

**Balancing Authority/Transmission Operator
Reliability Readiness Evaluation Report**

**Oklahoma Gas and Electric Company (OG&E)
Oklahoma City, Oklahoma**

June 11–14, 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 Oklahoma Gas and Electric Co. (OG&E) representatives on June 11–14, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of OG&E to meet its responsibilities as a balancing authority and transmission operator.

Evaluation Team

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Organization Profile

OGE Energy Corp. is an energy and energy services provider offering delivery and related services for both electricity and natural gas primarily in the south central United States. OGE Energy Corp. is the parent company of Oklahoma Gas and Electric Company (OG&E), a regulated electric utility, and Enogex Inc., a natural gas pipeline business.

OG&E generates, transmits, and distributes electric energy in Oklahoma and western Arkansas, serving more than 755,000 retail customers. OG&E operates a transmission system with approximately 4,300 miles of transmission lines, 470 substations, and 52 interconnection points operated at 69 to 500 kV. The transmission system spans approximately 30,000 square miles.

OG&E owns approximately 6,100 MW of generation capacity and contracts for an additional 700 MW of capacity as of 2007. The company has 2,800 MW of coal-fired generation; the balance is gas fired. The company's summer and winter peaks were 6,473 and 4,610 MW, respectively in 2006.

OG&E is a member of the Southwest Power Pool (SPP) regional transmission organization. SPP serves as the reliability coordinator and tariff administrator for OG&E, while providing an energy imbalance market. OG&E is a registered balancing authority and transmission operator.

The Transmission Operations group of OG&E includes the system operations and support groups under the vice president of transmission, who reports to the president and chief operating officer.

Executive Summary

The evaluation team found no significant operational problems and concluded that OG&E 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.

OG&E has developed a corporate culture that encourages high levels of performance, supports the continuous evaluation of performance, and supports the identification and implementation of improvements. Within system operations, there is strong support for improvements in system reliability and open communications with employees. System operations management, system operators, and support personnel are all actively involved in activities to improve system reliability in their operations and for the industry. Accordingly, the evaluation team made several positive observations related to these aspects of OG&E's corporate culture. In addition, the evaluation team recognizes that OG&E's management has taken a proactive stance in succession planning for key positions in system operations, requires its system operators to be certified with reliability operator credentials, and supports the overall training of system operations personnel, including active involvement in regional and national activities to improve system reliability.

The evaluation team, jointly with OG&E, identified three key recommendations related to OG&E's training program. These recommendations address the resources needed for

administration and delivery of training, additional training associated with balancing authority functions, and guidance for individualized training plans of system operators.

Overall, the evaluation team identified 10 positive observations and offers 13 recommendations that, if implemented, will enhance OG&E's readiness to operate reliably and maintain the reliability of the bulk power system. The recommendations are listed in order of importance.

Positive Observations

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

1. OG&E's work force planning program proactively addresses key personnel succession (Section 1.2.4).
2. OG&E's training simulator enhances operator training by providing realistic exercises and an environment to test skills on unique situations (Section 5.1).
3. Management supports diversity of training opportunities for system operators (Section 5.1).
4. Management supports all operators being certified with reliability operator credentials (Section 5.1).
5. Operator shift schedules allow adequate training opportunities (Section 5.1).
6. The separation of energy management system (EMS)/supervisory control and data acquisition (SCADA) hardware and personnel from corporate information technology ensures a high priority for system operations support (Section 3.2.2).
7. Documented shift-change log sheets provide consistent transfer of system conditions (Section 2.2.1).
8. A visual display of all flowgate loadings provides operator awareness (Section 2.1).
9. The blackstart program provides operators with numerous options for system restoration (Section 2.4).
10. System operators have total control of the manual load shedding program down to the distribution load level (Section 2.4).

Recommendations

The evaluation team offers the following recommendations:

1. Review, and adjust as necessary, the amount and type of resources for the administration and delivery of the training program to accomplish current and recommended initiatives (Section 5.1).*
2. Adjust the training program to add instruction for the balancing authority duties assigned to the system operators (Section 5.1).*
3. Provide guidance to system operations employees for developing their individualized annual training programs (Section 5.1).*
4. Incorporate lessons learned into the core training program to increase system- and event-specific knowledge of system operators (Section 5.1).
5. Develop and deploy operator training simulator training modules around system events in a timely manner to prepare all operators for uncommon situations (Section 5.1).

