

# NERC

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

## Reliability Readiness Evaluation Report Balancing Authority/Transmission Operator

Southern Company  
Birmingham, Alabama

to ensure  
the reliability of the  
bulk power system

**November 12–15, 2007**

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# Table of Contents

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Introduction and Evaluation Process .....	1
Evaluation Team .....	1
Organization Profile.....	2
Executive Summary .....	3
Positive Observations.....	4
Recommendations.....	4
Discussion.....	6
1. Culture.....	6
1.1 General.....	6
1.2 Organizational Effectiveness .....	7
1.2.1 Foundation for System Reliability .....	7
1.2.2 Leadership and Management .....	7
1.2.3 Corporate Oversight and Monitoring.....	8
1.2.4 Human Resources .....	8
1.2.5 Corporate Communications .....	9
2. Fundamentals of Operations .....	9
2.1 General.....	9
2.2 Operational Focus .....	11
2.2.1 Operational Safety .....	11
2.2.2 Operational Decision-Making.....	11
2.2.3 Operational Alignment.....	12
2.3 Managing System Configuration .....	12
2.4 Emergency Preparedness .....	14
3. Fundamentals of Maintenance .....	15
3.1 General.....	15
3.2 Equipment Reliability .....	15
3.2.1 Equipment Performance.....	15
3.2.2 Work Management.....	16
4. Fundamentals of Operational Planning.....	16
5. Fundamentals of Training.....	17
5.1 General.....	17
5.2 Organizational Effectiveness .....	20
5.2.1 Human Performance .....	20
APPENDIX 1: Critical Infrastructure.....	21
APPENDIX 2: Entity Participants.....	22
APPENDIX 3: Documents Reviewed .....	23

## 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 Southern Company (Southern) representatives on November 12–15, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of Southern to meet its responsibilities as a balancing authority/transmission operator.

## Evaluation Team

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## Organization Profile

Southern Company is one of the largest utilities in the United States, covering most of Georgia and Alabama, the Florida Panhandle, and the southeast portion of Mississippi. The primary balancing authority and transmission operator functions are performed by the Southern Company Services subsidiary at its Power Coordination Center. Southern Company has four operating company subsidiaries — Georgia Power Company, Alabama Power Company, Gulf Power Company, and Mississippi Power Company — that serve more than 4.3 million retail customers.

Southern coordinates system monitoring between the Power Control Center and the transmission control centers at each of the operating companies. Balancing authority functions are primarily performed at the Power Control Center along with reliability coordinator functions, load and generation balancing, interchange scheduling, outage approval, and line monitoring functions. The Power Coordination Center operators focus on reliability of the overall system and do not actually operate equipment. Operators at the transmission control centers are more involved in outage maintenance, actual operation of equipment, switching, and restoration.

Southern monitors the transmission system at several levels. The four operating companies monitor the transmission system at their respective transmission control centers, originate outage requests, and perform initial outage evaluations. The transmission system is monitored at a higher level at the Power Coordination center. The reliability coordinator is the final level of system monitoring.

Southern Services Company controls 12,628 miles of 115 & 161 kV; 5,333 miles of 230 kV; and 1,532 miles of 500 kV lines. It has 57 ties with 13 neighboring balancing authorities. Southern has 45,000 MW of capacity: 47% coal, 22% gas combined cycle, 11% gas turbines, 8% hydro, 10% nuclear, and 2% oil. Southern is a summer-peaking area with an all-time peak of 48,008 MW on August 22, 2007.

The transmission owners in Georgia have unified the state's transmission system under the Georgia Integrated Transmission System and developed an agreement to have Georgia Power Company serve as the system operator. The other transmission owners include the City of Dalton, the Municipal Electric Authority of Georgia, and Georgia Transmission Corporation.

This evaluation includes the operations at the Power Coordination Center and the Southern Company transmission control centers. The evaluations team visited the Georgia Transmission Control Center but did not visit the Georgia Power backup center or interview its planners or trainers. Southern provides reliability coordination for the area, but the reliability coordinator function is not included in this evaluation.

