.55	14,655.57	(21,803.49)	96534.34	106,071.09	480,476.33
NSPM MISO NSPP RT_DRR_UPL	1.85	4,299.81	1,960.61	5410.97	1316.11	301.04	(1.84)	4.23	311.86	462.88	8680.37	3,581.97	26,329.86
NSPM MISO NSPP RT_RAA	(56,150.61)	(55,715.90)	(54,774.01)	46377.24	-65962.25	(147,055.51)	(56,150.61)	-50716.68	(56,150.61)	(54,339.30)	-45717.46	(22,529.15)	(618,884.85)

Northern States Power Company
Electric Operations - State of Minnesota
MISO Charges By Charge Types (New Format)
Updated Part J, Section 5, Schedule 14

Internal Order Description	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	2017 AAA Total
NSPM MISO NSPP RT_MVP_DIST	48,919.08	(54,641.03)	(16,598.19)	-18670.35	-16320.19	(29,909.28)	(29,128.00)	-29339.69	(25,895.73)	(1,733.12)	-14056.32	(13,501.34)	(200,874.16)
NSPM MISO NSPP FTR_HR_ALC	(10,118,461.00)	(11,330,859.67)	(3,869,512.42)	-1812408.63	(1,486,846.17)	(4,664,786.32)	(1,331,375.67)	(838,171.65)	(670,851.35)	(1,104,997.12)	-2486208.9	(3,818,515.21)	(43,532,994.11)
NSPM MISO NSPP FTR_MN_ALC	(144,058.98)	(373,264.68)	(362,999.48)	-268558.74	(150,032.09)	(338,255.33)	46,647.87	17025.77	49,844.83	(60,192.81)	-246667.11	(65,364.59)	(1,895,875.34)
NSPM MISO NSPP FTR_YR_ALC	-									(131,400.71)			(131,400.71)
NSPM MISO NSPP FTR_FFG	(516,778.16)	78,648.31	171,296.61	-147801.3	422,882.21	(48,608.09)	(164,486.83)	16398.23	74,291.85	118,533.78	-14470.07	371.11	(9,722.35)
NSPM MISO NSPP FTR_GUL	535,488.44	(81,674.35)	(170,891.71)	149188.09	(420,266.26)	53,665.49	148,192.29	(3,867.10)	(73,725.92)	(145,918.59)	18213.79	(5,904.94)	2,499.23
NSPM MISO NSPP FTR_ARR_FTR_TXN	2,398,660.25	2,398,660.25	2,979,882.82	2979882.82	2979882.82	2,119,952.05	2,119,952.05	2,119,952.05	1,791,598.49	1,791,598.49	1791598.49	3,620,102.73	29,091,723.31
NSPM MISO NSPP FTR_ARR_ARR_TXN	-2416523.31	-2416523.31	-2999227.01	-2999227.01	(2,999,227.01)	(2,124,278.57)	(2,124,278.57)	(2,124,278.57)	(1,792,492.43)	(1,792,492.43)	-1792492.43	(3,628,762.14)	(29,209,802.79)
NSPM MISO NSPP FTR_ARR_INF_UPL	78,282.87	78,282.87	96,890.41	96890.41	96890.41	76,245.14	76,282.68	76,263.91	78,191.97	78,172.70	78210.49	92,725.55	1,003,329.41
NSPM MISO NSPP FTR_ARR_STG2_DIST	(72,008.18)	(75,228.96)	(129,623.96)	-130003.99	-130003.99	(145,479.96)	(149,844.35)	(147,923.92)	(198,870.83)	(196,120.48)	-200682.1	(123,228.74)	(1,699,019.46)
NSPM MISO NSPP DA Native Sales (EXP)	-5646119.83	-14272295.13	-5615888.5	-3079813.65	-2560073.94	(16,089,725.18)	(8,058,326.33)	-6149798.2	(5,261,460.77)	(4,680,260.79)	-6213954.9	(5,984,607.79)	(83,612,325.01)
NSPM MISO NSPP RT Native Sales (EXP)	1,077,165.05	95,371.66	347,558.16	738578.22	1227189.82	(2,125,956.06)	1,496,179.08	-2580279.91	(245,949.76)	1,423,309.20	1446885.52	811,341.06	3,711,392.04