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6. Implement an EMS alarm for OG&E operating reserves falling below the SPP obligation to increase situational awareness (Section 2.1).
7. Review, and decrease as necessary, the 50-minute timing of the automatic real-time contingency analysis execution to provide operators with current data (Section 2.3).
8. Investigate and implement, if practical, separating the reactive capability display into dynamic and static sources and display by islanding areas to provide operators with better information for normal conditions and indicators of where islanding is possible (Section 2.1).
9. Confidential information on plans for loss of control facilities redacted from public report. See discussion in Appendix 1.
10. Confidential information on communication systems and support redacted from public report. See discussion in Appendix 1.
11. Implement a trouble tracking system for EMS/SCADA that parallels the network operations center tracking system to ensure that each problem is tracked to completion and to provide a historical record of EMS/SCADA hardware issues (Section 3.2.2).
12. Reduce, to the extent practical, the amount of overlap between the automatic and manual underfrequency load shedding (UFLS) programs to improve the total capability and help operators determine the remaining capability at a given time (Section 2.4).
13. Revise documentation procedures to require dated and signed approvals of all procedures and policies to ensure operators are provided with up-to-date information (Section 2.2.3).

*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.

OG&E corporate vision and mission statements emphasize both operational excellence and a focus on reliability; accordingly, its strategy aims at investing in reliability and reliability-centered maintenance. A major part of OG&E corporate improvement plan focuses on a three-pronged approach that emphasizes people, technology, and process. The focus on people is directed at training and performance feedback, the focus on technology is directed at providing the proper tools, and the focus on process is directed at establishing the proper metrics for accountability and feedback.

The vision of the Transmission Operations division of OG&E is to be recognized as a leading provider of reliable transmission-related services, in compliance with federal regulations, to entities within SPP needing to transmit electric energy from generation to load. The Transmission Operations division’s mission statement commits the division to provide safe, reliable transmission-related services within SPP while maximizing the value of transmission assets to OG&E.

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.

OG&E has a culture that supports individual responsibility for performance, continuous performance evaluation and feedback, and incentives for improvements in operations. OG&E went through a major reorganization in 1994 that has led to evolutionary changes in the corporation. Change management and process improvements efforts are encouraging employees to take the initiative to promote changes that both lead to improvements and prevent negative impacts on the company. Teams are being formed within the business units to focus on issues that arise and seek solutions. This ongoing process is positively impacting communications with employees and the employees’ commitment to taking individual responsibility for improvements.

Within the Transmission Operations division, the results of these corporate changes and initiatives can be seen in the dedication of the employees, the openness of communications, and the expectation that corporate support will be provided as needed to resolve issues and pursue improvements in operations. Senior management in the division is seen as personally involved with and supportive of operations.

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.

OG&E's corporate safety council was established to make safety a top issue within the corporation. The leadership for the safety council rotates among senior management. A safety leadership team has been established for each business unit to promote safety programs and to ensure that safety issues are addressed. System operations issues such as switching errors are reviewed and, if significant, escalated to the management level. Reviewing switching errors, publishing reports on the results, and holding local safety meetings and "tail-gate" meetings to review the switching program have become a part of the system operations' culture.

OG&E's commitment to system operations can be seen in the support given to regional activities, especially participation on NERC and SPP committees that provide the opportunity to learn from other organizations, keep abreast of industry developments, and contribute to developing the industry. The system operations group currently has personnel on the NERC Operating Committee and the SPP committees associated with operations reliability, training, critical infrastructure, modeling, and operating procedures.

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.

Performance goals for OG&E's system operations group and its individual employees are tied to performance metrics, which ensures that system reliability is closely monitored and evaluated. The system operations and transmission planning functions conduct quarterly reviews on various reliability topics, such as peak-day analysis, reactive power study results, and SCADA security. Monthly reviews of the NERC standards management process is held to ensure that all departments are informed of their responsibilities. Operational error investigations are conducted with all employees being made aware of lessons learned.

Goals for individuals that directly affect base pay and incentives goals include such issues as operational switching errors, voltage control, participation on NERC readiness evaluation teams, compliance with NERC standards, and NERC continuing education training. Metrics such as SAIDI, CAIDI, and SAIFI, which track system interruption averages, are employed to measure performance. All of these keep emphasis on improving system performance and reliability.

