NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Balancing Authority/Transmission Operator Reliability Readiness Evaluation Report

Xcel Energy, Inc. — Northern States Power Minneapolis, Minnesota

August 20–23, 2007

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Introduction and Evaluation Process

The North American Electric Reliability Corporation (NERC) Reliability Readiness Evaluation and Improvement Program is one of the commitments of NERC and the industry to strengthen the reliability of the North American bulk power system. The program conducts independent evaluations of balancing authorities, transmission operators, reliability coordinators, and other key entities that support the reliable operation of the bulk power system to assess their preparedness to meet their assigned reliability responsibilities. The evaluations identify strengths and areas for improvement in an effort to promote excellence in operations among these organizations.

Since its inception in 2004, NERC and the industry have been working collaboratively to enhance the program. The evaluation process is based on fundamental aspects of reliability: culture, operations, maintenance, planning, and training. The document *NERC Readiness Evaluation Procedure* describes and defines the process used for reliability readiness evaluations. This document and other documents related to the program are available at http://www.nerc.com/~rap/.

The reliability readiness evaluation teams, each led by a NERC staff member and a regional co-leader, include industry volunteers with considerable expertise selected to provide representation from other interconnections, other regions, and neighboring operating entities. The teams also typically include representatives from the Federal Energy Regulatory Commission (FERC) staff.

The public version of the reliability readiness evaluation report contains the majority of the evaluation team's findings. Any discussion of findings pertaining to critical infrastructure will be contained in Appendix 1, a confidential appendix to the report that is sent privately to the evaluated entity and is not included in the public version of the report.

An evaluation team met on-site with representatives of Northern States Power Company-Minnesota and Northern States Power Company-Wisconsin, Xcel Energy Companies (the NSP Companies) on August 20–23, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of the NSP Companies to meet its responsibilities as a balancing authority/transmission operator.

Evaluation Team

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Organization Profile

Xcel Energy Inc. (Xcel Energy) is a holding company with four utility subsidiaries serving electric and natural gas customers in eight states. The utility subsidiaries are Northern States Power Company-Minnesota, Northern States Power Company-Wisconsin, Public Service Company of Colorado, and Southwestern Public Service Company. The Northern States Power Company-Minnesota and Northern States Power Company-Wisconsin transmission systems are operated as a single system commonly referred to as Northern States Power (NSP). The balancing authority and transmission operator functions and related support functions for NSP are provided by employees of Xcel Energy Services Inc.

The NSP service area covers the western third of Wisconsin; the central third of Minnesota; an area surrounding Sioux Falls, South Dakota; and areas surrounding Fargo, Grand Forks, and Minot, North Dakota. NSP's peak system load in 2006 was 9,301 MW. NSP provides electric services to approximately 1.7 million customers. The total capacity of NSP owned generation is 7,648 MW in the summer and 8,144 MW in the winter. The fuel mix is 46.18% coal, 21.14% nuclear, 1% diesel internal combustion, 3.5% hydro, 28.5% natural gas, and 1% wind.

NSP owns approximately 1,400 miles of transmission circuit miles rated 200 kV and above. NSP has transmission ties with Manitoba Hydro Electric Board at 500 kV; Alliant West at 345, 161, and 69 kV; Alliant East at 345 kV; Wisconsin Public Service at 115 kV; Great River Energy at 345, 230, 115, and 69 kV; Dairyland Power Cooperative at 161, 69, and 34.5 kV; Minnesota Power at 500, 230, and 115 kV; Western Area Power Association at 345, 230, and 115 kV; Otter Tail Power at 115 and 69 kV; and Southern Minnesota Municipal Power Agency at 69 kV.

Midwest Independent Transmission System Operator (MISO) is the reliability coordinator for NSP, and NSP is a member of the Midwest Reliability Organization. The balancing authority functions performed by NSP are executed at its Minneapolis control center, with the exception of economic generation dispatch, which is delegated to Xcel Energy Marketing at Xcel Energy's Denver, Colorado office. NSP's system is operated as one contiguous load balancing area, with a dynamic schedule for loads served in Otter Tail Power's balancing area in North Dakota. The system operators performing NSP's transmission operator and balancing authority functions are located in the NSP's Minneapolis control center. NSP's system operators located in its Wisconsin control center perform switching functions for the NSP's transmission system in Wisconsin. Interchange scheduling is the responsibility of MISO, in accordance with the *Balancing Authority Agreement*. NSP approves interchange schedules based on 12 grandfathered agreements.

Executive Summary

The evaluation team found no significant operational problems and concluded that NSP has adequate facilities, processes, plans, procedures, tools, and trained personnel to perform the balancing authority/transmission operator functions necessary to maintain the reliable operation of the bulk power system.

