NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Balancing Authority/Transmission Operator Reliability Readiness Evaluation Report

FirstEnergy Corporation (FE-West MISO Territory) Akron, Ohio

April 16–19, 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 opportunities 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 together to enhance the program. The current 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 organization evaluated and is not included in the public version of the report.

An evaluation team met on-site with FirstEnergy Corp. (FE) representatives on April 16–19, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of the FE to meet its responsibilities as a balancing authority and a transmission operator within its FE West footprint located in the Midwest Independent Transmission System Operator, Inc. (MISO) regional transmission organization territory.

The FE Verification Team also met with FE, following the evaluation team visit, and addressed the status of two recommendations (29 and 33) from the readiness audit of FE in 2004. The results of the discussions of these two recommendations are addressed in the Recommendations Update — August 14, 2003 section of this report.

Evaluation Team

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FE Verification Team

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Organization Profile

FirstEnergy Corp. (FE) is a diversified energy company with subsidiaries and affiliates involved in generation, transmission, distribution, energy management, and related energy services. It owns seven electric utilities serving approximately 4.5 million customers over an area of 36,100 square miles in Ohio, Pennsylvania, and New Jersey. FE has approximately 12,000 miles of transmission lines, with 94 interconnections to 13 other electric utility systems. FirstEnergy Solutions, an unregulated subsidiary of FE, provides a wide range of energy-related products and services, including the generation and sale of energy and energy planning and procurement services.

FE's transmission system is separated for operational purposes into two parts, FE-West and FE-East. FE-West is the subject of this reliability readiness evaluation. American Transmission System, Incorporated (ATSI), a subsidiary of FE, owns all transmission assets in FE-West. All of these assets are in the footprint of the Midwest Independent Transmission System Operator (MISO). MISO is the federally regulated regional transmission organization for FE-West. The regional transmission organization for FE-East is the PJM Interconnection, LLC (PJM). FE is a member of the Reliability*First* Corporation (RFC) regional reliability organization, and RFC has reliability oversight for all of FE's bulk transmission system responsibilities. ATSI is a NERC-registered transmission operator and balancing authority, and ATSI employees perform those functions in FE-West's primary control center.

The FE-West transmission system includes approximately 7,000 circuit miles of transmission lines operated at 69, 138, and 345 kV. This system has 39 transmission tie lines (345 kV [19], 138 kV [16] and 69 kV [4]) to five neighboring systems. One of the 345 kV lines connects two FE companies, The Cleveland Electric Illuminating Company (CEI) in the MISO territory and Pennsylvania Electric Company (Penelec) in the PJM territory.

FE-West established a peak load of 13,793 MW in August 2006. FE owns and operates approximately 14,000 MW of generation, including approximately 7,500 MW of coal-fired generation, 3,900 MW of nuclear generation, 650 MW of hydro generation, and 1,600 MW of gas- and oil-fired generation. Within the FE-West control area, there are several independent power producer generation plants, which are coordinated under interconnection agreements with both FE and MISO.

Executive Summary

The readiness evaluation team found no significant and few operational issues or concerns and concluded that FE has excellent 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.

FE has established a culture that promotes system reliability as a top priority. The culture encourages all employees to become involved in achieving high goals that directly relate to reliability. It encourages employees to improve their performance and contribute to improving the company's performance. Corporate goals and progress are continuously communicated to all employees, along with information on how the goals directly relate to their work. The communications both up and down the organization are open and designed to encourage contributions to improvements.

The evaluation team made several positive observations about the system operations area of FE. These observations covered areas from corporate culture to those directly related to system operations, operator training, and support for system operations. In general, the team thought the transmission operator and balancing authority functions were aptly handled by well-trained operators, and these functions were receiving the support needed from other groups, including corporate management, to accomplish their duties and provide reliable system operations. The FE Verification Team, in a follow-up evaluation of FE's progress on recommendations from the 2004 readiness audit, concluded that the remaining outstanding recommendations were not only completed, but the innovative approach taken to develop a diversified communication system to support system operations was a potential example of excellence.

The evaluation team made several recommendations of changes FE could make to enhance system reliability. Some of these cover strictly procedural changes, such as clarifying internal protocol documents and improving documentation tracking. Others address enhancements to facilities and analysis capabilities, such as expanding contingency analysis, modifying displays, and reviewing security requirements. The two recommendations jointly identified by FE and the evaluation team as key recommendations, address staffing/succession planning and records management.

Overall, the evaluation team identified 10 positive observations and one potential example of excellence. It also offers eight recommendations that, if implemented, will enhance FE's readiness to operate reliably and maintain the reliability of the bulk power system. The recommendations are listed in order of impact.

Potential Examples of Excellence

The FE Verification Team identified the following potential example of excellence in its reliability readiness evaluation of FE.

1. FE's innovative use of diversified front-end processor architecture has improved the reliability of the systems it uses to monitor and control the bulk power system (Recommendations Update — August 14, 2003).

Positive Observations

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

1. FE's training program includes comprehensive courses and training exercises, the integration of the training simulator, a process to keep the program current, and management overview of the entire process (Section 5.1).
2. System operators have direct control and display of load shedding down to the distribution level (Section 2.4).
3. The corporate culture is focused on excellence and committed to safety and reliability (Section 1.1).
4. FE's communication process uses a variety of methods to engage employees in strategic objectives (Section 1.2.5).
5. FE displays a corporate commitment to evaluation and compliance (Section 1.2.2).
6. The outage request process uses many checks and balances before implementing a scheduled outage (Section 2.2.3).
7. The energy management system (EMS) displays provide operators with diverse and convenient information (Section 2.1).
8. Data integrity is verified using a backup EMS to compare data from the primary EMS (Section 2.3).
9. The positive transmission operations culture promotes reliability as a top priority (Section 1.2.3).
10. FE has developed a generating unit testing and modeling program and uses disturbance monitoring equipment to check data integrity (Recommendations Update — August 14, 2003).

Recommendations

The readiness evaluation team recommends that FE take the following actions to address issues discovered during the evaluation process:

1. Review staffing and succession planning to reflect the potential impact to the control center of personnel turnover and competition for qualified replacements (Section 1.2.4)*.
2. Establish a single internal protocol document between the balancing authority/transmission operator and generator owner/operator that defines the reliability and emergency roles and responsibilities (Section 2.2.3).
3. Confidential information on physical security redacted from public report. See discussion in Appendix 1.