## Executive Summary

The evaluation team found no significant operational problems and concluded that Southern 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.

The evaluation team found that Southern performs all the balancing authority and transmission operator functions with a high degree of competence towards maintaining system integrity. A culture of placing reliability and safety first is ingrained in the employees at all levels of the organization. The evaluation team finds that commitment to reliability is reflected in the employee attitudes, company procedures, and the equipment supplied to the operators.

Southern has a culture of continuous improvement and has been an innovator in the electric industry. The company developed one of the first automated control systems, the first state estimator, and are developing a real-time stability analysis. Southern has representatives on most of the committees of NERC and the SERC Reliability Corporation (SERC) as it helps set the direction of future reliability initiatives.

The Southern energy management system (EMS) has the necessary functions, including a near-real-time stability analysis. The EMS is networked with the systems at the five control centers, allowing the control centers to use the same tools with identical data to provide consistent system views and study results. Southern has several different operators at separate control centers observing the electrical system from different vantage points to help ensure that the system is operated reliably. Southern has a robust data and voice communications system that includes access to its radio and cellular phones system.

Southern has a comprehensive training program with several dispatcher training simulators for the operating companies. Southern has training time built into its shift schedule, and the training program is planned in advance so that the staff can plan to complete the training activities. Southern has reviewed its future staffing needs and has added trainees to its operating staff to prepare for anticipated vacancies. Southern also provides an electrical system restoration drill for all the operators in the Southern subregion of SERC.

The evaluation team recommends improvements in the areas of shift turnover, documentation, and backup capabilities. In cooperation with Southern, the team labeled the use of a shift-turnover checklist as well as the update of the blackstart unit list to include primary and backup fuel sources as key recommendations. The operators cannot operate from the backup control center EMS without significant interruption of the operating control system. Southern is replacing the EMS with a system that will resolve this problem.

Overall, the evaluation team identified 12 positive observations. In addition, the team offers 6 recommendations that, if implemented, will enhance Southern's readiness to operate more 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. The Southern EMS includes real-time data for transient security assessment for support engineer review (Sections 1.1, 1.2, and 4).
2. Southern is hiring operators ahead of anticipated vacancies to allow time for initial and advanced training (Sections 1.2.4 and 5.1).
3. Southern has an open communications environment that allows issues to be discussed among all organizational levels and gives all staff an opportunity to provide input into company decisions (Sections 1.1 and 1.2.5)
4. Southern has a designated training staff with 14 trainers at the various operating companies, and each operating company has a simulator tailored to its needs (Section 5.1).
5. Southern was instrumental in establishing an industry organization to develop benchmarking measurements and data and uses the benchmarks to evaluate its operations (Section 1.2.3).
6. Southern participates extensively in the NERC and SERC organizations (Section 1.1).
7. Confidential information on computer and communications support redacted from public report. See discussion in Appendix 1.
8. The EMS includes a flag to put the electrical system in conservative operations when the electrical system is stressed, and the system sends a message to the entire company to curtail operations that affect reliability (Section 3.1).
9. Southern has complete documentation related to operating policies and procedures readily available for the system operators (Section 2.2.3).
10. Confidential information on communications redacted from public report. See discussion in Appendix 1.
11. Southern leads subregional restoration drills, including a tabletop exercise at the Southern office and a wide-area drill with operators participating from their own control rooms (Sections 2.4 and 5.1).
12. The training staff develops a full training schedule during the prior year, which is early enough for the staff to plan around, to ensure high participation (Section 5.1).

## Recommendations

The evaluation team offers the following recommendations:

1. Confidential information on plans for loss of control facilities redacted from public report. See discussion in Appendix 1.
2. Require the use of a shift-turnover report and checklist to highlight significant operational conditions and planned activities to the oncoming operator to ensure uniform and complete transfer of information (Section 2.2.3).\*

3. Add operator-action and response-time measurements to simulator training exercises to help develop more consistent operation responses for resolving contingency violations (Section 2.2.2).\*
4. Add an annual class on human performance into operator training to help develop error prevention skills (Section 5.2.1).
5. Update the blackstart unit list to include primary and backup fuel sources so operators are fully aware of options available during an emergency (Section 2.4).\*
6. Maintain initial training records for operator training to the same level of detail as the current continuing education records for experienced operators to ensure the trainees successfully complete all necessary training activities (Section 5.1).