Regular visits by corporate management, division and team meetings, and management's encouragement and feedback for improvements and concerns demonstrate the importance of the performance of the system operations area.

1.2.4 Human Resources

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

OG&E is aware of the critical need to prepare for and maintain proper staffing of the system operator positions in both the short and long term. Five of the nine system operations personnel that are NERC certified as operators are currently eligible to retire. NERC certification is required for staffing the positions and requires nine months to attain, at a minimum. In the near term, OG&E has adequate staffing to meet its requirements with a six-person shift rotation for its system operators. Long-term issues are being addressed by OG&E's Workforce Planning program. Under that program, a system operation has been able to add two temporary positions targeted for permanent system operator positions. The personnel currently occupying the positions are trained and waiting for a vacancy.

The Workforce Planning program has also changed the way succession planning is addressed. Historically, succession planning was informal. Now, a more visible method is used. Employees with high potential are identified, and a development plan is put in place to prepare the individuals for the higher-level positions expected to have a critical need. Consideration is also being given to establishing engineering rotation positions that will offer more exposure to more employees to positions. This will enable employees to gain the experience necessary to fill key positions. The Workforce Planning program also is starting to address retention plans for critical positions. The evaluation team cites as a positive observation the Workforce Planning program's proactive approach in addressing key personnel succession.

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.

OG&E's corporate goals and performance are routinely posted on a corporate Web site, and monthly corporate publications are distributed to all employees to highlight achievements. New corporate goals and business unit goals are communicated to employees during face-to-face meetings.

Every two weeks, OG&E's chief executive officer meets with the vice president of transmission to inquire about the general condition of the power system. The vice president of transmission holds "town hall" meetings quarterly for all personnel in the division to discuss current issues and to provide an open forum for discussions.

OG&E corporate, departmental, and individual performance objectives are linked to the business-unit and individual goals. The business unit and individual goals often arise from suggestions to improve performance and become tied to performance evaluations. Suggestions are encouraged through mechanisms such as OG&E's Enterprise Information and Performance

process, where employees submit detailed process and technology enhancements for consideration. Another option is OG&E's Listen Line, where employee comments are submitted anonymously and reviewed by senior management. Similarly, OG&E has an employee hotline for personal issues. Employee surveys are used to give management feedback on how open communication is with management, and focus groups are formed from the survey results to develop action plans. Individual team meetings are also held to formulate ideas for improvements.

2. Fundamentals of Operations

2.1 General

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

OG&E's control room has three main workstations. Each station has five or six computer monitors and two 42-inch liquid crystal display screens for monitoring the transmission system and balancing authority functions. Telephones are located on each desk. Radio and satellite phones are located between the two desks occupied by system operators, and one cell phone is available in the control room. The system operators' primary source for voice communications with the reliability coordinator and neighboring systems is a telephone system routed through a private branch exchange (PBX) and a public telephone network. The operators can use the satellite phones for direct contact with SPP, and OG&E's power plants and district offices. The company radio system can be used to contact the district offices and transmission and distribution crews in the field.

OG&E's EMS employs an Open Systems International, Inc. EMS application software system running on IBM AIX and Windows servers with Windows clients. The basic functions provided are SCADA, an Oracle relational database management system, inter-control center communications protocol (ICCP), generation control, energy accounting, and trending. Advanced applications available to support system operations include state estimation, real-time contingency analysis, power flow, optimum power flow, load forecasting, and off-line unit commitment. Automatic generation control is executed every 2 seconds. Operating and spinning reserves are calculated every ten seconds. The typical update time for SCADA and applications is 10 seconds or less.

OG&E has an ICCP data exchange with neighboring systems to improve area visibility. Five thousand status and analog values from the ICCP data exchange are mapped into SCADA and available for advanced applications. SCADA transmission displays typically show at least the first external bus linked to the ICCP data exchange, so that the displayed substations in neighboring systems show actual status, line loadings, and voltages. The state estimation model provides an accurate assessment of the transmission systems extending beyond OG&E.

Overview displays show breaker-to-breaker diagrams of the transmission system, including interconnections covered by ICCP, and provide breaker status, generator and line loadings, and voltage levels. Transmission operating limits are displayed for the system operators, including limits for internal line flows, imports, exports, and system operating limits

(SOLs)/interconnection reliability operating limits (IROLs). Voltages are displayed on system one-line diagrams for each substation. Voltage levels monitored include 69 to 500 kV for buses within the OG&E footprint. All monitored quantities are alarmed at 92, 95, and 105 percent of nominal values and displayed in priority order based on seven priority levels. Breaker statuses for interconnections are alarmed to identify trip/close actions.

