

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Reliability Readiness Evaluation Report Balancing Authority/Transmission Operator

Puget Sound Energy
Redmond, Washington

to ensure
the reliability of the
bulk power system

September 10–13, 2007

116-390 Village Blvd., Princeton, NJ 08540
609.452.8060 | 609.452.9550 fax
www.nerc.com

Table of Contents

Introduction and Evaluation Process	1
Evaluation Team	1
Organization Profile.....	2
Executive Summary	3
Positive Observations.....	4
Recommendations.....	4
Discussion.....	6
1. Culture.....	6
1.1 General.....	6
1.2 Organizational Effectiveness	6
1.2.1 Foundation for System Reliability	6
1.2.2 Leadership and Management	7
1.2.3 Corporate Oversight and Monitoring.....	7
1.2.4 Human Resources	7
1.2.5 Corporate Communications	8
2. Fundamentals of Operations	8
2.1 General.....	8
2.2 Operational Focus	9
2.2.1 Operational Safety	9
2.2.2 Operational Decision-Making.....	9
2.2.3 Operational Alignment.....	10
2.3 Managing System Configuration	10
2.4 Emergency Preparedness	11
3. Fundamentals of Maintenance	11
3.1 General.....	11
3.2 Equipment Reliability	12
3.2.1 Equipment Performance.....	12
3.2.2 Work Management.....	12
4. Fundamentals of Operational Planning.....	13
5. Fundamentals of Training	14
5.1 General.....	14
5.2 Organizational Effectiveness	16
5.2.1 Human Performance	16
APPENDIX 1: Critical Infrastructure.....	17
APPENDIX 2: Entity Participants.....	18
APPENDIX 3: Documents Reviewed	19

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 Puget Sound Energy — Operations (PSEI) representatives on September 10–13, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of PSEI to meet its responsibilities as a balancing authority and transmission operator. Puget Sound Energy has registered as two functional entities, Puget Sound Energy — Operations (PSEI) and Puget Sound Energy — Marketing (PSEM), for the purposes of supporting the NERC reliability standards. Some of the discussion reflects evaluation of activities performed corporately, which would include both functional entities. For the purposes of this report, the abbreviation PSEI will be utilized.

Evaluation Team

Mitch Needham*	NERC
Paul Rice*	Western Electricity Coordinating Council (WECC)
Terry Baker	Platte River Power Authority
Lauri Jones	Pacific Gas and Electric
Norb Mizwicki	ReliabilityFirst
Steve Singer	New York ISO

*Team co-leader

Organization Profile

PSEI is located in portions of ten western Washington counties around the Puget Sound Region and in one central Washington County east of the Cascade Mountains. The company is a combined gas and electric utility serving approximately 1,040,000 electric customers and 718,000 gas customers (approximately 350,000 customers use both forms of energy). PSEI's load center is focused in King County, where 152 out of 358 substations are located, and there are several large industrial loads in the northern region of the company.

The PSEI service area covers 4,500 square miles in Washington. The PSEI electrical facilities include 2,176 miles of transmission lines and approximately 20,000 miles of distribution service lines operated at the following voltages: 230 kV, 115 kV, 55 kV, 34.5 kV, and 12 kV.

PSEI owns or jointly owns generation facilities totaling approximately 2,400 MW, approximately half of its requirements, and purchases the remainder of its requirements through long-term arrangements. PSEI's largest thermal resource is located at Colstrip in eastern Montana. Approximately 520 MW of combined-cycle independent power producer generation is located in the PSEI service territory (typically situated near large industrial loads).

A major portion of PSEI's power requirements are transferred on Bonneville Power Administration's (BPA) high-voltage lines from five dams located on the Mid-Columbia River in the central part of the state. PSEI has 23 interconnections with BPA that operate at the 115 and 230 kV levels. Also, the company either directly connects, or has access rights, to many other surrounding utilities — including BC Hydro; Seattle City Light; Avista; Tacoma Power; and Snohomish, Chelan, Douglas and Grant County Public Utility Districts — and smaller municipalities and cooperatives in the region.