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

## Discussion

The reliability readiness evaluation team examined the following key areas during the evaluation. The detailed discussion that follows provides the foundation for the recommendations and positive observations 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.*

As an organization, Southern puts a high value on safety and reliability. The Southern mission statement sets expectations for operating the transmission system to the highest standards. Southern has also developed a philosophy statement titled *SouthernStyle* that reinforces its corporate principles of unquestionable trust, superior performance, and total commitment.

Southern management has put an emphasis on encouraging open communication. The evaluation team found the operating staff members believe they could take an issue to any organizational level necessary, including the top management of the operating organization. The Southern culture encourages two-way communication throughout all levels of the organization, and the staff feels it has input into Southern’s future plans.

Organizational goals are formed with input from all staff, and individual goals are tailored to align with the organization goals. This coordinated process results in each staff member providing input for setting individual goals that contribute to achieving corporate goals. The evaluation team commends Southern for its open communications of issues between management and staff.

Southern encourages peer feedback from operators and planners to pursue operating excellence. Operators provide feedback during staff meetings and after reviewing operating procedures. Operators and planners perform peer reviews of operations and suggest improvements. Planners attend two operations meetings yearly.

Southern provides the operators with the tools, training, and systems necessary for reliable operations. Southern has always been an innovator in the electric industry, developing one of the first automated control systems and the first state estimator. The company is currently developing a real-time stability analysis.

Southern has extensive participation in NERC and SERC as well as other industry organizations. Southern has representation on just about every NERC and SERC committee, subcommittee, and working group. The evaluation team commends Southern for providing this industry leadership.

For questionnaires sent by NERC for this evaluation, neighboring balancing authorities and transmission operators responded positively, with no concerns, regarding Southern operations. All respondents indicated that Southern operators are knowledgeable, helpful in resolving system problems, and professional.

### **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.*

The company mission statement and *SouthernStyle* document reinforce the attitudes that make safety and reliability Southern's most important objectives. The evaluation team found that the employees interviewed have adopted the concepts of the *SouthernStyle*. When managers were asked about *SouthernStyle*, they indicated the statements actually reflect the attitude of the employees rather than leading the employee attitudes.

Southern has a bonus structure dependant on achieving its well-defined corporate, team, and personnel goals.

#### **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.*

Corporate goals and objectives put reliability first, and policies and procedures support the reliability goals. The corporate goals and progress in meeting those goals are reviewed in monthly staff meetings, in the monthly company newsletter titled *Southern Highlights*, and the annual internal transmission report.

Performance appraisals include individual improvement goals, such as training, and goals that are linked to corporate goals. Staff goals are developed from a gap review to determine individual needs. Southern reviews performance goals semiannually. Merit pay is based on how employees meet goals, and the operators interviewed stated that good performance is recognized and rewarded by Southern.

A high level of trust has been developed by emphasizing open communication. Southern forms system operator teams to provide input on various operator issues such as shift schedules, control room layout, and control room equipment. Management listens to and acts upon the views of the operating staff; the operating staff, in turn, understands, appreciates, and works towards meeting organizational goals, fostering a spirit of teamwork and cooperation.

### 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.*

Management has established clear objectives and communicates those objectives and corporate progress on them regularly. Individual contributions to company goals are regularly reviewed in the appraisal process.

Each of the four Southern operating companies has a separate organization and somewhat independent operation. Southern measures each operating company's performance against the others and against its own past year's performance. Southern has developed transmission versions of the commonly used distribution indices, the System Average Interruption Duration Index and the System Average Interruption Frequency Index. These performance measurements are used to improve the operation of each of the companies. Southern was instrumental in establishing an industry group of 37 utility companies that establishes operating benchmarks and Southern uses those benchmarks to measure its performance. The evaluation team commends Southern for its efforts to compare subsidiary performance, compare current to past performance, and to measure its operations against the benchmarks established by the industry group to which it belongs.