4. Implement a records management system that includes control and tracking information to ensure operators have the most up-to-date information and procedures (Section 2.2.3)*.
5. Redesign the operating reserve display to show both spinning and supplemental reserve margins to provide operators with a more complete picture of available reserves (Section 2.1).
6. Expand the contingency list to include selected n-2 cases for real-time contingency analysis to increase operator situational awareness (Section 2.3).
7. Add an EMS visible/audio alarm for special protection system operation to enhance operator awareness of potential problems (Section 2.2.1).
8. Develop an EMS display that uses the FE footprint as a backdrop and identifies the location/status of all blackstart generating units to help operators support restoration activities (Section 2.4).

*Jointly identified by the entity and evaluation co-leaders as a key recommendations

Discussion

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

1. Culture

1.1 General

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

FirstEnergy's corporate vision focuses on being a leading regional energy provider, recognized for operational excellence and customer service. Its mission statement emphasizes providing competitively priced, high-quality products and value-added services in generation sales and services, energy delivery, power supply, and regulated and unregulated supplemental services related to the core business. To accomplish this mission, FE has established a set of key performance indicators at the corporate level for 2007 that address pursuing continuous improvement in all aspects of its business.

To measure its progress on the indicators, FE focuses on multiple, industry-standard indexes of transmission and generation reliability. FE utilizes "root-learning maps" as an educational and talent development vehicle to ensure that all employees understand the factors contributing to the success of the business, including compliance and reliability. The maps have been translated into critical success factors that are integrated into individual performance appraisals, reinforcing FE's overall culture of achieving operational excellence in all aspects of its business, including placing a high priority on system reliability.

Similar to compliance and reliability, safety is a top priority for FE. FE's Corporate Safety Department implements and tracks safety programs and goals for all employees and incentives are provided for achieving safety goals. FE has established a safety committee that involves senior management in all functional areas of the company and publishes a monthly safety newsletter. Any safety incident occurring in any functional area is presented to and reviewed with the respective business units. In the system operations area, every operations meeting begins with the discussion of a safety initiative.

The evaluation team was impressed by FE's focus on excellence in all of its business activities, particularly those areas related to system reliability and safety, and the team identifies this commitment 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 above, all employees share key corporate objectives, for which incentives are provided. These objectives include three key operating objectives: 1) pursuing continuous improvement in all aspects of the business, 2) maximizing generation availability, and 3) improving distribution reliability. These objectives are linked to key performance indicators shared by employees within the business units and include an operational performance index encompassing elements of generation availability, transmission line outage performance, and distribution reliability.

FirstEnergy's focus on operational excellence in the reliability and compliance areas is directed by FE's FERC Policy and Compliance Group. This group is headed by FE's chief compliance officer and reports directly to FE's chief operating officer. The group's mission is to provide a reliability compliance oversight function that monitors compliance and manages self-assessment and reporting, as well as managing the resulting initiatives. This provides internal, but independent, oversight for compliance and the reliability functions of system operations as well as a sponsor for initiatives that lead to excellence in system operations.

Establishing a group focused on developing and implementing strong reliability and regulatory compliance programs indicates the focus and importance attached to these initiatives by FE's senior management.

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.

System reliability performance indices at the line management and individual employee levels are incorporated in FE's corporate key performance indicators. The indicators are included in the objectives of the individual operating business units and directly linked to incentive compensation for each employee. As a result, these goals are frequently reviewed, quarterly updates on the progress in achieving the key performance indicators are provided to all employees, and close attention is directed to performance in these areas.

As a part of FE's emphasis on achieving reliability compliance, it has established a core team of subject matter experts to work with its compliance organization to ensure that FE achieves full compliance, can demonstrate complete readiness to provide reliability of the bulk power system, focuses on efforts to self-identify and address areas that need attention, and builds the foundation for operational excellence.

The evaluation team took special note of FE's corporate commitment to achieving full compliance in system reliability, its preparation for the readiness evaluation and openness in communications with the team, and its desire to learn from the readiness evaluation process. The team identifies FE's corporate commitment to the evaluation process as a positive observation.

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.

FE's Operational Leadership Council, composed of senior management representatives of all FE operational business units, serves as one of FE's forums for frequent executive discussions surrounding operational performance and system reliability issues. FE's Senior Management Committee and Executive Management Committee provide another forum, meeting frequently to discuss various operational and reliability performance topics. In addition, FE's Executive Reliability Compliance Steering Committee, composed of key business unit executives, meets monthly to provide overall guidance and direction on reliability issues. The guidance provided by the steering committee shapes the organizational initiatives required to transition to the mandatory reliability standards and provides a long-term perspective associated with advancing reliability and operational performance initiatives throughout the business units.

To keep abreast of developments in the industry and develop a basis for measuring FE's performance in operational areas, FE's executives and subject matter experts are extensively engaged within several industry organizations, including the RFC Reliability Committee, the NERC Planning Committee, and Electric Power Research Institute research initiatives and committees.

The evaluation team recognized the attitudes and efforts of the control center operators, supervisors, and management to promote reliability as a top priority, strive to continuously improve system operations, and involve all employees in the process. The team notes this culture of system operations as a positive observation.

1.2.4 Human Resources

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

FE's succession plan for system operations and related support areas is tied to development and promotional opportunities within the company. In the past, these have included assignments in the regional dispatching operating centers, rotating experience within the various business units, and participating in FE's formal Talent Management/Workforce Development Programs. FE has also utilized external career consultants for targeted positions. A key corporate objective for 2007, which all employees share, is to attain vital hire goals. FE recognizes the importance of retaining and attracting qualified system operations and key support personnel, and these positions are included among the corporate vital hires categories. General succession plans are supplemented based on business unit and position-specific evaluations of succession needs and by establishing development paths for individuals.

Within FE's Talent Management/Workforce Development Programs, FE identifies a variety of opportunities that facilitate development of targeted employees. The talent and workforce development objectives and opportunities have been extended throughout the employee, supervisory, and management chain of business unit functions. This process provides further encouragement to gain experience by rotating personnel among different business units.