The load office performs transmission switching and outage coordination, generation dispatch, automatic generation control, real-time scheduling, and balancing area accounting. The staff engineer operates the state estimator and performs other studies as needed. All dispatchers and the manager are NERC-certified.

Executive Summary

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

PSEI fosters a culture of engagement, communicating routinely with the system operations group, which is located apart from the main company headquarters. The evaluation team noted a general sense of camaraderie and openness among the staff members interviewed.

The evaluation team noted a number of positive observations related to the company's overall approach to reliability. PSEI is preparing for load growth by replacing or repairing equipment and adding dedicated staff for its scheduling/tagging process so system operators and the training coordinator can focus on other duties. To increase overall effectiveness, the senior power dispatchers routinely rotate between the transmission operator and balancing operator positions and the operations trainer is stationed near the system operators. PSEI has a policy of requiring NERC certification credentials for system operator supervisory personnel and the operations trainer, and system operations personnel are included in many specific corporate initiatives.

The team identified recommendations regarding training, document control, and information availability. Operators would benefit from annual training in key areas, and an increase in the system operator staffing level to a six-person rotation would allow for adequate training time. A formal document control process to include ownership, revision logs, and periodic review for operating procedures would ensure system operators are using up-to-date processes. Finally, a reliable real-time contingency analysis application and more formal shift-turnover process would increase operator situational awareness.

Overall, the evaluation team identified eight positive observations. In addition, the team offers 13 recommendations that, if implemented, will enhance PSEI's readiness to operate reliably and maintain the reliability of the bulk power system. The findings are listed in order of importance.

Positive Observations

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

1. PSEI demonstrates a culture of teamwork and ownership that is emphasized from the top down, providing system operators with a feeling of support and a good work atmosphere (Section 1.1).
2. PSEI has placed a corporate emphasis on infrastructure development for load growth and for the repair or replacement of obsolete equipment (Section 1.2.1).
3. Senior power dispatchers routinely rotate between the transmission operator and balancing operator positions, providing for staff flexibility and knowledge retention (Section 5.1).
4. PSEI has adopted an organizational change and is adding dedicated staff for the scheduling/tagging process to relieve the system operators and training coordinator of this activity (Section 2.2.3).
5. The PSEI operations trainer is stationed near the system operators, improving interaction within the group (Section 5.1).
6. PSEI has a policy of requiring NERC certification credentials for system operator supervisory personnel and the operations trainer (Section 5.1).
7. PSEI's system operations personnel are included in many specific corporate initiatives, and system operators appreciate that their input is being sought and used (Section 1.2.5).
8. The PSEI corporate succession plans are complete and include the system operator level (Section 1.2.4).

Recommendations

The evaluation team offers the following recommendations:

1. Develop and implement a policy to train (or conduct drills for) system operators on the following items on an annual basis (Section 5.1):
 - a. An overall review of the energy management system (EMS) platform and capabilities
 - b. PI Historian functionality
 - c. Use of state estimator and power flow
 - d. Evacuation, startup, and operation of the backup control center
 - e. Underfrequency tripping of generation (already documented)
 - f. Overlap of manual and underfrequency load shedding (not documented/monitored)*
 - g. Blackstart and restoration simulation
2. Increase the system operator staffing level to a complete six-person rotation to allow for adequate training time, taking into account vacations and absences (Section 5.1).
3. Adopt a policy and provide training to system operators for entering system tags and other system configuration information into the EMS to provide operators with critical information in the event of an evacuation (Section 2.3).*
4. Implement a formal switching order development process to document individual switching steps and provide for second party review and approval to help prevent errors (Section 5.2.1).
5. Confidential information on communications system and support redacted from public report. See discussion in Appendix 1.

6. Expedite the move to the new software version or obtain vendor assistance to get the real-time contingency analysis working properly to increase operator situational awareness (Section 2.1).
7. Expedite the implementation of a formal document control process to include ownership, revision logs, and periodic review for operating procedures to ensure system operators are using up-to-date documentation (Section 2.2.3).
8. Develop and implement a more formal shift-turnover process, including a checklist of items that must be covered, to ensure a more complete information exchange and review (Section 2.3).
9. Confidential information on plans for loss of control facility redacted from public report. See discussion in Appendix 1.
10. Confidential information on physical security redacted from public report. See discussion in Appendix 1.
11. Confidential information on physical security redacted from public report. See discussion in Appendix 1.
12. Confidential information on physical security redacted from public report. See discussion in Appendix 1.
13. Confidential information on physical security redacted from public report. See discussion in Appendix 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 and positive observations 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.