NSP has a culture that supports reliability being a top priority through its goals and continuous review of system performance. Company leadership has open communications with employees in system operations and promotes an atmosphere that encourages the employees to take responsibility for improving system operations.

The evaluation team identifies the document control program in system operations as an example of excellence because it ensures that all operating procedures are current and properly controlled and that all system operators are properly informed of changes in policies or procedures in a timely manner. The team also identifies 15 positive observations related to system operations activities ranging from the tools provided for system operators to the training they receive and the staffing of the system operator positions.

The evaluation team lists six recommendations it thinks will enhance system operations and improve system reliability. Two key recommendations, which were jointly decided with NSP system operation's management, are related to reviewing the procedures for communicating with NSP's reliability coordinator and training additional system operators in the use of satellite phones for emergency communications.

Overall, the evaluation team identified one potential example of excellence and 14 positive observations. In addition, the team offers six recommendations that, if implemented, will enhance NSP's readiness to operate reliably and maintain the reliability of the bulk power system.

Potential Examples of Excellence

The evaluation team identified the following potential examples of excellence in its reliability readiness evaluation:

1. The documentation control program provides assurance that all policies and procedures are current and properly controlled, and all system operations personnel are informed of changes in a timely fashion (Section 2.2.3).

Positive Observations

The evaluation team noted the following positive observations during the reliability readiness evaluation process:

1. The inclusion of a network reliability lead operator on the system operations team enhances the team's functionality (Section 2.2.3).

2. The comprehensive shift-change checklist ensures thorough and accurate communications on system conditions (Section 2.2.3).

3. New displays and tools under development will provide subregional load shedding capabilities that refine the load shedding program (Section 2.4).

4. Improvements under development for automating the calculation of reactive reserves will provide quicker and more accurate information for the transmission operator (Section 2.1).

5. The automation of automatic voltage regulator status through the EMS under development provides the operator improved system information (Section 2.1).

6. Providing six independent frequency sources improves reliability of area control error calculations (Section 2.1).

7. Providing eight frequency measurements across the system footprint assists system operators in detecting electrical islands (Section 2.1).

8. Operational planning is a complete and thorough process that provides added system operations support (Section 4).

9. Training of system operators is comprehensive and taken seriously at all levels (Section 5.1).

10. Dedicated information technology support to system operations improves reliability of the EMS (Section 3.2.1).

11. Communications within the Transmission division promotes effective power system operations (Section 1.2.5).

12. The succession plan is a thorough and effective tool in meeting future needs (Section 1.2.4).

13. The corporate culture promotes a professional atmosphere in system operations (Section 1.2.2).

14. Redundancy of power supply and telecommunication systems at the backup control center provides exceptional reliability. See further discussion in Appendix 1.

Recommendations

The evaluation team offers the following recommendations:

1. Review procedures and determine whether timing of communications with the reliability coordinator should receive an earlier priority (Section 2.2).*

2. Expedite, to the extent possible, the upgrade of the training simulator to simulate events that have occurred on NSP's bulk power system and provide enhanced training for new and experienced system operators (Section 5.1).

3. Install the "B-57 Overload Program" software in the system control center to provide system operators with direct access to weather-adjusted transmission loading analysis as opposed to needing to request runs via telephone or the EMS from an off-site computer system (Section 2.3).

4. Confidential information on power supply for control facilities redacted from public report. See discussion in Appendix 1.

5. Add more measurements for external systems in state estimator models to provide system operators with enhanced information about conditions at interfaces with neighboring systems (Section 2.3).

6. Train all system operators on use of satellite phone (Section 2.1).*

*Jointly identified by the company and lead evaluator as a key recommendation

Discussion

The reliability readiness evaluation team examined the following key areas during the evaluation. The detailed discussion that follows provides the foundation for the recommendations, positive observations, and potential examples of excellence that the team identified. The report uses the generic term "system operator" to refer to all on-shift operating personnel responsible for executing the functions necessary to operate reliably and maintain the reliable operation of the bulk power system. This term will be used for the discussions unless additional specificity is required, such as the *balancing* system operator, or *transmission* system operator.

1. Culture

1.1 General

The corporate organization provides the necessary leadership and management for system operations to sustain high levels of safe, reliable operation.

Xcel Energy's corporate mission statement reflects a commitment to operational excellence and providing its customers with reliable energy. The corporate vision and mission is founded on seven corporate values:

1. Work safely and create a challenging and rewarding workplace
2. Conduct all our business in an honest and ethical manner
3. Treat all people with respect
4. Work together to serve our customers
5. Be accountable to each other for doing our best
6. Protect the environment
7. Continuously improve our business

Every employee is held accountable for knowing and following these values.