In discussing FE succession planning process, the evaluation team raised questions about the experience FE has had in replacing system operators, the amount of time required to train a system operator, and the possibility of establishing a process to pre-qualify personnel. FE's staff stated that the time required to train operators depended on their previous experience and how closely their skills fit the positions they were to fill. Generally, it would take six to twelve months to train an operator; however, if candidates lacked experience, it could be a year and a half or more. FE's staff noted that they generally relied on personnel being hired with experience from other similar companies or from FE's distribution functions as a feeder source. The evaluation team noted that the operations staff had not been at its full staffing level for several years. The team recommends that FE review staffing and succession planning to reflect the potential impact on the control center of personnel turnover and competition in the industry for qualified replacement candidates.

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.

FE provides a variety of formal and informal opportunities for its employees to give feedback and recommendations that improve performance, such as wide-ranging employee engagement meetings held throughout the organization to explain business objectives and gather feedback. FE uses a recently enhanced Web-portal and a monthly newsletter, *Employee Update*, to communicate corporate objectives, initiatives, goals, and targets, including those related to reliability and operations, as well as other information of interest to employees.

In addition to the staff meetings conducted by FE's chief executive officer at least three times annually to communicate key corporate objectives and progress to senior managers, the chief executive officer personally conducts several employee meetings across the company with the objectives of improving employee understanding of the importance of corporate objectives and soliciting feedback. The chief executive officer also delivers progress reports on corporate objectives via satellite broadcast periodically, and tapes are made for those that cannot attend the broadcast.

FE has established an initiative described as "rules of engagement," which promotes the principle of engaging in constructive discussions about continuously improving both personal and organizational performance. As a part of this initiative, all employees are expected to share best practices, participate in a questioning and self-critical learning environment, and promote teamwork across business units.

From a system operations perspective, operators and operations management have several opportunities to identify and communicate issues related to operating improvements associated with post-event analysis, lessons learned, and corrective-action efforts, and experience gained from dispatcher training simulator (DTS) exercises. Engagement meetings are held for system operators at least quarterly, where the opinions of the operators are solicited on operations improvements. In addition, supervisors are coached to work as a team to address issues raised by the operators.

The evaluation team noted the frequent communications between all levels of the company and the numerous methods used to keep employees informed about general business performance issues as well as issues of special interest to each business unit. The team was especially impressed by the use of the rules of engagement process to promote discussions and feedback on opportunities for improvements in personal and organizational performance. The team found general agreement across all levels of the company that communication was both frequent and open, and that all employees had many ways of becoming engaged in strategic objectives of the company. The team cites the overall communications process as a positive observation.

2. Fundamentals of Operations

2.1 General

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

FE transmission operators have electronic displays of real and reactive generation and power flows, voltages, current flows, and the status of breakers and switches for the 69 through 345 kV system, including interconnections to transmission customers and other utilities connected to the FE's footprint. FE has visibility into neighboring systems one or more busses beyond its control area boundary for all tie facilities at 138 kV and above. This includes 34 of the 35 tie-line facilities. Transmission displays provide information on a geographical layout of the substations, displaying buses, breakers, switches, transformers, and transmission lines for FE facilities and interconnections.

FE transmission operators are provided visual and audible alarms by the EMS for real time and for next contingencies. Transmission limit values are made available to MISO through model updates and are communicated to neighbors at operational meetings. FE's operators can also monitor transformer load tap changers and the status of capacity banks on station one-line displays.

The operators also have a discrete display for voltage stability information provided by MISO and displays for system operating limits and interconnection reliability operating limits with the capability to be automatically updated based on studies. In addition, the operators are provided alarms on substation entries on a display showing status changes and identifying the operator that provided clearance. The operators can see all the alarms with an alarm viewer or filter the alarms by color to indicate criticality.

FE does not have any area where the system experiences problems meeting scheduled voltages or reactive reserves, but FE does monitor and maintain dynamic reactive reserves for the northeast and northwest Ohio areas to aid in providing post-contingency voltage support. FE plans, monitors, and maintains dynamic reactive reserves at specified seasonal levels in the Cleveland area (800 Mvar in the summer and 300 Mvar in the winter) and in the Toledo area, where positive dynamic reactive reserve is maintained year round. Under contingency conditions, FE operators can contact MISO for coordination and further assistance. As additional steps are required, FE operators can implement emergency procedures and take actions up to and including shedding firm load to alleviate voltage conditions.

System frequency is provided to the transmission operators through the primary AREVA EMS. Should an EMS failure occur, an independent frequency trend is provided to the operators from a separate backup OSI EMS. The backup system provides continuous frequency trending and monitoring ability, and output is displayed on FE's wide-screen displays for enhanced operator situational awareness. The frequency sources used in calculating area control error (ACE) are independent of the EMS. There is an automatic failover from the primary to the secondary frequency source for ACE calculations, and both of these sources are True Time Global Positioning System-based sources. The operator can manually select from three additional sources if required. In addition, a display of over 30 frequency measurements across FE's footprint helps the operators to detect islanding.

FE employs a weather-channel feed, which is shown on the wide-screen display system, to view weather forecasts for 11 sites around FE's system. The weather forecast is also incorporated in the EMS to calculate real-time temperature-dependent limits for FE's transmission facilities.

The evaluation team noted the diversity and convenience of information supplied to system operators and identifies the EMS display of information as a positive observation. The team recommends that the operating reserve display be redesigned to show both spinning and supplemental reserve margins.

The primary system operator interface for voice communications in the control center is a multi-function voice console linked to both FE's internal phone network and the public phone network. A remote dial tone is supplied to the control center over FE's communication network, providing a diverse route for voice traffic. For backup voice communications, the control center is equipped with a number of digital telephone sets utilizing the private branch exchange. Normal communications with MISO are handled by virtual ring-down technology accessed through a control center multi-function console. FE's regional dispatching offices within the control area and FE's systems and network operations center ring-downs are also integrated in the control center console. Operators have access to FE's radio system to communicate with field crews, and satellite phones are available as an additional backup communications method.

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.

FE has one special protection system (SPS), located at its Richland substation, that can require tripping of combustion turbines to eliminate overload. Digital over-current relays monitor the appropriate current flows; when limits are exceeded, a signal is automatically sent to the generation control system to trip the appropriate units. If the overload is not eliminated in 60 cycles, the relay will trip the appropriate breaker.