Discussions with operations management indicated that the company has excellent focus on the customer. Customer service is emphasized while meeting corporate financial requirements, providing for a healthy balance with good fundamentals. The company is preparing for a large growth in demand while upgrading an aging infrastructure. In all, the evaluation team believes there is good motivation at the senior leadership level, as evidenced by the corporate emphasis on reliability.

The evaluation team found that PSEI demonstrates a culture of teamwork and ownership that is emphasized from the top down. Discussions with system operators indicated that they have a feeling of support for their decisions. In addition, the system operators noted that there is an overall good work atmosphere. The evaluation team notes this culture of teamwork and ownership as a positive observation.

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 mentioned earlier, one of the challenges facing PSEI is its aging infrastructure, both power system equipment as well as communications and computer resources. The evaluation team found that there is a corporate emphasis on infrastructure development for load growth and for the repair or replacement of obsolete equipment. The evaluation team notes this as a positive observation, one indicating that PSEI is seeking to position itself for the longer term. PSEI indicated that it has placed over \$190 million in transmission and high voltage projects in the past five years.

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.

Discussions with PSEI management indicated that the company has corporate goals and objectives that impact system operations. While there are no specific goals dealing only with the transmission system, goals related to customer satisfaction and outage responses are impacted by the activities of the system operations group. For example, if a transmission line goes out of service due to a sustained fault and several distribution substations are affected, a customer outage could occur and impact customer satisfaction.

PSEI faces challenges in communicating with its experienced workforce, particularly the system operations group, which is not located in the corporate headquarters facility. Senior management is taking specific actions, such as regular communications through the local managers, to keep system operations personnel up to date on about company activities and directives.

Within the PSEI system operations facility, the evaluation team noted a focused approach to system reliability with an acknowledgement that corporate happenings have some impact on that focus. System operators and managers work to find solutions to such communication problems and are determined to keep personnel informed regarding corporate events, process, and procedures, even though the group is geographically divided from the corporate offices.

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.

Corporate oversight and monitoring at PSEI are implemented through corporate staff meetings with reviews of important performance indicators. Corporate goals are set to provide for alignment of job functions to support customer satisfaction and have strong links to system operations. PSEI has several corporate-level committees that routinely review operations issues. The operations management team believes this structure will continue to improve employee knowledge and engagement in the organization.

PSEI has adopted a new documentation and control system, and reports that approximately 30 to 50 percent of the system operations documents have been converted. The new system takes into account periodic review and distribution control.

1.2.4 Human Resources

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

The evaluation team noted that PSEI has taken an aggressive approach to pending openings in the power system operator function. PSEI stated that in its geographical area several opportunities exist for NERC-certified system operators with neighboring utilities as well as with a reliability coordination facility. This close proximity makes potential moves more immediate in nature, allowing less time for PSEI to prepare for upcoming vacancies.

In response to this and other corporate needs, PSEI has developed a corporate succession plan that identifies key positions and makes preliminary plans for the approach to be taken if a key position is vacated, whether through retirement, promotion, or resignation. The evaluation team determined that the PSEI corporate succession plan is complete throughout management ranks and extends to the system operator level. The team notes this focus on system operators as a positive observation and believes that PSEI is working to position itself for filling future vacancies in a timely fashion.

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 noted earlier, PSEI is engaged in efforts to keep system operations employees abreast of corporate developments, particularly in order to maintain good focus on safe and reliable operations. Operations management noted that this effort also seeks to obtain information from system operations by including system operations personnel in several company working groups and corporate initiatives.

System operators indicated that they take pride in and feel professionally rewarded for being selected to work with these groups. The evaluation team believes that this effort to include system operations in many specific corporate initiatives, and the fact that system operators appreciate that their input is being sought and used, is a positive observation of PSEI's culture.