The Transmission function translates these corporate values into performance objectives directly tied to the performance of the transmission system. Two major performance indices that are tracked monthly and reported on a scorecard: the Transmission System Average Interruption Duration Index and the Transmission Circuit Outage Duration Index — Bulk. Both of these performance indices directly impact team performance goals for system operations.

1.2 Organizational Effectiveness

1.2.1 Foundation for System Reliability

The organization's values and behaviors—modeled by its leaders and practiced by its members—serve to make system reliability a top priority.

As a result of tracking transmission performance indices for transmission maintenance, planning, and operations on a monthly basis, system reliability is a routine topic of discussion among Xcel Energy's senior management. Xcel Energy has established a Reliability Committee consisting of vice president-level executives to manage system reliability initiatives and evaluate specific reliability events and outages as well as an Operations Council comprising senior executives to

review operational issues and reliability results for all of Xcel Energy's operating companies on a monthly basis. The results of these monthly evaluations and the performance indices are made available to all operations personnel.

For any major Transmission System Average Interruption Duration Index event (more than 100,000 customer interruption minutes), a report is developed detailing the event and reviewed with Transmission management at a monthly meeting to identify system operations improvement opportunities. Within the Transmission function, the substation construction and maintenance, system operations, transmission planning, and transmission construction groups work as a team to optimize the performance of the transmission system.

1.2.2 Leadership and Management

Managers, by leadership, commitment, and example, establish and reinforce high standards of performance and align the organization to achieve safe, reliable system operation.

The corporate values promoted within Xcel Energy — "to treat all people with respect, work together to serve the customers, and be accountable to each other for doing our best" — form the basis for the work culture in system operations. The evaluation team notes as a positive observation that this corporate culture promotes a professional atmosphere in system operations that enhances system reliability.

Management support for the participation of system operations personnel in a wide range of regional and national activities aimed at improving system reliability also directly contributes to enhancing system reliability. System operations personnel are currently providing support to and participating in the work of committees for the Midwest Reliability Organization (MRO), MISO, the Mid-Continent Area Power Pool (MAPP), NERC, the Missouri Basin Sub-Regional Planning Group, the Minnesota Transmission Owners Planning Group, and the Minnesota Transmission Owners and Operators Forum.

1.2.3 Corporate Oversight and Monitoring

Line management is used to strengthen reliability and improve performance. System reliability is kept under constant scrutiny through techniques such as self-assessments, performance indicators, and periodic management meetings.

NSP's performance management program is designed to assist managers and employees in identifying the important items for each employee to accomplish during the year and to provide an objective basis for rating the employee's contributions. The progress starts with the employee drafting goals and development plans, which are reviewed for approval by management. These goals and plans are evaluated in ongoing discussions of progress and mid-year and year-end reviews to establish a performance rating.

Employees in system operations have team goals in their performance plans related to reliability that affect the team's "performance and incentive" pay. Employee bonuses are based on both team and individual performance.

1.2.4 Human Resources

Personnel resource needs are anticipated and individuals are systematically recruited, developed, and assigned positions in the system operations organization.

Xcel Energy's Transmission function implemented a workforce succession plan for 2007 that included a proactive plan to replace retiring employees, develop a transmission employee recruitment plan, and establish a succession plan to ensure the company is developing employees for the future. To accomplish these objectives, system operations has advanced the hiring of a lead shift system operator ("network reliability leader") position. This provides considerable flexibility for system operations, since the position is qualified to cover both the balancing authority and transmission operator functions. The evaluation team finds the succession plan to be a thorough and effective tool to meet system operations future needs for personnel in critical positions and notes the development of the plan and additional position as a positive observation.

1.2.5 Corporate Communications

System operations communications inform and engage both corporate and system operations employees so they can contribute to the strategic priorities of the organization.

As previously discussed, system reliability is a routine topic among senior executives of Xcel Energy, and reliability indices are tracked and made available to all operations employees monthly. Xcel Energy's corporate management also holds weekly staff meetings in which system operations is a regular topic; when a system event occurs, the event report is provided to the executive team. The corporation publishes a monthly newspaper, *Bright Lights*, for the transmission and substation employees covering a broad range of issues facing the transmission business. The vice president of transmission holds "town hall" meetings twice a year, which include all system operations personnel, to discuss current issues and transmission performance and to open the door for feedback from the employees. He also holds monthly staff meetings where system operations issues are a routine topic.