The benchmarking studies found the Southern training staff to be smaller than other similar-sized utilities. As a result, Southern has increased the size of its training staffs at the various operating companies. Southern also conducts customer satisfaction surveys. Southern has considered the results of the benchmarking comparisons and the customer satisfaction surveys to help prioritize reliability efforts.

Southern analyzes any incident on the system to improve future operations. Lessons learned are incorporated into company training and in the desk and floor meetings.

### 1.2.4 Human Resources

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

Southern has taken aggressive action to develop employees for anticipated attrition. The company staffs and trains for positions prior to the loss of employees and has a business goal of filling positions 18 months prior to the vacancy; the evaluation team commends Southern for this practice. Southern is training personnel for the entry operating position while using available training time to prepare existing operators for other positions in the control room. To reach the highest pay grade within the operations, the operators must qualify for three of the operating positions. This policy encourages the operators to cross-train, providing Southern flexibility in filling positions.

Southern is working with universities within its area to develop power engineering programs. Southern believes that finding operators and engineers with a power background will be difficult

when they need to add staff or replace employees who leave the company. Southern has provided \$2 million in endowments to help finance power engineering programs.

Management stated that Southern has detailed succession plans for the higher levels of the organization, while potential operator needs are met by cross training and acquiring staff for anticipated attrition.

### **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.*

Southern communicates with its operating staff using many formats. Comprehensive quarterly operating meetings include reliability issues. The planners are invited twice each year to discuss the seasonal study results for the upcoming period. The bulk power operations group holds quarterly meetings to review reliability needs and lessons learned.

Several corporate publications include reliability. The monthly newsletter, *Southern Highlights*, often focuses on the company mission statement and reliability improvement transmission projects. The chief transmission officer sends a weekly newsletter to the operating staff. Southern also develops an annual internal transmission report that focuses on the performance of transmission operations; report topics include progress on goals and information on other transmission-related events.

For the past two years, Southern has used an internal feedback process through its upward assessment company survey. Southern had high employee participation, with 80 percent of the employees completing the survey. Responses on company communications questions led a director to develop a process to improve communications. For example, corporate executives visit the operators in the control room and discuss professional and personal issues. The evaluation team found this process effective; because the director made an effort to improve communications, the operators felt that their voices were heard.

## **2. Fundamentals of Operations**

### **2.1 General**

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

Southern's up-to-date EMS monitors the necessary system parameters, such real and reactive power generation, real and reactive line flows, voltages, and frequency. The EMS has adequate data points to monitor the Southern system and monitors two buses into the neighboring transmission systems.

The EMS has alarming and a full suite of advanced applications. The EMS is a vendor-standard design with significant enhancements made by the Southern computer support staff. Southern has the source code for the EMS, enabling improved maintenance support and flexibility in developing custom applications. The Power Control Center and all the transmission control

centers use the same EMS platform, and updates and revised system ratings are automatically transferred between systems. All Southern control centers use the same tools and see the same data. This eliminates the confusion caused by different data or different study results.

The alarm function prioritizes the alarms to allow the operators to react to the highest priority alarms first. The operators interviewed were unsure of how the alarm priorities were determined and assigned. The alarm system alerts operators when alarm points become inactive, and the System Operations Center monitors the health of the alarm function around-the-clock.

The Power Control Center operators use the EMS to monitor the voltage on all 115 kV and above transmission lines, while the transmission control centers monitor voltages above 46 kV. Each transmission element is alarmed when it exceeds the predetermined high or low voltage values. The acceptable voltage range is generally determined by nominal voltage, but specific areas may have a voltage range determined by planning studies. The operators have a power quality guide for each nuclear plant. The plant's voltage is set by the *Nuclear Plant Procedures BPO-2*. Voltage schedules are provided to all power plants above a minimum size, including independent power producers, and the interconnection agreements specify the plant requirements to meet the voltage schedules. Southern receives the status of the generator automatic voltage regulators and power system stabilizers where required. The operators enter changes to the status of the automatic voltage regulators in the EMS for use with advanced applications.