Operation of the SPS is automatic and does not rely on inputs from the EMS. The SPS is always scheduled on for operation, and field personnel notify the operators if there is any problem with the system. A work-around procedure has been developed for times when the SPS is out of service that includes limiting generation to avoid contingency overloads. FE performs a

complete inspection of the SPS every five years as a part of its relay preventative maintenance program. The evaluation team considers the planning, design, and operation of the SPS adequate to support reliable system operations but recommends that visual and audible alarms be provided by the EMS to enhance operator awareness.

2.2.2 Operational Decision-Making

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

The FE operators who perform balancing and transmission functions are trained to account for various risks when making decisions to maintain reliability. The FE operators utilize operating procedures on which they were trained to follow specific steps and take specific actions to alleviate system conditions. The operators have clear authority and responsibility to take or direct appropriate real-time actions, up to and including shedding of firm load, to ensure the stable and reliable operation of the bulk power system without obtaining approval from higher-level personnel.

Changes in outage schedules and work plans are reviewed for possible human error or undesirable impacts to operations using detail root cause analysis. This process involves looking at each work order for the next day and following procedures to evaluate any potential impacts. If problems are discovered that cannot be resolved, the operator(s) will either cancel the work order or take other actions to alleviate the problem.

Following system operations events, a complete review of the event and operator responses is performed to determine the cause and corrective actions required. This may include reviewing tapes and other data and interviewing the parties involved. Follow-up actions could include training, coaching, fixing hardware, etc, and the event may be incorporated into the dispatcher training simulator for future training.

When infrequent activities are scheduled (i.e., transmission switching, EMS failover, telecommunications testing) the change is coordinated with the appropriate support functions prior to receiving operations approval. A minimum of two weeks is normally required for scheduling these types of activities, and the shift supervisor must be notified prior to the change occurring. The change is also reviewed to make sure it does not impact any other work, and the impact of the worst-case scenario is prepared.

When operators raise questions about procedures, FE's policy is the following: stop, get clarifications, know what you are doing, and then proceed accordingly. When operators are involved in switching, it always requires two operators to issue a switching order. This is also required to initiate emergency procedures.

For changes in policies or procedures, the change process may include required reading and training by the operators. This determination is made by the procedures group, and regardless of the path taken, the operators will be required to sign off that they read and understood the change.

2.2.3 Operational Alignment

Organizational structure supports safe and reliable system operation.

ATSI is the registered balancing authority for FE-West, while MISO is the NERC-registered reliability coordinator and provides the generation market and economically dispatches FE's generation. The responsibilities of the parties are detailed in a transmission and energy markets tariff and in the *Agreement Between Midwest ISO and Midwest ISO Balancing Authorities Relating to Implementation of TEMT,* effective April 1, 2005. MISO also issues FE net interchange schedules that are included in FE's calculation of ACE. FE monitors changes in the net interchange schedule and communicates with MISO if deviations occur. FE transmission operations provides ACE calculations to FE Solutions, and MISO sends automatic generation control set points to FE Solutions.

FE Solutions is a registered generation owner and operator. These functions are managed by generation subsidiaries of FE under internal procedures and agreements, which define the responsibilities of the subsidiaries in supporting FE's balancing authority and transmission operator functions.

ATSI is the NERC-registered transmission operator for FE-West and provides the transmission operations staff for local control of the ATSI system in FE's primary control center. All of the FE-West transmission is in the MISO footprint, and MISO is the registered reliability coordinator. In reviewing the roles and responsibilities of the parties involved in performing these functions, the evaluation team found it difficult to track the documentation covering roles and responsibilities internal to FE, including the generation subsidiaries. The team recommends that FE establish a single internal protocol document between the balancing authority/transmission operator and the generation owner/operator that defines the reliability and emergency roles and responsibilities.

FE has a set of policies and procedures in place that are adequate in describing the processes required to support system reliability. The document control process has been adapted to recognize changes in the way FE performs its functions and changes in the parties involved in the various functions. For FE-West, document control is the responsibility of the system operations manager and supervisors. A procedures and training supervisor is responsible for developing compliance procedures for system operations.

FE is currently investigating a software solution to recording and tracking documentation changes. The evaluation team found it difficult to determine whether they were looking at the latest version of documents and whether the current documentation process ensured that personnel consistently had access only to the latest version. The team recommends that FE implement a records management system that includes control and tracking information.

FE's outage coordination procedure addresses the process to be followed in planning the outage of generation and transmission facilities and specifies the coordination required to ensure the proper support is provided between FE's outage coordinating section, system operations, the MISO reliability coordinator, affected neighboring balancing authorities and transmission operators, and FE's generation subsidiaries. For all planned outages, the process begins a month or more in advance and leads up to the next-day security analysis process. For next day outages,

studies are made of all planned outages based on conditions expected during the peak of the outage day, and a report is provided to system operations the afternoon before the day of the outage. On the morning of the outage, the model is checked to determine if any system conditions have changed. If the model is still satisfactory, the outage is released by system operations. Otherwise, additional analysis or mitigation may be required. If the issues cannot be satisfied, the outage is changed or cancelled. The evaluation team found this process to be very thorough and notes the outage request process as a positive observation.

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.

The FE AREVA EMS is a real-time data collection system with a remote redundant pair of mirrored servers that automatically fail over to each other in case of unplanned outages. The dual servers are located at the primary control center and at FE's Information System Operations Center. In addition, EMS data entry points, front-end processors (FEPs), and intercontrol center communications protocol (ICCP) servers are built as redundant servers that automatically fail over to each other in case of unplanned outages. All network nodes have physical redundancy. The EMS network uses the FE telecommunications infrastructure and leased facilities as transport media. The EMS network is independent from the corporate network, and the EMS is software based and hardware independent (i.e., not vendor specific).

The EMS capabilities include

- supervisory control and data acquisition (SCADA)
- control area performance monitoring
- historical data processing, archiving and data access

Applications include

- real-time network analysis, including: state estimation, load flow, and real-time contingency analysis
- dispatcher training simulator

FE's EMS provides a built-in trending application to graph information for the operator displays and for the control center's wide-screen display system. FE has also incorporated a plant information history (PI historian) application as the EMS data archiving function. This provides the operators access to historical data in a spreadsheet fashion to aid their real-time analysis.