NSP has an employee suggestion program termed "Xpress Ideas" to encourage, recognize, and reward employees for their problem solving ideas. Xpress Ideas encourages managers to involve their employees in improving operations. Employees are encouraged to take ownership for improving the business by exercising initiative in solving problems and addressing inefficiencies. The process helps establish a climate that encourages open communications. Along with this program, an open-door policy is encouraged throughout the corporation.

Within system operations, the evaluation team finds the open-door policy to be effective at all management levels and the level of communications between the system operators and all the critical support functions to be very high. The evaluation team notes as a positive observation that communications within the Transmission function promote effective power system operations.

2. Fundamentals of Operations

2.1 General

Operations personnel monitor and control the system in a manner that ensures safe, reliable operation.

NSP's primary control center has three console stations staffed by system operators performing the balancing authority functions and transmission operator functions; the shift's lead system operator oversees, and can perform, both reliability functions. The three stations are centrally located around an electronic display wall. The balancing authority system operator and the shift lead share four display units, and the transmission operator has three additional display units. Extra consoles in the control room are currently used by engineering and as a backup location for distribution operators.

The transmission operator has displays providing an overview of NSP's 345 kV system and regional displays of the lower voltage system, with a drill-down capability. The displays show transmission and generation, real and reactive power flows, and voltage levels for each system segment. The balancing authority has displays of generation levels, area control error, system frequency, the MISO set points for generation, spinning and non-spinning generation reserves, and available generation regulation capability.

The electronic wall displays show the static and dynamic reactive reserves available, power flow and voltage limit alarms, metering error alarms, and weather information. Alarms are both audible and visual, with color coding by priority. System operators can display limit information for any system element by selecting the element's flow values. Tie-lines to neighboring systems have redundant metering used to detect metering errors and to support area control error calculations. Some of the tie-lines have automatic failover capability for metering errors.

NSP is developing a new display for the system operators to automate the calculation of reactive reserves available from generation units. Currently, reactive reserves are monitored, but calculated manually based on reactive output and capability curves. The evaluation team recognizes the development of the new display to automate this calculation and provide the transmission operator quicker and more accurate information as a positive observation.

The EMS provides alarms to the operators when any real-time application fails to solve. The real-time state estimation program generates a list of abnormal conditions that the system operators use to detect and pinpoint the location of measurement errors.

All of NSP's fossil and nuclear, and most of its hydro, units have automatic voltage regulators installed. Some small hydro units connected to distribution buses do not run in automatic voltage control mode. NSP's wind generators may be inductive generators or equipped with static reactive compensation systems; not all are equipped with automatic voltage regulators. NSP has power system stabilizers installed and operating on most of its units rated greater than 100 MW. Those units rated greater than 100 MW that do not have power system stabilizers installed are in the process of having the stabilizers installed.

Each weekend, NSP's system operators contact all generator operators with units having ratings of 15 MW or greater that are on-line to ensure their automatic voltage regulators are in service. The operators also confirm that generating units rated 70 MW or greater have power system stabilizers in service. The operators use an online spreadsheet to document the status of each unit. If a generating unit's automatic voltage regulator or power system stabilizer is out of service, the system operator is notified by the generating plant within 30 minutes and the system operator logs the outage on a "Generation Abnormal Report" and notifies NSP's reliability coordinator. The system operators also confirm the status the automatic voltage regulator and power system stabilizer of any generating unit that comes on-line. The system operators update the generation summary used to calculate the dynamic reactive reserves available for any status changes in the regulators and stabilizers. The status of each automatic voltage regulator is being automated to make the information available to the system operators through the EMS, and the evaluation team notes this as a positive observation.

NSP system operators have the capability to monitor key flowgates also monitored by MISO and, if required, notify MISO of the need to issue transmission line relief instructions. NSP monitors the Minnesota Wisconsin Stability Interface, an angular stability issue flowgate involving the 345 kV King-Eau Claire transmission line, and the 345 kV Prairie Island — Byron transmission line. NSP owns and operates these facilities.

NSP's primary source of frequency measurements for area control error calculations is provided by a redundant pair of Global Positioning System based frequency measurement devices. NSP also has frequency monitoring sources at two local substations that are automatically switched when needed to provide a source for area control error calculation and an additional source available at a generation station. NSP has frequency sources at six additional substations selected to provide system coverage in the event of an islanding condition. System frequency is also displayed on top of the control center's electronic wall display from a digital source that is not dependent on the EMS. The evaluation team notes as a positive observations the total of eight frequency measurements across NSP's transmission system footprint that assists the system operators in detecting electrical islands and six independent frequency sources that improve the reliability of area control error calculation.