Southern monitors the required power reserves and takes action to restore acceptable reserve levels when shortages are identified. Southern carried adequate operating reserves during the evaluation period, and operations staff indicated adequate reserves are routinely maintained. While the electric system peak increased by 6.9 percent this year, Southern reserves were adequate, and no capacity emergency action was required.

Southern monitors reactive reserves. In response to a specific local concern, Southern has developed the Fault Induced Delayed Voltage Recovery program to evaluate available dynamic reactive reserves within that area. To ensure the area has adequate dynamic reactive reserve capacity to maintain stability, the operators commit generation as indicated by the program. The contingency analysis determines post-contingency voltages and alarms on low voltages. The generation agreement for connecting to the Southern system includes minimum reactive generation requirements and voltage schedule standards.

The operator has available a tabular and graphical display of 32 geographically distributed frequency points that are considered sufficient to monitor for islanding conditions within the footprint. Southern has a primary and backup frequency monitor for automatic generation control and a third point at the backup control center. The underfrequency load-shedding program exceeds regional requirements. The system operators know the setpoints and percentage of load shed by the automatic underfrequency load shedding. System operators were familiar with approximate frequency of the generator underfrequency trip set points and time delays within the footprint.

Southern has a standard of conduct and has signed the NERC confidentiality agreement. The system operators act independently of market participants and understand their role to maintain system integrity above economic influences.

### **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.*

Reliability and safety are the highest priority goals at Southern. As it does with all meetings, Southern started the readiness evaluation introduction with a safety discussion. Southern has a “Target Zero” safety goal initiative that is actively embraced by the system operators and operating staff.

Southern has four special protection systems within its footprint, and the operators are trained on the purpose and operation of each. In response to evaluation questions, the operators were familiar with the systems and aware of their status. Procedures require operating companies to notify the Power Control Center of any special protection system change.

#### **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 operators’ responsibilities are well understood. Southern has several levels reviewing current and day-ahead operations — the first is the system transmission operator and the second is the security operator, both located at the transmission control center. The system operator at the Power Control Center coordinates and reviews all transmission operations, and finally the reliability coordinator can review and postpone any operation. Each of these positions reviews the operation from a different perspective. The responsibilities are documented and understood by each of the operators. These multiple levels of review enhance reliability.

During interviews, the evaluation team found that the operators responded to the same situations differently. The operators interviewed indicated differing views of the triggers for developing remedial actions or mitigation plans for certain contingency violations. While the evaluation team recognizes that all responses will not be identical, it believes that the Southern operators should provide a more consistent response. The evaluation team recommends that Southern add operator-action and response-time measurements to simulator exercises to review the responses to contingency violations.

Southern has formed a Bulk Power Operations Group to provide coordination among the operating groups within Southern. The managers of the control centers are the members of this group, and all operating companies are represented. The group, which holds monthly meetings, discusses operational issues and serves as a forum to discuss larger joint issues, such as the requirements of the new EMS. The group helps ensure that the staff members understand their responsibilities and how to interface with the rest of the organization. Lessons learned in one

area would be reviewed by the Bulk Power Operations Group to use in other areas if applicable. The Bulk Power Operations Group resolves differences that arise between the operating groups.

### **2.2.3 Operational Alignment**

*Organizational structure supports safe and reliable system operation.*

Each of the operators at the Power Control Center and the transmission control centers has the appropriate authority; the operators understand that they not only have the authority to direct operations, but the obligation to do so. The operator authority was documented in each of the job descriptions, and an authority memorandum to the operators was posted at both the Power Control Center primary and backup control centers. An appropriate memorandum was also available at the Georgia Transmission Control Center.