FE's ICCP servers are used to communicate with external companies such as PJM, MISO, etc. The ICCP servers are also used to transmit data to FE's generation management system. The ICCP includes a pair of remotely redundant servers that automatically fail over to each other in case of an unplanned outage.

FE has a separate backup EMS provided through a third-party vendor, OSI. This system supports transmission operations at FE's primary and backup control centers and operates independently and continuously for backup in the event of the loss of the primary and secondary AREVA EMS. This distinct and separate backup EMS provides FE control area balancing and

monitoring of several critical transmission facilities. EMS health is monitored by comparing data between the primary AREVA EMS and the backup OSI EMS. FE also has a dedicated MISO EMS terminal at FE's control center, utilized by the operations engineer to augment FE's real-time monitoring and coordination with MISO.

The evaluation team identifies the ability to compare AREVA and OSI EMS data to identify bad data and quickly take corrective actions as a positive observation. The evaluation team also recognizes the system coverage, display arrangement, and variety of data provided for the system operators from EMS displays as a positive observation.

FE's real-time contingency analysis (RTCA) model is based on the state estimator model and is maintained by scheduled uploads every two weeks, or as needed due to system changes. RTCA executes automatically every five minutes and take approximately 15 seconds to solve. RTCA results are presented in a table form in order of severity and are available to operators on their EMS displays and on the control center's wide-screen display system for operator situational awareness. FE's engineering staff assists real-time operations by providing offline power flow and contingency analysis modeling as required. The Transmission Planning and Protection group provides the contingency list for the RTCA.

The evaluation team raised questions about the use of RTCA, in particular, the identification of critical system facilities and the analysis performed for contingencies associated with these facilities. The team recommends that the RTCA contingency list be expanded to include the analysis of selected n-2 cases.

Voltage stability analysis monitoring of next-contingency voltage stability is accomplished in coordination with MISO. MISO identifies the flowgates requiring continuous monitoring and sends FE voltage stability interface limit values four times a day. These limit values are incorporated in the FE EMS and the MISO limit monitoring to alert operators of voltage stability contingency conditions.

FE is a participant in the AREVA "Decision Support System" project to improve situational awareness. FE intends to integrate the system with the current EMS. This will provide new overviews of the transmission system, including a graphical-based contingency analysis feature to aid operators in system analysis. FE is also implementing an online, real-time voltage stability analysis program for examining load increase margins and/or power transfers to assist the operator in taking actions prior to next-contingency events. FE is also enhancing its OSI backup EMS to provide operators additional monitoring of system voltage trends and primary EMS "health" checks to alert operators to possible EMS issues.

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.

FE is a party to the MISO *Contingency Reserve Sharing Group Agreement*, which includes supplying spinning and non-spinning reserves to all members of the Contingency Reserve Sharing Group (CRSG). FE's balancing area provides and receives reserves automatically when the reserve sharing system has been activated. The CRSG is operated as a Web-based system that can automatically allocate reserves from CRSG members to a requesting entity by issuing

new generation dispatch values along with real-time net interchange schedule adjustments at MISO.

FE has a capacity and energy emergency plan that is updated annually. The plan consists of several individual procedures that apply to the different conditions under which the plan is to be implemented. The criteria for declaring the implementation of FE's capacity and energy emergency plan is specified in FE's *Anticipated Short-Term Capacity Shortage Procedure (NOP-005)*. Implementation of the plan could be the result of a fuel shortage, the sudden loss of capacity, or operations of the CRSG. The steps taken are based on how much time is available for implementation.

Load shedding is accomplished utilizing EMS displays that show the load reduction available by levels, grouped by geographic area. Load shedding breaker trips initiated by the control center operators disable breaker control at the regional dispatch offices so that the regional dispatch offices see load shedding actions on their displays as load shedding and not breaker trips. Demand-side management implementation is handled by the ENVOY Emergency Notification System, which is a display-driven application that automatically notifies regional customer sales personnel of the assistance needed and initiates the calling of contractually interruptible customers.

The evaluation team noted the excellent display of information for the operators to control and track load shedding operations down to the distribution level and identifies this as a positive observation.

FE control center operators direct and own the implementation and operation of the emergency plan, and they conduct annual drills on the procedures. The FE operators have the authority to take or direct the appropriate actions, without obtaining approval from higher level personnel, to protect the reliability of the system and equipment during normal or emergency operating conditions. This authority is properly documented and posted in the FE control room.

In the event of an underfrequency and/or undervoltage load shed condition, the system operator and the regional distribution dispatchers are notified via EMS alarms that automatic relays have operated. FE's undervoltage load shedding program is based on RFC requirements, and trip points are coordinated annually with RFC. This is a system-wide program with 33 installations designed to shed 1,300 MW of load.

MISO has the overall responsibility for coordinating system restoration efforts, including synchronizing cross-jurisdictional islands. After approval by MISO, FE operators directly communicate with neighboring entities to synchronize neighboring islands. FE utilizes its blackstart plan to coordinate system restoration activities with other entities. As a part of FE's blackstart plan, FE utilizes MISO's *Interconnection Checklist* to guide the re-establishment of interconnections to islands. In reviewing the information displayed for the operators to support these activities, the team recommends that FE develop an EMS display that uses the FE footprint as a backdrop and identifies the location and status of all blackstart generating units.

FE has a business continuity plan that is used to direct company activities when facilities are out of service. It covers actions on a facility-by-facility basis and is not administered by system

operations. The system operations restoration plan addresses the entire bulk power system and has priority over the business continuity plan.

FE operators monitor the critical bus voltages for the nuclear power plants in its footprint during normal and contingency conditions. On a daily basis, the nuclear plant operators and the system operators discuss the status and configuration of the transmission system serving the nuclear plants to review any potential problems.

System operations has a variety of tools available to communicate system conditions with the outside community. These include the ICCP links, feedback through the Reliability Coordinator Information System (RCIS), a MISO messaging system, and a MISO system terminal. The communication protocols utilized depend on the situation.

FE has established a separate emergency operations center for management to receive information on system emergency conditions and direct certain activities without interfering with operations in the control center. The emergency operations center is activated under severe or system emergency conditions (e.g., ice storms, tornados, heat wave, etc.) and provides a centralized area to coordinate responses to inquires about the emergency conditions, to disseminate information to the media, and as the liaison with the control center and the regional dispatching offices to summarize system status and assist in directing hazard responders.