The status of automatic voltage regulators is shown on a display of generation. The system operators manually update the displayed status of the regulators when notified by a generation plant of a change.

A system-wide reactive reserve display shows the combined total of static and dynamic reserves. The system operators can access a summary display of the status of static or dynamic reactive resources, but the total resources available in each category are not shown.

Flowgates within and adjacent to OG&E are monitored for congestion on a bar chart display, updated on a four-second cycle, showing the n-1 loading. The bar display values update magnitude and change percentage as loadings on facilities reach pre-determined emergency limits.

Area control error is presented both on electronic displays and on a trending chart. The system operators have a generation display that shows the capacity ratings and output for each generation unit, along with the automatic generation control status of each unit on-line. Generation operating reserves are shown as a single number. Spinning and non-spinning are not differentiated, and there is no alarming for operating reserves falling below the daily minimum SPP requirement.

The system operators have a display screen that shows seven frequency measurement points. The display includes the two primary frequency sources used for the calculation of area control error and five other sources distributed across OG&E's footprint to assist the system operators in determining whether or not islanding has occurred. System frequency is also displayed on trending chart.

In reviewing the capabilities and information provided for the system operators to properly monitor and control OG&E's system, the evaluation team finds the control room facilities, the raw data available, and the basic display capabilities to be exceptional. The visual displays of flowgate loadings and the associated visual alarming are noted as a positive observation by the team. The team recommends that OG&E implement an EMS alarm to notify the system operators when operating reserves fall below the level that OG&E is obligated to provide in accordance with its agreement with SPP. The team also recommends that OG&E investigate, and implement if practical, modifying the displayed reactive reserves to show 1) the quantity of static and dynamic reserves available as separate quantities, and 2) the locations of the resources to provide the system operators better information for normal system conditions and additional information for the areas where islanding is most likely to occur.

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.

OG&E's shift-change procedure involves the outgoing system operator meeting with the incoming system operator 30 minutes before the scheduled shift change. A checklist covering 13 topics for discussion is used by the operators to ensure that all important issues are covered. Both the outgoing and incoming system operators must sign the checklist during the shift-change discussion. An outstanding clearance list is also available to the incoming system operator, and any extended outage clearances or temporary setups are discussed.

The evaluation team notes the use of the shift-change checklist to provide a consistent exchange of all critical information as a positive observation.

2.2.2 Operational Decision-Making

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

OG&E's system operators are trained to follow systematic steps when action needs to be taken associated with the real-time operation of the transmission system. It is expected that the actions will be based on state estimation and real-time contingency analysis results. Operating procedures are also available that address the risks associated with exceeding voltage or thermal loading limits and provide guidance to the system operators on actions to be taken. System operator's roles in emergency operations are well defined, and operators are trained and drilled on the operating and emergency procedures. Except for emergency situations, it is standard practice to have at least two system operators review each transmission clearance order before it is sent to the field.

2.2.3 Operational Alignment

Organizational structure supports safe and reliable system operation.

OG&E's system operations staff includes six system operator positions, two transmission operator positions and one transmission coordinator position. The system operator position is staffed around-the-clock with a six-person rotation which allows for vacation, training, and various absences. This position is responsible for the overall operation of the system. The transmission operator position is staffed 16 hours a day, five days a week with a two-person rotation Monday through Friday. This position is responsible for switching on the lower-voltage system. The transmission coordinator position performs operational planning and outage coordination. Supporting these positions are two engineers.

Operating policies and procedures are available to the operators in hard copy in the control room and electronically through a corporate system. When a new policy or procedure is implemented, a memo is prepared and presented to the operators for review. The operators sign an attached routing sheet to verify that they have read the memo and the policy or procedure. Once all

operators have read and signed the memo, the document is placed in a policy memo book. New and changed policies or procedures that have been issued are reviewed at the next operators meeting.

In performing the on-site review of OG&E's documentation, the evaluation team finds that OG&E has a complete set of agreements to clearly identify OG&E's responsibilities and the responsibilities of other reliability authorities to support OG&E's system operations, and a complete set of internal operating procedures and policies to define the responsibilities and actions required to support reliable operations. The system operators' letter of authority to take all actions necessary to protect the system, including shedding firm load, was signed by the president of OG&E and is available in the control room. The team also finds the documentation to be current and the documentation review process to be generally adequate. The team recommends that OG&E review its documentation procedures to be sure that the timely review of each document and approvals of all changes and additions to the documents are confirmed with dated and signed approvals.