In addition to the corporate working groups, system operations personnel are routinely surveyed as part of a Human Resources' sponsored program called the "Great Place to Work". The results of these surveys are distributed and discussed by corporate management to understand trends in employee morale and to determine where additional communication efforts are needed. Corporate Communications is also involved in routine and emergency situations where information is given to public agencies and news groups.

2. Fundamentals of Operations

2.1 General

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

PSEI power system operators are knowledgeable about the company's industry-standard supervisory control and data acquisition (SCADA)/EMS. The evaluation team observed several tools that have been developed on the industry-accepted platform that are used for trending of data and for overall viewing of the power system status. The PSEI system operators indicated that their use of advanced applications (state estimation and real-time contingency analysis) is limited. These applications are typically accessed by the support engineer associated with the operations group, but PSEI noted that the real-time contingency analysis application is troublesome to get a solution to occur, most likely due to the software version in use.

The evaluation team noted that the wide-area view afforded to PSEI system operators is limited; the visibility of all remote ends of interties is not in place, although it is possible to infer the logic based on measured line flows. Having the actual status available via telemetry into the control center would improve operator awareness and provide for better state estimation and real-time contingency analysis results.

PSEI is currently using a slightly outdated version of SCADA/EMS software. Operations management indicated a project is underway to update the software version in the near future, and additional applications may be considered as part of that update. The evaluation team recommends that PSEI expedite the move to the new software version or obtain vendor assistance to get the real-time contingency analysis working properly.

System operators have a good view of the balancing area. System alarms and other critical applications are monitored to identify any failed process or data communication path. The team feels that the alarm processing could be improved, but does not offer a specific recommendation in this area, noting that the current software version would allow for up to eight levels of alarm definition.

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.

PSEI system operators monitor the status of remedial action schemes in their area. Any change of status is promptly reported to the transmission system operator. In addition to these schemes, PSEI is a participant in several remedial action schemes operated by BPA. These remedial action schemes are reviewed annually by WECC and may be triggered by events outside the PSEI balancing area.

PSEI system operators indicated they are not heavily involved in the development of new or revised operating procedures. Operating procedures are developed as needed by the operations planning staff. These new or revised procedures are then shared with the system operators via several methods, including email and hard copy.

2.2.2 Operational Decision-Making

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

PSEI system operators and operations management indicated that PSEI uses a collaborative approach to risk management. Many operations management personnel have been system operators in the past and are available as needed for consultation regarding system operating conditions. Both management and staff emphasized that the ultimate authority for system operations decisions lies with the system operator. The expectation is that the system operator will consider risks involved and may discuss scenarios with others, but the operator is the final point of decision.

PSEI has a letter describing the ultimate authority of the system operator to act independently, if need be, to take actions to preserve the reliability and integrity of the electric system including load shedding. The document is signed by a corporate officer and posted in the primary and backup control centers in a visible location.

2.2.3 Operational Alignment

Organizational structure supports safe and reliable system operation.

PSEI has adopted an organizational change and is adding dedicated staff for the scheduling/tagging process to will relieve the system operators and training coordinator of this activity. The evaluation team notes this as a positive observation, one which will allow the system operator to have a better focus on system monitoring.

As mentioned earlier, PSEI is moving to an online document control process that will include the tracking and revision control for operating procedures. The evaluation team recommends that PSEI expedite the implementation of this formal document control process to include ownership, revision logs, and periodic review of operating procedures (and a review of regional/national standards). The team believes this will ensure that the system operator is using the most current and up-to-date process. PSEI management indicated that the corporate expectation is for the online versions of such documents to be used in the operating atmosphere.

The evaluation team examined hard copy backup procedures and processes and found them to be adequate and up-to-date. As procedures are moved into the new online mechanism, PSEI will continue to update these documents as needed.

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.

PSEI system operators demonstrated a number of their monitoring tools, including displays of reactive reserves by geographic location and voltage indications. Upon examination, the team noted that the PSEI system operators use a paper tag system to indicate the status of power system equipment that is out of service or altered for maintenance or construction activities. At present, this information, while recorded in the operators' logs, is not otherwise indicated in the EMS because there is no policy to do so. The evaluation team recommends that PSEI adopt a policy and provide training to system operators for entering system tags and other system configuration information into the EMS so this critical information will available in the event of an evacuation scenario.