3. Fundamentals of Maintenance

3.1 General

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

The FE systems and network operations center is staffed around-the-clock to monitor the communication and computer capabilities associated with system operations. As previously discussed, a comparison of data from the AREVA EMS and the OSI EMS automatically notifies the center of data integrity issues, and a priority is set for resolving the issues. The system operators can increase the priority level on any data issue they consider urgent. Support personnel for communication and computer issues are on call around-the-clock to respond to requests.

FE has disturbance monitoring equipment installed on the transmission facilities required to be monitored, as defined by ECAR requirements. Currently, FE has projects identified to install time synchronizing capability at 13 existing disturbance monitoring equipment locations, based on an implementation schedule and requirements established by ECAR. These installations are scheduled for completion by the end of 2007.

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.

Critical EMS assets and processes, such as front-end processors, critical applications, and the host and other servers associated with the EMS are monitored by staff at the Systems and Network Operations Center using HP Openview software. Abnormalities are reported to the Systems and Network Operations Center, which is staffed around-the-clock to monitor, identify, and correlate critical system issues. The center also monitors an EMS log file to detect offline remote terminal units (RTUs). When an issue is reported, analysts create an incident report and page on-call EMS support analysts, who carry pagers and have secure, remote access to the system. These on-call analysts are supported by subject matter experts in SCADA, network applications, RTUs, ICCP, and automatic generation control.

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.

FE carefully evaluates the potential impacts on system operations when change initiatives are considered. Testing, proof-of-concept, or pilot programs are utilized before implementing changes in the system operations environment. Prior to implementation, change initiatives are evaluated and incorporated with changes required in the system operations process flows, operating procedures, tool enhancements, and training. This is intended to thoroughly prepare the operators to effectively implement the change initiative.

In cases where the change initiatives result from external activities, the internal change management process is the same. For example, FE routinely conducts joint operational and emergency conditions drills in concert with regional transmission organizations, resulting in reviews and enhancements of existing procedures and coordination processes. FE utilizes a review process of system operations conditions and experiences to improve situational awareness and enhanced operating capabilities.

4. Fundamentals of Operational Planning

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

FE's transmission planning and protection group provides support to system operations by developing models and performing seasonal analysis of system conditions. Each May, FE's planning staff holds an "all-hands meeting" to communicate seasonal assessment results to the operations staff. The results of the studies are then integrated into normal and emergency operating procedures. Operating procedures and associated mitigating steps derived from the seasonal assessment are also presented to operations. As part of the FE seasonal and long-range planning process, FE performs first-contingency incremental transfer capability studies to determine limiting constraints and associated import and export limits. MISO calculates FE's total transfer capability and available transfer capability on a monthly basis for the next 36 months.

For shorter-range operational planning (a week to two months ahead), FE uses the EMS AREVA Study Network Analysis program, based on a model consistent with the models used for real-time state estimation network analysis and real-time contingency analysis. The analysis program

model includes at least one bus into FE's neighboring systems, with several interconnections modeled to include up to three busses external to FE. Study cases are developed from a real-time snapshot base case. The model is updated as needed with thermal and voltage limit and rating changes provided by Transmission Planning and Protection's limit synchronization process, which synchronizes both planning, operations, and MISO models to ensure consistency. These limits are integrated into the EMS applications for both real-time and n-1 contingency monitoring.

The next-day system security analysis includes study load flows of all planned outages on FE's 345, 138, and 69 kV systems and tie lines, with generation at expected dispatch levels for peak loads. All planned outages and deratings of equipment on the 345 and 138 kV systems are reviewed with the reliability coordinator at MISO. Results of the day-ahead study are provided to real-time transmission operations for review and concurrence. Included in this report are all planned switching operations and projected abnormal conditions, expected weather and temperature conditions, offline and derated generating units, MW and Mvar reserves, and projected contingencies with possible mitigating actions. As needed, FE's Transmission Planning and Protection group provides assistance to the operations group for day-ahead and real-time analysis.

Nuclear plant-specific voltage limitations are detailed in FE planning and operating criteria and are used when performing long-range, seasonal, and operational planning assessments. FE transmission planning staff performs a degraded grid voltage study annually for each nuclear plant and provides information to FirstEnergy Nuclear Operating Company on expected transmission bus voltages under stressed system conditions. Planned outages that affect nuclear plant off-site sources are coordinated six weeks in advance. A day ahead of such outages, FE's transmission outage coordination group contacts the nuclear plant to discuss operational status. On the outage day, a morning call is held between the transmission operations and the nuclear plant to confirm any operational changes to the work plans and to confirm transmission conditions.

FE's staff actively participates in reviews of its transmission system conducted by RFC and MISO. FE also participates in various MISO and RFC committees and working groups. RFC's Transmission Performance Subcommittee forms working groups to perform seasonal operating assessments for the upcoming summer and winter. RFC also performs near- and long-term (one to five years and beyond) transmission system assessments and produces reports as needed.

RFC has recently formed the Eastern Interconnection Reliability Assessment Group, comprised of the six regional groups in the Eastern Interconnection, to perform inter-regional power transfer capability studies similar to those previously produced by the regional groups. FE plans to be involved with any studies performed by this interregional group.

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.

FE's operations training program is well organized and comprehensive. The training program is comprised of four key components: initial training, continuing training, dispatcher training simulator, and multiple drills. In addition, each newly hired operator is assessed by his or her assigned supervisor and manager to determine the extent of initial training required and is given an orientation to the control center.

The orientation and assessment process requires each new employee to complete a "New Employee Check-Off Sheet," which guides the employee in becoming familiar with the personnel and processes of the control center. The orientation also provides the opportunity for one-on-one discussions with managers and supervisors.

The initial training program covers the knowledge and skills needed to become NERC certified and to independently perform assigned functions. A waiver may be granted for parts of the initial training, if approved by the lead trainer, the supervisor, and the manager. The initial training includes the completion of both a series of structured courses and a series of qualification check-outs that are knowledge and skill based. Completion of each technical topic is documented on a checklist. Topics include the control center's manual of operations, blackstart plans, restoration procedures, and several additional topics. The trainee must be certified on each topic by a subject matter expert prior to the supervisor making a decision about the trainee assuming duties as an operator. Each operator must also be NERC certified before assuming duties. Initially, the operator will be assigned a mentor for additional on-the-job training. The supervisor monitors and assesses on-the-job performance to determine when the operator is ready to work alone.