OG&E's outage coordination process for planned generation and transmission outages starts with project management coordinating with system operations for clearances of new projects. A project management meeting is held every six weeks to discuss outage schedules, and a simulation study is performed by system operations for each request. All SPP critical facilities requests are coordinated with SPP through entry in SPP's outage scheduling application, OPS1. Generation outages are submitted to SPP through the OPS1 in advance based on the annual generation plan developed by OG&E's power supply group. OPS1 is also used to communicate mitigation plans for SOL/IROL violations to the SPP reliability coordinator. Tie-line overloads are communicated to neighboring systems by SPP.

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.

OG&E's system operators have two EMS servers specifically available for running the state estimation, power flow, and contingency programs. In normal practice, the system operators will have one server executing the state estimation program every 50 to 60 minutes, along with the contingency analysis program. The state estimation model has approximately 850 observable buses and approximately 4100 total buses and takes 10 seconds to solve on a dedicated server. Contingency analysis processing generally takes less than 10 minutes to complete, depending upon the contingency list selected. Contingency analysis solutions are presented to the system operators on a graphical display that shows the 10 highest line loadings and the highest and lowest voltage results. The operator can initiate the state estimation program and real-time contingency analysis from a graphical display. OG&E has seven sets of contingencies (one for line outages at each voltage level and one for generating unit outages) and a comprehensive contingency list. The operator can also choose to evaluate individual selected contingencies.

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OG&E's state estimation model is updated as new equipment is placed in service within OG&E's system or as changes are made to adjacent buses in external systems. Updating the model for external systems is driven by the accuracy of calculated line outage distribution factors (LODFs). When flowgates monitored by OG&E indicate the error in the LODF for an external system exceeds 5 percent, a new planning model for the external system is developed. OG&E uses Nextant as a contractor to evaluate and model sections of the external transmission systems that have a 1.5 percent impact on OG&E monitored facilities. Contingency analysis model updates typically occur monthly. The servers are individually updated with a 10-minute outage required during each database update. Software updates occur annually and take approximately four hours. A vendor performs the software updates, and support staffs update the displays and perform model verification.

OG&E's system operators monitor all the critical flowgates on a single EMS display. Currently, 35 flowgates located within OG&E's footprint and in adjacent systems are monitored on this display. Flowgates listed in NERC's *Book of Flowgates* is the basis for monitoring facilities. The worst-case contingency loading percentage for each flowgate, based on seasonal flowgate ratings, is shown on a bar graph display updated every two seconds. OG&E updates the LODFs as the system configuration changes, based on values in NERC's CRC website. OG&E uses a database archival program to capture all internal flowgate line flows on an hourly basis. The historical database allows after-the-fact query for management review of operations.

OG&E's system operators verify system equipment ratings annually, including a review of all transformers, lines, and voltage alarms. SCADA and power-flow databases are also reviewed for accuracy. Ratings are obtained from equipment records and changes in the state estimation database. SPP is informed of any changes in ratings and coordinates changes with neighboring systems.

To evaluate voltage adequacy and reactive requirements, system operators use the real-time contingency analysis program to perform daily peak-hour analysis. An Excel spreadsheet is used to total the calculated inductive and capacitive capabilities of generators based on unit output in the contingency cases. A reactive reserve of at least 300 Mvar is expected to be available to accommodate the loss of any generating unit. Voltage is planned to be at least 100 percent at peak conditions for the buses monitored.

If OG&E's EMS loses functionality for any extended period, system operators manually update a spreadsheet with the load forecast, system load profiles, tie-line flows, generator outputs, and interchange schedules to track system load and area control error. The system operators contact the reliability coordinator and the adjacent control areas to inform them of the loss of the EMS and to coordinate the collection of readings needed to maintain control. Flows across extra-high voltage interconnections are checked with the interconnected companies at least three times per hour. Flows across 69 through 161 kV interconnections are checked with the interconnected companies at least twice each hour. The generation stations are contacted to collect generator readings for all on-line units at least twice each hour. Interchange schedules are confirmed with SPP each hour.