Discussions with PSEI system operators and management indicated that the outage planning process is thorough and is common to other entities in the northwestern United States. For ongoing activities on the PSEI system, the operators indicated that there is no formal shift-change procedure, but rather information is exchanged with oncoming shifts via discussion and review of the operator logs. The evaluation team discussed this situation and potential problems that such an informal arrangement could cause. The evaluation team recommends that PSEI

develop and implement a more formal shift-turnover process, including a checklist of items that must be covered. The team believes that this process will correctly position PSEI for a more complete exchange of information and review.

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.

The evaluation team found the PSEI plans for evacuation of the primary control center to be workable and complete. PSEI has agreement with its reliability coordinator to provide monitoring while in transition to the backup control facility.

In the event of a capacity and energy emergency, PSEI has documented its process up to and including contacting the reliability coordinator for declaration of an appropriate alert. PSEI's plans identify several trigger levels and include information to be exchanged with the reliability coordinator. PSEI considers the probability of such a capacity and energy emergency to be unlikely but has the necessary plan in place.

PSEI indicated that emergency coordination service for a widespread event — one covering entities beyond the PSEI geographic footprint — would rest with the Pacific Northwest Security Coordinator (PNSC). Services would include the coordination of blackstart and system restoration activities. PNSC conducts annual training for entities such as PSEI using a dispatcher training simulator, but not all PSEI system operators have been afforded the opportunity to participate. PSEI indicated that available training slots are very limited and that PSEI uses its allotment at each offering. The evaluation team has added the need for system operator training regarding blackstart and restoration activities to a larger list of training needs as detailed in Section 5.0 Fundamentals of Training.

PSEI employs underfrequency load shedding as required by WECC. The system operators have displays showing the frequency set point for the underfrequency relays. There is no way of showing the amount of overlap between manual and automatic load shedding except that operator displays are located in the same area. The evaluation team was not comfortable that the PSEI system operators were fully aware of the impact manual load shedding could have on the automatic underfrequency schemes and has added this to the list of training needs mentioned earlier.

In addition to the displays related to underfrequency load shedding, PSEI employs similar displays for undervoltage load shedding where appropriate. (This is largely a local issue at a limited number of locations on the PSEI system.) PSEI system operators indicated that they can manually control the arming of undervoltage load shed schemes.

3. Fundamentals of Maintenance

3.1 General

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

PSEI uses redundant systems for its primary control center functions, providing for minimal EMS downtime. PSEI system operators indicated they are satisfied with the reliability of their equipment and response times for problems are very good. Applications on the redundant systems provide for monitoring of the mirrored system, acting in what is referred to as a “heartbeat” mode. Alarms are used to alert system operators of any application or database failure. The system operators indicated that alarm processing is the only application that is not essentially self monitoring, but operators would consider any prolonged period without an alarm to be unusual and would prompt them to check the alarm processor.

A corporate information technology (IT) department with specific employees assigned to the operations center handles maintenance and repair of PSEI system operations computers. Support personnel are available continuously, if needed by system operations.

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.

As stated above, the redundancy of the operators’ systems allows for a high degree of availability. The system operators indicated satisfaction with both the application platforms as well as the level of support from the corporate IT department.

PSEI indicated that the primary and backup control center applications are monitored by an extensive set of alarms. The alarms will indicate any application processes that abort, any critical functions that stop, or any abnormal processing that occurs in an application.

In order to identify any possible metering errors, the EMS performs an hourly meter check designed to identify any errors in telemetry values. PSEI’s tie-line flows are integrated and compared with a second derived value (from an hourly reading of the remote meter). The system operators have a display showing the tie-line values, and if there is a substantial difference between the integrated and derived line flow values an alarm is issued. PSEI system operators indicated that any discrepancies are addressed in conjunction with the adjoining balancing area.

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.

PSEI performs a controlled failover on a weekly basis to fully test the redundant servers and associated process applications. The PSEI system operators are accustomed to this testing mechanism, and indicated that no serious incidents have resulted from it.