The continuing training program includes a list of training topics presented on a rotational basis that allows each operator to complete all of the training topics every two years. The program is divided into annual and biennial training to accommodate specific training topics being included each year, including NERC requirements. The control center work schedule provides each operator a week of training time every six weeks, ensuring each operator is able to attend the training classes, simulator training courses offered with each module, special drills, and lessons-learned training. The training modules are offered for seven weeks, and the basic schedule identifies the classes offered. The supervisors ensure that each operator attends when they have a training week.

The process for developing training courses includes preparing the learning objectives, developing lesson material, reviewing and approving the material, determining the training setting, creating the test, and determining whether a pilot training session would be beneficial. New courses are developed based upon training requested by operators, new regulations, changes in the transmission system, added or modified control center functions, or lessons learned from operator incidents. The lead trainer reviews all operator events using root cause analysis, and incorporates any changes needed in the training program, including simulator training. A course on human performance enhancement and error prevention is also utilized to train employees on methods of preventing errors. The annual training program includes training for summer and winter peak periods developed by the training staff and FE's planning group and blackstart procedures and restoration drills conducted with MISO.

The Training Review Committee, consisting of the director of transmission operations, operations managers, and supervisors, meet four times a year to review the planned training and determine any changes needed. At present, the lead trainer for the control center is a senior transmission specialist who has several years of training experience. He has received Analyze, Design, Development, Implementation, Evaluation (known as ADDIE) program training and attended several other programs for trainers. Subject matter experts from other operations functions and corporate training staff are called on to supplement training requirements as needed. Along with the program, the trainers are evaluated by the trainees and by the control center supervisors and managers as each course is presented. FE's personnel involved in training participate in EMS users groups, simulator training programs, and meetings with MISO and PJM neighboring reliability organizations to improve their skills and knowledge. FE's control center is a NERC-approved continuing education provider.

The evaluation team notes as a positive observation the overall development and delivery of the training program, including the comprehensive courses and training exercises provided, the integration of the training simulator in the courses, the process used to keep the program current, and the management overview of the entire training process.

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.

FE undertakes a range of operational self-assessments and coordination reviews with the goal of enhancing operator performance and effectiveness. Within the system operations area, gap analysis evaluations are conducted to improve operator effectiveness and training. The system operations and transmission planning and protection departments review relay events and misoperations individually and initiate corrective actions as required. Switching errors are reviewed through a switching audit procedure and root cause analysis process designed to improve the reliability and safety associated with operators' actions. Reviews are also undertaken following equipment failures to determine underlying causes and necessary operating actions required during any interim period.

The system operations group routinely conducts joint operational and emergency drills with the Regional Transmission Organizations (RTOs), which lead to self-assessment reviews and improvement of existing procedures and coordination processes. Situational training is conducted on the Dispatcher Training Stimulator (DTS), leading to self-assessment and improvements in operating procedures and training. Self-initiated reviews of operating events, contributing conditions, and experiences are conducted to improve situational awareness and operating capabilities.

Overall, these self-assessments and resulting actions provide an interactive form of feedback among the affected internal groups that improve operational, reliability, and safety performance. In addition, regional directors hold frequent meetings at which operational and other assessment aspects, along with resulting implementation initiatives, are reviewed for broader implementation across FE. Finally, senior management conducts quarterly operational performance review

meetings with operation managers and supervisors to address system reliability assessments, performance, and effectiveness of implementing assessment results.

FE risk analysis and decision process for evaluating the impacts of system reliability issues are integrated and consider the time period of interest. In the operating environment, protocols and procedures govern the operators' approach to making critical decisions regarding system reliability and are reinforced through training programs, such as DTS scenarios.
FE participates in various external benchmarking initiatives. Among these is the SGS Consulting initiative, in which roughly 50 percent of the U.S. utilities participate in transmission benchmarking to gain insight into transmission system performance and underlying causes for that performance. One major aspect of this initiative addresses transmission outage performance, which is linked to the FE's individual and group performance objectives for incentive compensation purposes.

FE conducts internal benchmarking and associated metrics analyses on monthly and quarterly basis. The operational business units are primarily responsible for implementing any initiatives that result from these evaluations. A number of these performance results are also linked to individual employees' incentive compensation program to further enhance the accountability for the results. The FE FERC Compliance and Policy group monitors and facilitates operational improvement initiatives through the business units. The compliance and operational excellence software management tool (Catsweb by AssurX) is being implemented to drive overall reliability and operational performance improvement. This tool will also support an INPO-style corrective action program with self-assessment modules as well as formalized root-cause elements.

FE has been a leading participant in various industry reliability-centered programs. As a charter member, FE directly contributed to the development of the Transmission Owner/Operator Forum launched in late 2006 with the objective of sharing and implementing best practices. This program is styled after the INPO model of providing a comprehensive forum for identifying and sharing best practices. FE, MISO, and PJM have executed a memorandum of understanding that provides a forum to periodically review and compare operating performance, and to implement reliability and operating performance initiatives. This has resulted in the development of a joint operating procedure to address the interface operations between these entities near the Ohio, Pennsylvania, and New York borders.

Recommendations Update — August 14, 2003 Blackout

Report on the Implementation of Recommendations from the FirstEnergy Readiness Audit of February 26–27, 2004

BACKGROUND:

On February 26 and 27, 2004, NERC conducted a readiness audit of the FE control area. The readiness audit team that conducted the audit identified a total of 44 recommendations, which are contained in the FE audit report, *NERC Control Area Readiness Audit for FirstEnergy — February 26–27, 2004*.

Subsequent to the 2004 audit, NERC established the FE Verification Team (FEVT) to independently verify that FE had implemented the policies, procedures, and actions contained in recommendations 27–33 in the FE readiness audit report. The FEVT consisted of five subject-matter experts and two NERC representatives. On June 22–23, 2005, the FEVT team returned to verify that FE had implemented recommendations 27–33. During that verification, recommendations were closed out with the exception of recommendations 29 and 33.