OG&E's system operators have additional tools that support their operations, including several sources of weather information. One of the weather sources is "Weatherbank," a weather data source customized for the OG&E service area, which includes an Internet site plus an alert system for special weather conditions. OG&E system operators also have a unit commitment analysis capability and perform daily unit commitment studies to provide hourly forecasts for the next seven days to SPP. In addition, the system operators have the capability to build and display trending charts of selected metered quantities and to maintain a catalog of trending charts for ease of selection.

Changes in reactive capabilities of generating units are coordinated with the system operators, who estimate and model reductions in capabilities for contingency analysis. Estimates of actual reactive capability of capacitors and shunts are estimated with real-time analysis of associated voltages and branch flows.

In reviewing the tools and capabilities provided to the system operators to evaluate and monitor OG&E's system, the evaluation team noted the frequency for running real-time contingency analysis. In demonstrations, the system operators were able to manually execute the real-time contingency analysis and receive a solved case for n-1 contingencies in approximately three minutes. The cycle time set to automatically run the analysis is 50 minutes. The team recognized there is a tradeoff between shortening the cycle time and consistently obtaining solved cases. Regardless, the team considers the 50-minute cycle time too conservative and recommends that OG&E review the timing and, based on findings, adjust the cycle to give the system operators more current results to support the monitoring of the system.

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.

OG&E has widely dispersed high-speed underfrequency relays to control automatic load shedding. The relays will drop approximately 10 percent of OG&E's system load at each of the three different frequency steps: 59.3, 59.0, and 58.7 Hz. SPP requires a minimum 10 percent of the system load to be shed at each of the three steps. OG&E's capability is set to exceed this minimum requirement.

OG&E does not use undervoltage load shedding. OG&E does have manual load shedding capabilities, and the system operators can select the load to be shed by system region. The system operators have direct control of the manual load shedding through the EMS. The manual load shedding program is broken into six blocks of feeders. The system operators can request a specified load shed amount, and the EMS program will choose the appropriate number of feeders to achieve the desired result and arm the system for manual execution. The system operators can also manually cycle feeders, if required, to perform a rolling blackout.

The evaluation team considers the manual load shedding program and the associated displays to be well developed and intuitive, with the necessary safeguards to ensure safe operations. The team notes as a positive observation that the system operators have total control of the manual load shedding down to the distribution loads. The evaluation team was informed that the loads

included in OG&E's automatic load shedding program and the loads that can be shed manually overlap as much as 80 percent, and the operators do not have information available to anticipate the amount of overlap that may occur at any stage of load shedding. The team recommends that OG&E review the amount of overlap in the automatic and manual load shedding capabilities and, if possible, reduce the overlap to improve the total capability and to give the system operators more assurance of the capability remaining at any time.

OG&E also has the capability to reduce system load with contracted interruptible loads. The system operators do not have direct control of the contracted loads. OG&E's customer service group implements the interruptible program based on forecasted system conditions a day ahead of the needed reduction.

OG&E's capacity and emergency plan is executed in five stages: 1) emergency action anticipated, 2) emergency action imminent, 3) emergency action initiated, 4) major system disturbance, and 5) system separation. The plan is coordinated with OG&E's reliability coordinator as well as other internal organizations that assist in reducing unnecessary loads and making public appeals, if necessary.

OG&E's reliability coordinator is responsible for coordinating system restoration activities, including synchronizing interconnections and directing restoration efforts. Blackstart plans are also coordinated with the reliability coordinator. OG&E's system operators participate in periodic SPP blackstart drills with other regional members, SPP's Chief Transmission Operator meetings, and meeting of the SPP Black Start Task Force. Restoration scenarios are available on OG&E's training simulator to support additional operator training on restoration and blackstart procedures. In reviewing OG&E's blackstart plans, the evaluation team notes as a positive observation the numerous options and flexibility the plan provides the system operators in restoring the bulk power system.

3. Fundamentals of Maintenance

3.1 General

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

The SCADA/EMS function, within OG&E's Transmission Operations department, has an engineer, two advanced EMS application programmers, a database application specialist, a network application specialist, and two SCADA/EMS technicians. SCADA/EMS real-time operations use a rotating on-call list to troubleshoot issues for system operations. All members of the SCADA/EMS support function have cell phones and come in to support SCADA/EMS operations or network issues. In addition, the vendor is available to support substantive issues and has access into the system or can provide support by telephone if needed. OG&E has a maintenance response contract with the vendor. This provides system operations support for SCADA, automatic generation control, alarm processing, remote terminal trouble shooting, historical data archival, and SCADA/EMS displays and hardware. OG&E's operator training simulator, power flow, state estimation, contingency analysis, and flowgate applications are maintained by system operations personnel.