NSP's system operators use a private branch exchange (PBX) phone system with a speed-dial capability for frequently dialed numbers. The PBX system has fully redundant processors and power supplies. The operators in the Minneapolis control center and the Wisconsin control center have ring-down communications circuits to the generating plants, the distribution function, and most neighboring control centers. Operators also have cellular phones, satellite phones, and a company radio system and in both control centers. Both control centers also have access to the MAPP communications network to communicate with MISO and all control centers in the MAPP region and a MISO "blast call" capability for the MISO regions. The system operators in the Minneapolis control center have access to a MISO messaging system with Voice over Internet Protocol capability. NSP's system operation utilizes the Government Emergency Telephone Service to gain access to emergency priority channels for its landlines and the Wisconsin Public Service system for its cellular phones. The shift lead system operators are trained in the use of the satellite phones, but the other system operators cannot use the phones

without referring to instructions. The evaluation team recommends that all system operators be trained to use the satellite phones.

2.2 Operational Focus

2.2.1 Operational Safety

System operation activities are conducted in a manner that maintains high levels of safety and reliability for all system conditions.

NSP has four special protection schemes installed to trip either generators or transmission lines to avoid escalating contingencies. NSP's special protection schemes do not rely on the EMS for initiation or the proper sequence of operations. Each special protection scheme can be armed and disarmed by the system operators through the EMS or manually at the substation. All of the special protection schemes are normally armed. The special protection schemes are monitored by the system operators, and changes in status are provided to the reliability coordinator. NSP's current maintenance program calls for relay condition assessments to be performed on a six-year cycle, including those for the special protection schemes. The maintenance plan has provisions to revise the maintenance frequency based upon actual operational data on relays.

2.2.2 Operational Decision-Making

Operational decisions are reached using a systematic and thorough approach that supports safe, reliable, and efficient system operations.

NSP's system operators are trained to use operating policies and procedures, emergency system procedures, and operational experience when making critical decisions to support the safe and reliable operation of the bulk power system. The system operators use NSP's *Emergency Reference & Plan Guide* (a.k.a. the Red Book) and the *NSP System Major Disturbance Guide,* which document the decision triggers and operator responsibilities for abnormal and emergency system conditions and Xcel Energy's procedures to guide actions in administrative and facilities emergencies. System operators receive training on abnormal and emergency operations both for internal system and regional (MISO) operating issues. The operators also receive training on lessons learned from events on NSP's system and annual training on system restoration.

NSP's process for developing and approving switching orders involves the evaluation of the impacts, verification by an operations engineer, and a review by a night-shift system operator prior to being issued for release to the day shift for final review by the shift lead and day-shift system operator. All switching orders are reviewed by at least two system operators prior to execution, except in emergencies. The system operators are trained to review the results of switching actions for confirming expected results or investigating reasons for unexpected results.

In reviewing the use of advanced applications to evaluate contingencies, the evaluation team found that when the advanced applications failed to solve, the system operators first tried to resolve the issue, then contacted operations support engineers to try to find a solution. This process could take from minutes to hours before additional steps were taken to request support from the reliability coordinator. In emergency situations, the coordination with the reliability coordinator appeared to be very close and communications were timely; but in the case of the

system operators working without the support of the advanced applications, the communications appeared to be slow. The evaluation team recommends that NSP review its procedures and determine whether the timing of communications with the reliability coordinator should receive higher priority.

2.2.3 Operational Alignment

Organizational structure supports safe and reliable system operation.

NSP has a comprehensive set of procedures and agreements covering its normal and emergency operations. Letters giving the system operators the authority to operate the system, including shedding load to protect equipment and the reliability of the system, signed by the presidents of Northern States Power Company Minnesota and Northern States Power Company Wisconsin are maintained in NSP's policy book and posted in the control rooms.

NSP's system operators at its Minneapolis control center are scheduled in two 12-hour shifts each day. Three system operators are scheduled for each shift, with one position performing the transmission operator functions, one performing balancing authority functions, and a lead position to assist in either capacity. At NSP's Wisconsin control center, one system operator is scheduled per shift to perform transmission switching. The operators work a six-week rotation, which includes days, nights, training, and off-shift periods. The evaluation team finds having the lead shift system operator — the network reliability lead operator — work as a part of a three man team enhances the team's functionality and results in a closer working relationship than normally found with a shift supervisor/system operator arrangement. Accordingly, the evaluation team cites this staff arrangement as a positive observation.

During each shift change, NSP's procedure requires a complete review of the operations log. The system operators are paid for any extra time required to complete the shift change, and there is no time limit established. There is a checklist for transmission operator function and one for balancing authority function. The system operators have to sign off verifying that the checklist has been completed. The evaluation team makes a positive observation that the comprehensive shift-change checklist ensures thorough and accurate communications on system conditions.