NSPM MISO NSPP Battery Unit FERC Reclss	-		(3,639.48)			(3,443.90)			(3,484.98)			542.70	(10,025.66)
NSPM MISO NSPP RT Native Sales (EXP)	5,646,119.83	14,272,295.13	5,615,888.50	3079813.65	2,560,073.94	16,089,725.18	8,058,326.33	6149798.2	5,261,460.77	4,680,260.79	6213954.9	5,984,607.79	83,612,325.01
NSPM MISO NSPP RT Native Sales (REV)	-1077165.05	-95371.66	-347558.16	-738578.22	(1,227,189.82)	2,125,956.06	(1,496,179.08)	2,580,279.91	245,949.76	(1,423,309.20)	-1446885.52	(811,341.06)	(3,711,392.04)
NSPM MISO NSPP DA_ADMIN	580,690.42	479,191.26	617,794.83	518878.54	517,927.85	640,080.83	558,272.76	460940.16	693,296.91	511,310.92	567555.59	591,697.02	6,737,637.09
NSPM MISO NSPP DA_SCHD_24_ALC	91,294.75	92,907.00	110,893.73	109274.42	95,809.57	103,086.65	98,166.49	88219.7	437,736.53	86,711.70	93929	87,450.99	1,495,480.53
NSPM MISO NSPP RT_ADMIN	45,672.58	36,248.32	53,940.97	42448.82	49,500.61	46,842.84	38,505.76	32,504.59	48,532.23	49,465.93	38601.04	46,692.09	528,955.78
NSPM MISO NSPP RT_SCHD_24_ALC	7,203.46	6,991.03	9,602.36	8961.9	9,276.33	7,874.61	6,901.50	6,346.72	7,122.22	8,574.64	6480.53	7,017.63	92,352.93
NSPM MISO NSPP RT_SCHD_24_DIST	(124,774.72)	(121,703.81)	(123,990.82)	-103063.78	(109,445.08)	(113,752.63)	(106,329.53)	(98,523.99)	(113,150.48)	(107,222.13)	-93396.55	(96,924.87)	(1,312,278.39)
NSPM MISO NSPP FTR_ADMIN	40,601.76	34,137.28	26,959.20	11575.68	29,368.48	29,508.32	33,859.84	39,455.52	34,286.72	25,168.00	18517.92	28,547.04	351,985.76
TOTAL	14,670,444.64	12,867,855.83	9,299,438.07	7,579,659.63	6,495,828.38	9,465,049.51	8,163,617.47	6,383,993.70	8,651,903.12	9,302,357.62	9,057,497.19	7,551,915.28	109,489,560.44
Purchased Power Gen Trading													
RSG/RNU Wholesale Allocation													
Manual Adjustment - DA RSG	(7,734.67)	(10,956.92)	(19,975.92)	(30,404.60)	7,072.69	(30,097.61)	(8,200.55)	(4,860.64)	(26,438.00)	(5,533.27)	(21,561.26)	(3,880.60)	(162,571.35)
Manual Adjustment - RT RSG	(27,643.89)	(40,149.68)	(48,285.70)	(22,118.46)	(15,384.90)	(48,868.48)	(25,235.67)	(875.10)	(20,371.84)	(18,324.72)	(19,027.04)	(17,477.20)	(303,762.68)
Manual Adjustment - RNU	(116,866.71)	(113,066.42)	13,918.69	(94,660.65)	(77,779.66)	(60,426.68)	(10,505.61)	(228,718.63)	(55,632.39)	(71,140.34)	(46,454.95)	(52,411.92)	(913,745.27)
Total RSG/RNU	(152,245.27)	(164,173.03)	(54,342.92)	(147,183.70)	(86,091.87)	(139,392.77)	(43,941.84)	(234,454.38)	(102,442.22)	(94,998.33)	(87,043.25)	(73,769.72)	(1,380,079.30)
Congestion and Loss Wholesale Allocation													
Manual Adjustment - DA Congestion	(585,590.20)	(988,690.86)	(114,237.85)	33,639.55	(173,050.64)	(695,513.76)	(174,008.90)	(32,125.86)	(133,685.90)	(53,387.74)	(85,987.48)	(63,562.49)	(3,066,202.12)