In 2005, the FEVT returned to verify the progress made on recommendation 29, which dealt with FE's position that it updates generator model information when test information shows a difference between original characteristics and actual performance. FE also stated that it did not use disturbance monitoring equipment to update models. The audit team suggested FE review this practice and use actual disturbance information to update its models.

During the 2005 meeting, the FEVT also reviewed FE's progress on recommendation 33, which concerned the dependence of FE's EMS/SCADA communications front-end processors (FEPs) and remote terminal unit (RTU) communications on a single point of convergence at the primary control center location. FE committed to explore options to alleviate this FEP location dependency, with a goal of having each of its primary and backup FEP pairs physically separated from each other (with subsequent duplicated RTU communication paths) at different company facilities. FE also committed to having the first 54 "most operationally critical RTUs" communicating to somewhere other than the primary control center location in 2006. In addition, a commitment was made to transfer the remaining bulk transmission RTUs to this FEP diversity project.

In April 2007, the evaluation team reviewed recommendation 29 and a sub-set of the original FEVT, including the FEP subject matter expert, returned to FE to verify the work that had been completed since the 2005 visit on recommendations 29 and 33.

OBSERVATIONS — Recommendation 29:

FE's approach to benchmarking generator model data is to perform actual generator testing using a program similar to that required by WECC. In 2006, FE worked with a vendor to develop a procedure based on the WECC generator testing system. FE has developed a generator test program, entitled *Synchronous Generating Unit Testing and Modeling Requirements*, which defines the roles, responsibilities, and testing requirements. FE's generation subsidiary has

formally agreed to meet all the requirements detailed in this document. FE is currently in the process of working to expand this program to include the independent power producers (IPPs) within its footprint.

FE is also using disturbance monitoring equipment to supplement the results obtained through the generator testing program. FE is investigating and verifying 1) whether disturbance monitoring adequately fills-in gaps in testing data and 2) if the accuracy of dynamic parameters derived through disturbance monitoring is on-par with that of generator testing or direct calculation. FE has written a procedure, "Process of Analyzing Events to Validate Models," for comparing disturbance recordings with simulations after a generator or significant transmission element trips in order to validate the system model. The details of this procedure are still being developed, and since most of FE's disturbance recorders are monitoring transmission elements, it is expected that the dynamic model validations will be more on higher transmission levels rather than on specific distribution loads and generators. FE has 16 disturbance recorders installed in the MISO footprint.

FE currently uses digital fault recorders and digital relays to estimate fault locations based on the recordings and short circuit studies. When a fault is located, the actual and estimated locations are compared. If the locations are significantly different (typically greater than 10 miles for double-ended estimates), FE investigates the cause of the error in order to improve the system model. The model in the faulted area is considered validated if the locations match.

In addition, FE is supporting projects such as the EPRI Solutions Synchronous Generator Testing and Model Validation program and is sponsoring the EPRI Power System Load Modeling Phase 2 project to develop methods for estimating load models from measurement data.

CONCLUSION — Recommendation 29:

Based on discussions with the FE planning staff, a review of the work they have been performing, the testing program, and the use of disturbance data in an attempt to fill in the gaps, the FEVT closed recommendation 29. The readiness evaluation team recognizes the effort FE has put into the development of the generation testing program as a positive observation and notes that that FE should consider developing a contract with the IPPs in its footprint, similar to the agreement between FE's system operations and FE's generation subsidiary, for the testing of the IPPs' generators.

OBSERVATIONS — Recommendation 33:

In 2005, FE embarked on a solution to create geographic diversity for its FEP server pairs to address the single point of failure and improve EMS availability. In high-availability EMS architecture, pairs of FEP servers are employed to allow automatic failover to the parallel server in the event that the first server fails. Although this provides redundancy of components, most utilities co-locate FEP pairs because analog technology requires an audio bridge to split the signal. The proximity of the redundant communications hardware creates additional risk. Some companies solve this problem by dual-porting RTUs to send independent signals to two diverse locations. This process involves two sets of circuits and requires ports to be available at the substation RTU, but these ports are often unavailable since they are used to send data to the

reliability coordinator and neighboring utilities. Additionally, dual porting retains the outmoded analog circuitry, which creates additional complexity and maintenance issues.

FE's FEP diversification project reconfigures the FEP architecture to support digital communications to critical substations, interconnections, and power plants. This allows for the parallel FEP servers to exist at different physical locations, eliminating dependency on any single facility. It also increases flexibility, since the FEPs can be located anywhere on the EMS network.

The key interface hardware consists of a substation-hardened all-in-one industrial frame router, which is both ANSI-C37 and IEC-61850 compliant. Frame relay technology and logically separated private virtual circuits are used to provide enhanced security and improved communications circuit reliability compared to analog circuits. The solution also allows for Simple Network Management Protocol alarming through FE's Enterprise System Management monitoring system.

FE's solution required no EMS software modification and only minimal database changes. The company was able to keep the serial-connected FEP ports and serial-connected RTUs, which maintained both simplicity and security in the new design. The design, prototype, and pilot project occurred in the third and fourth quarters of 2005. After extensive proof-of-concept testing in its quality assurance environment, FE began rolling out the solution to its bulk transmission RTUs in 2006. FE expects all of the bulk transmission RTUs to be fully diversified by the end of 2007.

In addition to increased availability, the communications architecture can be leveraged for other operational uses. For example, support for a variable RTU speed provides FE with future flexibility regarding the amount of data that can be brought back from the substation, which positions the corporation for future substation integration and automation.

CONCLUSION — Recommendation 33

FE has fulfilled its commitment of having the first 54 "most operationally critical RTUs" communicating to a FEP remotely located from the primary control center by the end of 2006. The design, prototype, and pilot project occurred in the third and fourth quarters of 2005. After extensive proof-of-concept testing in its quality assurance environment, FE began rolling out the solution to its bulk transmission RTUs in 2006. FE expects all of the bulk transmission RTUs to be fully diversified by the end of 2007.

The FEVT and the evaluation team agree that recommendation 33 has been completed. In addition, the FEVT and the evaluation team recognize FE's innovative use of technology to improve reliability of the systems used to monitor and control the bulk power system as a potential example of excellence.

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 organization only and will not be included within the public version of the report.