The evaluation team found NSP's comprehensive document control program to be a potential example of excellence. The document control program provides assurance that all policies and procedures are current and properly controlled, and all system operations personnel are informed of changes in a timely fashion. The document control program is accurately applied to the development of new documents and to the review and revision of existing documents — all changes in policies and procedures must be placed in a review file until all system operators sign-off that they have read the document.

All planned outages on NSP's system are entered into the MISO outage scheduler program. A study is performed by NSP's system operations support engineers to determine whether the outage results in possible limit violations. If violations are not expected, the request for the outage is shared with neighboring system. If operating restrictions are identified, NSP develops an operating guide and shares it with the reliability coordinator and the neighboring systems.

2.3 Managing System Configuration

Power system configuration is carefully designed, analyzed, maintained, and controlled throughout the life of the infrastructure, ensuring that system and equipment margins are understood, considered in decision-making, and managed consistent with design and system requirements.

NSP's EMS for the primary control center in Minneapolis is a Siemens Spectrum System Version 3 — Revision 4.1. The system is based on an IBM AIX platform and uses distributed processing to provide various systems functions, including intercontrol center communications protocol (ICCP), system control and data acquisition, and advanced network analysis applications. The system utilizes a private Internet protocol-based network for server and workstation communications and is independent from Xcel Energy's corporate systems. The EMS servers are fully redundant with failover capabilities. The communications from the EMS to the MISO reliability and real-time dispatch systems is through an ICCP data link and an XML data link. The backup control center in Wisconsin utilizes a different set of servers. The system scans status points on a four-second cycle. The system scans for analog values at least every 10 seconds.

NSP's state estimation and real-time contingency programs take approximately two minutes to solve and are run every eight minutes. State estimation results are displayed on one-line system diagrams for comparisons with real-time data. The system network model is updated with system topology and limit changes when new equipment is installed or changes in limits are recognized, and the model is updated quarterly in conjunction with the MISO model updates.

NSP has a list of critical facilities that is updated at least annually when emergency procedures are reviewed or as system conditions dictate. The system operations support engineers determine the contingencies evaluated in real-time operations, currently about 500 contingencies. During normal hours, the engineering staff makes any needed modifications to the list. After hours, the lead shift system operator works with the transmission operator to modify the list. As a member of MISO, the NSP system (transmission and generation) is under the functional control of MISO. In addition to NSP's review of its own system, MISO uses a similar state estimation program to evaluate regional issues.

NSP's system operators communicate all system operating limit and interconnection reliability operating limit violations to the reliability coordinator. The MISO, NSP, and neighboring reliability authorities investigate and determine the reasons for the violations and then develop plans to keep the violations from occurring again.

NSP uses a program developed in-house (the B-57 Overload Program) to determine if a transmission line can support loading in excess of the seasonal static limit under current actual ambient weather conditions. The B-57 Overload Program requires the user to input the pre-contingent and post-contingent loadings on the circuit as determined by the real-time contingency analysis program. The program augments the contingency analysis results by calculating the loading and response time for all elements in the circuit (i.e., breakers, line switches, disconnects, buses, and conductors). The program is used by the system operations support engineers, the lead shift system operator, and the transmission operators. Currently, the

program is installed on an Xcel Energy computer system in Denver, Colorado, and system operations has to request runs of the program through the EMS or by telephone. The evaluation team recognizes the usefulness of this application and recommends that NSP install the B-57 Overload Program software at the Minnesota control center.

In reviewing the tools available to the system operators, the evaluation team recognizes that a trade-off has been made between the details of external systems that can be included in the models used for state estimation and the reliability of the program solving; however, the team recommends that NSP add more measurements for the external systems being modeled to provide the system operators enhanced information about system conditions at the interface with neighboring systems.

The *Midwest Reliability Organization (MRO) Generator Testing Guidelines* have been issued recently, defining reactive power capability testing requirements. NSP reactive power capability testing procedures are being modified, and testing is expected to be performed in real time starting in October 2007.

2.4 Emergency Preparedness

The organization is prepared to manage and mitigate the impact of system emergencies in order to preserve the reliability of the system and to protect the interests of the public.

NSP participates in the Midwest Contingency Reserve Sharing Group through the MAPP Generation Reserve Sharing Pool. NSP provides or receives spinning and non-spinning reserves when required to restore resource balance following a contingency within the reserve sharing group. NSP has contractual requirements to serve the spinning and non-spinning reserve requirements for the Minnesota Municipal Power Agency, a load-serving entity within the NSP balancing authority area.