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.

The EMS is monitored via a “heartbeat” system that is visible on the system operators displays. The system pulses each time the EMS cycle updates and stops if the system fails or goes offline. A diverged condition in contingency analysis is another indicator that a system failure may have occurred. A second server is available for use if a failure occurs. Recent EMS performance data indicate the system availability rate is approximately 99.95 percent.

Meter errors are detected from electronically generated flags on meter values, communications alarms on remote terminal unit failures, comparisons between primary and secondary values for area control error, and inadvertent interchange issues. For failures in data communications, the system operators will normally see changes to data display colors that indicate bad data or loss of communications. The operators also receive alarms for loss of communications circuits. Failures in execution of advanced applications to automatically start or solve causes a flashing alarm to be issued and displayed on the system operators displays.

The SPP telephone service is tested every Wednesday morning and satellite phone service to the power plants is tested weekly. Service to the district offices is tested monthly.

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.

OG&E’s system operators are normally the first to observe anomalies in system performance and capabilities and report issues of concern to system operations management. Depending upon the type of alarm issued, the reported issue may stay within the SCADA/EMS function or may be handled by OG&E’s telecommunications function at the network operations center. If the issue is handled by the network operations center, a trouble report is automatically generated and tracked to completion with the system operators. If the issue remains with the SCADA/EMS function, the issue is manually recorded and resolution is verbally provided to the system operators.

The evaluation team notes the separation of the support for SCADA/EMS hardware from corporate information technology functions as a positive observation because it ensures that priority does not become an issue in maintaining critical capabilities of the control center. The team recommends that OG&E implement a trouble tracking system for the issues handled by the SCADA/EMS function to ensure that each issue is tracked to completion and to provide a historical record of the issues with SCADA/EMS hardware.

4. Fundamentals of Operational Planning

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

OG&E's transmission planning group performs seasonal studies for system operations in coordination with operations management. Mitigation plans are developed and provided to system operations. System operations performs additional seasonal studies for several load levels on SPP models and on models based on the EMS state estimation results. The results of the studies are incorporated into transmission operations procedures, which are updated annually by system operations.

The EMS state estimation and real-time contingency analysis models are also used for most short-term operational planning studies. The source of the base case model is the latest state estimation results, or results from the previous day or season as needed. OG&E archives models every hour and maintains months of historical base cases on-line. The neighboring systems are modeled in detail, with breakers, switches, line flows, and generation levels for all closely interconnected companies. The system operators also have a General Electric power system load flow model available if needed. The EMS model is normally used.

In preparing for the next-day operating plan, OG&E's night-shift system operator identifies outstanding clearance, develops the next-day base case, and runs the contingency analysis program to evaluate the impacts of all planned system changes at the forecasted peak hour. SPP load forecasts and weather data are reviewed to develop the peak hour load forecast. Based on the contingency analysis results, the operator develops permission slips for approval or denial for scheduled outages and develops reports for the day shift.

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.

OG&E has an annual corporate strategic plan development process that leads to the development of strategies and business plans for the business units. The business units develop initiatives and determine the resources needed to support the strategies. As a part of this development, OG&E stresses providing for personnel development and training, which drives training initiatives in the business units. For system operations, metrics are developed to monitor and measure the operator training programs. These metrics are evaluated quarterly and compensation for performance is made on an annual basis. As a result of this process, system operations employees are encouraged to complete their scheduled annual training. OG&E's organizational goals and objectives support one week of training week every six weeks, and the budget for system operations provides for one trip per year for each operator to participate in programs dedicated to training. Operators may also attend the SPP operator conferences and NERC training programs.

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New system operators begin their training by working their way through a series of structured training modules, which address each topic in Appendix A of NERC's *System Operator Certification Program Manual*. Each module contains fundamental required concepts, regulatory standards applicable to the subject, and the resources available to support training on the subject. The overall initial training program can be tailored to each individual's needs. OG&E currently has two positions in system operations available as training positions that the employees stay in until a system operator position becomes available. One of the positions is currently filled by an employee that is NERC certified as an operator.