PSEI support services are provided by a corporate staff, with personnel routinely on-site from 6:00 a.m. to 10:00 p.m. Monday through Friday. During significant weather events, the support personnel are on-site 24 hours a day. When not on-site, the support staff provides coverage by call out on a staff rotational basis. PSEI operations management indicated that one of the

primary requirements for the system operator is determining whether a reportable communications problem has to do with the corporate telecommunications network or a private network.

Discussions with the system operators and support personnel indicated that the work management process is informal at PSEI, typically involving verbal discussions of work to be performed along with any scheduling issues. The evaluation team understands that this structure works well for PSEI at present, but notes any significant growth of staff or functions may create a need for a more formal process.

4. Fundamentals of Operational Planning

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

PSEI operations planning personnel indicated that the company uses several industry-accepted analysis tools for system studies. System data for PSEI are supplied to the data area coordinator, who then is responsible for supplying the data for WECC base-case development. The base cases are then used for operational planning studies and include system data for neighboring systems. PSEI stated that in the Northwest, most facilities above 50 kV are modeled explicitly in the base cases.

For seasonal planning, specific generation dispatch scenarios are considered based on conditions that stress the system and on historical data from the planning group. For the PSEI area, seasonal planning results in the development of nomograms used by system operators. These nomograms indicate specific allowable line and facility loads for hypothesized contingencies and are designed to account for a range of temperatures, loads, and generation scenarios. During these study processes, seasonal equipment thermal ratings in the EMS and state estimator are compared to the ratings in engineering databases and power flow cases. In addition, voltage settings for generators and transformer taps are validated.

For operational studies, PSEI is a participant in two regional study groups, the Puget Sound Area Study Group and the Northwest Operating Planning Study Group. The former performs a biannual review of selected intertie studies, producing nomograms for winter and summer operations that take into account any pre-existing outage conditions, such as a planned maintenance outage. The latter studies and provides the seasonal operating transfer capabilities for designated paths in the Northwest Power Pool area.

PSEI indicated that load forecasts are produced by the company's merchant organization, where billing data are used to trend load growth at the distribution level. The load forecasts for various time periods are then disseminated to other groups for the development of transmission planning and generation planning. In addition to studies for the operational timeframe, PSEI conducts planning studies for various scenarios and time periods up to many years ahead.

For major system events involving widespread outages, an investigation team is typically formed to determine whether data used in power system studies corresponds to the results actually encountered. These investigation reports are reviewed throughout the company, and any indicated corrections to system configuration are determined at that time. PSEI acknowledged

that the models developed and used assume fixed tap settings for major system equipment but that system operators have some control over them in real time.

The evaluation team observed that, like most other entities within the Northwest, PSEI is closely tied with BPA and prepares studies in conjunction with committees that are organized by both BPA and the Northwest Power Pool. The committees develop future plans for transmission and generation dispatch throughout the area. Very few entities within the Northwest operate on an isolated basis, and operational planning for PSEI does not typically consider local scenarios unless requested by the system operators for a specific circumstance. Rather, plans are conducted with other entities throughout the region to ensure that the whole area is prepared for each seasonal change based on new equipment or updated equipment ratings.

Outage coordination activities involving neighboring systems are performed using a WECC tool known as the Outage Coordination System. The system is used to ensure that activities in PSEI or neighboring systems that can have an adverse effect on others are discussed and agreed to prior to any actual switching activities. The team noted this tool is primarily used in the Northwest, but there are ongoing activities in WECC to expand its use to other areas within the region.

PSEI system operators indicated that they have available advanced network analysis tools, including dispatchers' power flow, state estimation, and real-time contingency analysis. The applications are typically run by support engineers in the operations center. The evaluation team observed that the operators are knowledgeable about these applications, and the software is user friendly from the operators' perspective. System operators are comfortable conducting specific outage studies, and the system contains many predefined contingencies for analysis. The results of the analysis are presented to the system operator in tabular form with any network violations identified for further study or operation action.

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.

PSEI has an internally developed training program for its system operators. The company has purchased a training system that has been specialized for PSEI-specific activities. A *Training Manual for Dispatchers* (system operators) includes a systematic approach to development of the training curriculum.