NSP has an underfrequency load shedding program that meets the regional requirements to shed at least 10% of system load in three steps (59.3, 59.0, and 58.7 Hz). NSP's distribution group provides underfrequency load shedding locations and clearly separates manual load shedding blocks from automatic load shedding blocks. Currently, there are 15 blocks with ranges of 92 to 150 MW per block available for manual load shedding. NSP is developing the capability to shed load on a subregional basis and building new displays for system operations to refine the load shedding program; the evaluation team notes this as a positive observation.

NSP has over 1,000 MW of demand side load management available on its system. The demand side load management program is managed through NSP marketing groups and is automatic. The marketing groups determine the need and control the execution of the program. NSP system operations can initiate a request based on system reliability.

NSP has a capacity and energy emergency program that is initiated by the system operators or NSP marketing functions if they feel the reliability of the system is at risk. The program is also initiated if the reliability coordinator declares a capacity emergency.

NSP is a member of the MISO Emergency Preparedness/Power System Restoration Working Group. The working group consists of all transmission operators within the MISO reliability footprint and meets on a regular basis to coordinate blackstart and system restoration plans. NSP's system operators are responsible for real-time coordination with neighboring transmission operators and balancing authorities, NSP generating plants, the distribution group, and reliability coordinator during any blackstart or system restoration activities. The reliability coordinator has overall responsibility for coordinating blackstart and system restoration efforts, including synchronizing cross-jurisdictional islands.

3. Fundamentals of Maintenance

3.1 General

Maintenance is conducted by skilled personnel to achieve safe, reliable control center equipment and system performance.

The EMS, data and voice communications, and miscellaneous computer applications are all supported by highly trained and qualified personnel that are on-call around-the-clock to support system operations. The priority system operations receive in resolving problems is not an issue.

3.2 Equipment Reliability

3.2.1 Equipment Performance

The organization achieves high levels of equipment reliability. Equipment problems that impact reliability are resolved in a thorough and timely manner.

NSP has an automated system that monitors all critical system functions and alarms the system operators if a critical subsystem fails. Failure of certain subsystems or applications will cause a failover to a redundant server. The EMS support staff receives the output of the automated daily system check and responds to any problems.

Daily checks of disk space usage, central processing unit utilization, database integrity, and remote terminal unit communication errors are performed by EMS support personnel. System support personnel are on-site during normal business hours and routinely communicate with the operations staff concerning any unresolved problems. The EMS support staff is on-call around-the-clock to provide after-hours support. The evaluation team notes as a positive observation the dedicated staff provided to support the EMS. The priority given to resolving EMS problems directly contributes to improving the reliability of the system.

MRO is preparing to issue requirements for locating disturbance monitoring recorders. NSP has developed a plan to comply with the expected MRO requirements, and expects to be able to comply with the replacement of a few recording relays that have insufficient sampling rates and with the addition of few disturbance monitors.

3.2.2 Work Management

Work activities, including corrective, elective, and preventive maintenance, surveillance testing, and modifications, are managed effectively to support safe, reliable operation during both outage and routine periods.

NSP's telecommunication group monitors the voice and data communication capabilities supporting system operations and informs the system operators if any problems are detected. The MISO hotline and other voice communication systems are tested weekly. The telecommunications group opens trouble tickets to track reported issues to resolution.

The EMS has an automatic monitoring capability that runs every five minutes to check the performance of the EMS. If a problem is detected, a visual alarm is generated for the system operators, who contact the support engineers for resolution. The engineering support staff is available around-the-clock to respond to the system operators.

EMS database changes are done online with minimal interruption of operations. Changes in databases are quarantined until fully checked by system operations and then released to update the system.

4. Fundamentals of Operational Planning

Operational planning provides the technical information and support necessary for safe, reliable system operation.

NSP's bulk power system models used for operational planning are developed through a regional planning process. Members of MRO submit model data through the MRO Model Building Working Group to create the models. The Northern MAPP Operating Review Working Group reviews the near-term models and creates base cases for operational studies. Both steady state and stability models are developed through this process, and the input data for these models is validated by the MRO members. NSP supports the Northern MAPP Operating Review Working Group seasonal operating studies and development of operating guides.

NSP also participates in the MISO seasonal assessment studies based on the models developed through the Northern MAPP Operator Review Working Group process. The models are updated four times a year. NSP performs studies based on these models for both the summer and winter peak seasons and develops guides for the system operators as needed.