Manual Adjustment - DA Loss	(230,742.27)	(324,930.53)	(318,831.79)	(314,667.04)	(377,863.10)	(893,473.75)	(626,786.47)	(405,740.83)	(477,983.94)	(155,859.60)	(234,720.41)	(179,447.55)	(4,541,047.29)
Manual Adjustment - DA Non-Asset Congestion	(147,097.34)	(176,422.93)	(392,736.85)	(327,786.97)	(148,806.30)	(328,637.26)	(82,218.52)	(115,517.76)	(224,033.43)	(95,486.39)	(332,444.64)	(174,187.18)	(2,545,375.57)
Manual Adjustment - DA Non-Asset Loss	(157,694.33)	(161,267.94)	(239,201.29)	(188,176.16)	(114,809.10)	(165,559.65)	(79,031.80)	(98,839.53)	(140,385.92)	(83,087.38)	(160,188.46)	(103,297.00)	(1,691,538.56)
Manual Adjustment - RT Non-Asset Congestion	19,383.24	15,682.95	7,691.14	7,190.19	4,570.26	40,153.98	(5,542.49)	16,411.00	(7,653.50)	22,096.78	30,083.77	40,911.63	190,978.96
Manual Adjustment - RT Non-Asset Loss	688.61	9,829.80	(561.35)	(9,938.55)	(11,967.39)	(1,041.06)	(12,350.14)	6,501.45	(17,655.66)	(11,195.93)	25,215.18	7,695.90	(14,779.16)
Manual Adjustment - ASM RT Asset EN GEN CONG	(2,631.41)	(27,079.10)	(19,124.47)	(10,195.49)	2,735.24	(8,431.01)	5,363.84	(16,236.52)	(11,026.98)	(10,908.64)	(28,346.42)	(35,030.53)	(160,911.50)
Manual Adjustment - ASM RT Asset EN GEN LOSS	(4,951.66)	(13,675.04)	(7,800.28)	711.25	(600.35)	(344.92)	21.11	(7,477.48)	(2,562.25)	1,885.63	(13,083.44)	(9,736.26)	(57,613.68)
Manual Adjustment - RT Asset EN Load CONG	(3,551.86)	(17.07)	2,794.23	5,435.16	(152.38)	7.32	-	(35.52)	(376.81)	1.15	(552.72)	67.55	3,619.04
Manual Adjustment - RT Asset EN Load LOSS	(1,439.73)	(20.76)	868.16	2,228.27	(281.30)	1.49	-	44.36	613.56	(2.28)	786.80	112.27	2,910.85
Total Congestion and Loss	(1,113,626.96)	(1,666,591.48)	(1,081,140.36)	(801,559.77)	(820,225.05)	(2,052,838.62)	(974,553.38)	(653,016.68)	(1,014,750.84)	(385,944.40)	(799,237.83)	(516,473.66)	(11,879,959.02)
Ramp Capability Amount													
Embedded in ASM - DA Regulation	**-**	**(27,351.11)**	**(17,100.23)**	**(11,268.78)**	**(8,746.72)**	**(5,502.49)**	**(990.23)**	**(1,491.40)**	**(4,180.11)**	**(5,782.89)**	**(8,167.09)**	**(3,882.83)**	**(94,463.88)**
Embedded in ASM - RT Regulation	**-**	**948.08**	**228.29**	**(2,055.07)**	**(3,749.39)**	**(967.40)**	**(706.00)**	**(1,677.12)**	**(822.67)**	**143.67**	**(542.64)**	**(341.52)**	**(9,541.77)**
ASM Regulation Excluded Ramp Capability Amount													
NSPM MISO NSPP DA_ASM_REG	**(203,253.49)**	**(183,679.38)**	**(193,149.88)**	**(361,270.89)**	**(210,088.64)**	**(254,525.29)**	**(149,251.78)**	**(83,909.89)**	**(249,466.40)**	**(303,514.89)**	**(239,127.88)**	**(161,874.33)**	**(2,593,112.74)**
NSPM MISO NSPP RT_ASM_REG	**(86,566.96)**	**(32,700.30)**	**44,554.61**	**35,996.40**	**77,279.88**	**88,067.46**	**(2,764.78)**	**1,211.57**	**29,553.70**	**27,840.40**	**(16,806.30)**	**(39,535.15)**	**126,130.53**