The evaluation team examined PSEI's documentation relating to the training program. The training manual contains job task analyses for each of the major operating positions. Included in the manual are items relating to each NERC reliability standard, organized by standard designation. For each of the standards in the manual, PSEI has added specific tasks required for each system operator position.

The PSEI training coordinator indicated that specific course content is generally based on the individual needs assessment. Often, PSEI is able to identify and use industry vendor training opportunities that match the needs. The training coordinator pointed out that PSEI's senior-level system operators routinely rotate between the transmission operator and balancing operator positions, providing for staff flexibility and knowledge retention. The evaluation team sees this routine cross training as a positive observation.

System operator knowledge is assessed using several methods, including a peer-review evaluation. For a typical peer review, a more senior system operator observes the trainee's work methods for a number of scenarios. PSEI indicated that newly trained system operators have their training records reviewed by the supervisor, who would determine if any additional follow-up activities were warranted.

Discussions with the PSEI training coordinator indicated that the company is not an approved continuing education hour provider under the NERC process, but plans are in place for this to occur in the near future. A number of activities in the PSEI training program will likely be included in the program, giving system operators credit for PSEI-specific training activities as appropriate.

The PSEI training program is based on having 10 weeks per year available for training activities; however, the team understands that this time allotment is also to be used for system operator vacation time. The team discussed the training time allotment, including the fact that all operators are generally long-time employees with significant vacation time. In some instances, this may make scheduling of training or filling in for any absences difficult. Discussions with training staff, system operators, and operations management has indicated a level of concern that training would be difficult to complete given the current five-person rotation at one of the operating positions. The evaluation team recommends that PSEI increase the system operator staffing level to a complete six-person rotation to allow for adequate training time taking into account vacations and absences. The team notes that this will also improve PSEI's ability to deal to growth in the work load due to new construction and loads.

PSEI has a dedicated training coordinator (albeit with some additional duties) who tracks operator training activities and helps identify and develop course needs. The PSEI operations trainer is stationed near the system operators, within a few steps of the control room, improving interaction in the group. The evaluation team notes this as a positive observation, increasing the credibility of the training coordinator within the system operator staff.

In discussions with the training coordinator and operations management, the evaluation team notes that PSEI has a policy of requiring NERC certification credentials for system operator supervisory personnel and the operations trainer. The team believes this to be a positive observation that demonstrates PSEI's commitment to training requirements.

The PSEI training program has many PSEI-specific training requirements to equip its system operators with the knowledge needed to monitor and operate its power system. However, several discussion sessions relating to specific requirements on system operators indicated to the evaluation team that reiterative or initial training is needed in several areas. The evaluation team

recommends that PSEI develop and implement a policy to train (or conduct drills for) system operators on the following items on an annual basis:

- An overall review of the EMS platform and capabilities
- PI Historian functionality
- Use of state estimator and power flow
- Evacuation, startup, and operation of the backup control center
- Underfrequency tripping of generation (already documented)
- Overlap of manual and underfrequency load shedding (not documented/monitored)
- Blackstart and restoration simulation

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.

PSEI operations management indicated that events on the power system often lead to “lessons-learned” discussions. The operations group holds a monthly meeting at which such events are discussed to help system operators identify potential problem areas, including possibility of human error. At present, no specific training is offered for human error prevention, but the company and system operators indicated that problem scenarios are understood and acted upon as a routine part of the system operator’s job. Both operations management and system operators indicated their expectation that for instances where an unexpected result occurs, work would stop immediately until the results could be analyzed (unless there was a compelling safety reason to take other actions).

In discussions with PSEI system operators, the evaluation team understands that detailed switching orders developed by the transmission system operators are not routinely reviewed for potential errors. The evaluation team believes that PSEI can further reduce the possibility of human errors with respect to the preparation and issuance of transmission equipment switching orders. The evaluation team recommends that PSEI implement a formal switching order development process to document individual switching steps and provide for second-party review and/or approval.

PSEI indicated that it approaches risk analysis through collaboration. System operators are encouraged to discuss problem scenarios with one another and to include operations management or other experts as needed. PSEI emphasized that it is ultimately the system operator that is responsible for making operational decisions with or without input from other staff members.

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.