Trainees are required to receive their certification as an operator before beginning to operate on a shift. On-shift training begins with oversight of a senior system operator. The manager of operations, with recommendations from the senior system operators, makes the decisions on when operators have progressed to the point that they are ready to assume duties without oversight by a senior system operator.

The continuing education and training provided for incumbent system operators is designed to complement their existing knowledge and experience by providing further instruction on rules, policies, and procedures in which they have been trained and to ensure they have the opportunity to complete the training required to maintain their certifications. It also provides an opportunity for presenting new or revised procedures, policies, and rules in a structured format, and provides additional training on emergency plans, standards of conduct, and cyber security.

Operators have a training week built into their work schedule every 6 weeks. The system operations relief shift is used to fill in for personnel during their training week. The first priority is given to training required to maintain certification, and each operator is responsible for identifying personal training needs.

Each training session contains written exams, oral exams, or observations of operator performance on simulations. These evaluations are structured to determine if the training has met its objectives and the operator has gained the knowledge presented in the training. Feedback on the training effectiveness is also solicited from the system operators at the end of each session. The course evaluations are used to determine the improvements needed in future sessions. All course evaluations are recorded in the operators' training records.

A committee approach is used to develop and revise the training program and involves the system operators, the senior compliance engineer, and the manager of transmission operations. New standards, incidents, and observations are used as input in determining when and what revisions are needed in the program. A NERC certified senior system engineer develops most of the training material, and the senior compliance engineer delivers most of the training. Both of these employees have attended the SPP train-the-trainer classes. Vendor-supplied courses are used to supplement the courses developed in house.

During one training week each year, each of OG&E's system operators receive blackstart training on OG&E's training simulator. Each operator is allotted 32 hours of blackstart training on the simulator and additional time using WebEx training presentations developed by SPP. The operators also participate in annual SPP regional blackstart training sessions. The OG&E

simulator uses state estimation models to accurately represent the actual response of OG&E's power system to events. Blackstart plans are updated annually or when a facility change requires a change to the plan.

OG&E's training simulator is also used to train new operators on normal and emergency operations. From the discussions with system operators and demonstrations of the training simulator, the evaluation team makes a positive observation that the simulator greatly enhances overall operator training by making the training exercises realistic and giving the operators a tool to explore more situations that they could encounter. The team also notes that system events that have been analyzed and discussed with the system operators are not being added to the training program for new operators in a timely manner. The team recommends that these events be added to the core training program and simulator training scenarios in a timely manner to ensure that all new operators are exposed to the possible events and agreed-upon solutions.

OG&E supports system operations maintaining its status as a provider of NERC continuing education hours. System operations is a NERC-approved trainer and currently has eight approved and three pending classes. The evaluation team cites as a positive observation the overall management support, from the corporate level throughout system operations, for training and development of the system operators. This is evidenced by the diversity of training opportunities made available to the system operators, training of all operators to achieve certification as reliability coordinators, and the amount of time dedicated to training activities. The team notes that OG&E does not have a dedicated trainer or training staff, and no significant guidance is given to individuals for developing an individual annual training program, beyond what is provided for initial training or scheduled to meet continuing certification requirements. The team recommends that OG&E provide the guidance necessary for the development of individualized annual training programs for each system operator and adjust the training program to add the balancing authority duties assigned to the system operators as specific training modules in the training program. Considering the preceding issues, the team recommends that OG&E review, and adjust as necessary, the amount and type of resources it provides for the administration and delivery of the training program.

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.

OG&E's training program and operating procedures incorporate decision-making methods, risk analysis, human error prevention techniques, and lessons learned from past system events. Emergency operating plans incorporate flowcharts for outages, generation shortages, and transmission relief/congestion management to assist the operators in making decisions. Human error prevention techniques are incorporated in operating procedures and tools to minimize mistakes. The training simulator also enhances human error training by automatically resetting simulations of events to the beginning whenever human errors occur during the exercises.

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OG&E forms a corporate investigation team for each system incident. The team creates incident reports for the events, and safety meetings are held to review the root causes and ways to prevent or mitigate the events. The investigation and the resulting recommendations are published internally to OG&E's portal site, and training simulator models are developed for the events.

OG&E system operations personnel participate in a number of process-improvement initiatives. An example is the process to improve the generator and interconnection meter-reading processes and capability. Work is also in progress on an initiative to more quickly identify metering errors.

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.