NSP's day-ahead planning process begins with the development of a load forecast from an application that utilizes historic weather data and actual load information to develop a rolling seven-day estimate. NSP has a full-time meteorologist that reviews the load forecast produced by the application and updates the model as needed to incorporate his own weather forecast. MISO performs a day-ahead security constrained economic dispatch that determines a generation dispatch to allow for operation of the transmission system within limits. Based on the load forecast and generation dispatch, NSP's operations coordination engineer conducts next-day studies to determine operational conditions on the transmission system and to determine whether generation changes are needed for reliability. The next-day transmission plan is discussed with

the NSP's lead system operator, including all scheduled transmission and generation outages and any recommended transmission reconfigurations or necessary mitigation plans. The lead system operator verifies the accuracy of the plan and conducts additional studies as needed.

NSP has two nuclear plants within its balancing authority area. The plants have specific voltage criteria that are utilized in operational studies and in real-time contingency analysis. These limits are specifically addressed in operating guides for system operations.

The evaluation team notes the close working relationship between NSP's system operations and operational planning personnel and makes a positive observation that NSP's operational planning is a complete and thorough process that ensures system operators are prepared for all planned outages and have the support needed to study any unanticipated events.

5. Fundamentals of Training

5.1 General

Training in both specific job-related skills and broader technical fundamentals is used to provide highly skilled, knowledgeable personnel for safe, reliable operations, and to achieve performance improvement.

NSP has a comprehensive documented training program for initial and ongoing training of the system operators. A Training Advisory Committee comprised of the control center manager, senior system operators, assigned technical trainer, and other subject experts has been established to conduct an annual analysis of the training needed for system operators and develop the training plan for the next calendar year.

Two separate initial training programs have been established — one for Minnesota, which has exempt employees operating the bulk power system, and one for Wisconsin, which has bargaining unit employees. The entry-level position for Minnesota system operators is as a balancing authority system operator. The entry-level position for Wisconsin system operators is a system operator II, a two-year apprenticeship. Minnesota system operators have a six-month qualification target. To become qualified to assume independent shift-work, the trainee must complete a check-off list of training objectives, assigned supplemental training, and a final qualification test. The check-off manual contains 350 to 500 learning objectives. Each new system operator is assigned a mentor to serve as a training resource. The mentor, who is normally a system operator, identifies individual training needs and conducts ongoing performance reviews for the apprentice. A part of the initial training includes completing the NERC certification as a system operator. The control center manager performs the final review of the new operator's training and determines when the operator is qualified to assume a shift independently.

NSP's ongoing training for system operators is driven by the annual training plan developed by the Training Advisory Committee. NERC standards are used as a baseline for the operator training program. Part of training relies on MISO semi-annual workshops. Major events also get factored into the program. Each operator has a designed program for the year monitored by

supervisors and tracked through a corporate system. Each exempt/hourly operator's training requirements are included in the operator's performance plan and reviewed semiannually. The training includes formalized courses, online training modules, field visits, and external training. Seasonal operating plans are reviewed in mandatory sessions each spring. Spring and fall mandatory sessions cover disturbances in other utilities.

NSP has a procedure to collect and evaluate feedback to update and improve the training programs. Trainees provide feedback on the effectiveness of the instructors and of the training program in terms of content, materials, delivery, and preparation for job duties. The analysis, design, development, implementation, and evaluation (ADDIE) instructional design process is used in the development and improvement of training programs. NSP's Compliance, Safety and Technical Training Department provides technical training staff to support the training program. NSP is a NERC-approved training provider.

The evaluation team makes a positive observation that the training of system operators is comprehensive and taken seriously at all levels. The team recognized the dedication of all the personnel involved in delivering the program, the system operators in utilizing the program, and the shift lead system operators and management in supervising the program. The shift lead system operators are particularly instrumental in pursuing the causes of unusual system conditions and assisting in the development of simulations for training.

NSP has a training simulator that is used for part of its training program. As the simulator is currently configured, loading a system model causes a loss of all existing scenarios. An update to the simulator that will resolve this issue is being planned. The evaluation team recommends that the simulator upgrade be expedited, to the extent possible, to provide the capability to simulate events that have occurred on NSP's bulk power system and provide enhanced training for new and experienced system operators.

5.2 Organizational Effectiveness

5.2.1 Human Performance

Personnel select and apply appropriate human error prevention techniques commensurate with the importance of assigned tasks to minimize the frequency and consequences of events.

NSP has previously included human error reduction as part of its annual goals and is planning to implement it again. MAPP short courses are offered in situational awareness dealing with human error.

APPENDIX 1: Critical Infrastructure

The following discussion will be presented under private letter to the evaluated entity only and will not be included within the public version of the report.

APPENDIX 2: Entity Participants

The following will be presented under private letter to the evaluated entity only and will not be included within the public version of the report.

APPENDIX 3: Documents Reviewed

The following will be presented under private letter to the evaluated entity only and will not be included within the public version of the report.