Southern has complete and well-organized policies and procedures that are easily available to the operators. The evaluation team commends Southern for its complete, readily accessible documentation. Some of the documentation was not dated, but Southern is in the process of putting its documentation into an automated document control program. The format of the document control system will require a uniform format, approvals, proper updates, and dating of all documentation. The system will also keep a revision history of document revisions. The document control system will provide Southern with better electronic organization and document control. Documents on the system will be available at all control centers.

Southern has appropriate agreements with companies for which it is performing balancing authority and transmission operations services. Agreements with the generation owners include contract language regarding rights to request reactive power, voltage control, and power output from the plant during an emergency.

Southern has appropriate and documented outage coordination and communications procedures. Generation outages are communicated through the Southern GENComm communication system.

Southern has a detailed shift-turnover checklist, but operators are not required to use it. The evaluation team recommends that Southern require uniform documentation for the shift-turnover process to highlight important information for the next operator.

### **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 EMS has a complete suite of advanced applications, including two contingency analysis programs. The vendor program, referred to as power network analysis, is used for real-time contingency analysis. This program has predefined set of contingencies that include some double and triple contingencies. The program takes about two minutes to run and is run approximately every seven minutes. The operators cannot change the contingency list, but EMS support is available at any time to update the contingency list if necessary. This program can

also use a saved case of previous electrical system conditions for studies. The load, generation, line outages, and forecast can easily be varied to study different conditions. Southern also uses a company-developed contingency program referred to as the off-line power network analysis. This program runs all single contingencies approximately every eight minutes. This program can use the real-time saved case or any other data set for studies.

The contingency analysis programs run off the state estimator. The state estimator runs every six to seven minutes. Southern has decided not to allow the operators to run additional state estimator cases. Southern believes that running an extra state estimator case may interrupt the needed scheduled run.

When necessary, Southern uses local procedures to bring line limits within contingency ratings. Local procedures generally involve generator re-dispatch, but can also involve transmission system reconfiguration. While Southern seldom initiates the NERC transmission line loading relief process, it does respond when it has schedules impacted by line loading relief called by other reliability coordinators.

Southern has the standard trending package. The system monitors reactive power and alarms when reactive power is not adequate to maintain voltage after a contingency.

Southern operates an EMS at the Power Coordination Center and each of the transmission control centers. These systems are operated on a distributed system, and updates are automatically moved to all systems. Local transmission centers set line limits, but these are automatically propagated to the other systems. On many of its lines, Southern uses dynamic ratings based on actual temperatures from either remote readings or weather-service information. Forecasted temperatures are used to determine ratings for future cases. All actual and forecasted temperatures are automatically inputted to the EMS.

All elements are evaluated in its contingency analysis programs, and the operators will evaluate any contingency overload. The display at the Georgia Transmission Control Center showed contingency violations for which the operators developed post-contingency plans. These were lower voltage lines in remote areas of the Southern system. Major lines are documented in operations procedure BPO-31. The system operators would send substation operators to these facilities for the loss of the primary control facility. Southern does not have a list of critical facilities. Southern uses the real-time contingency analysis programs to evaluate the contingencies as they occur and then determines if any are an IROL, defined by Southern as an event that spreads past Southern boundaries. This definition is not consistent with the NERC IROL definition.

Southern uses the vendor-standard automatic generations control to balance load and generation. Southern operates the four operating companies as a single control area from the Power Control Center. Southern is participating in the NERC Balancing Authority ACE Limit field trial for load balancing.

Southern developed a near-real-time stability analysis tool that runs about once per hour from the real-time data saved case. The evaluation team commends Southern for developing this innovative program.

Southern has added large video displays in the Power Control Center to provide a wide-area display. Several company-developed displays show parameters such as voltage, real or reactive line flows, and frequency points. The Georgia Transmission Control Center also has large dynamic displays.

The operators demonstrated available tools as requested by the evaluation team and were familiar with all of them.

### **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.*

Southern has the necessary emergency plans. The plans are well documented, and the operators are familiar with them. The responsibilities between the Power Control Center and the transmission control centers are documented and understood.

The load reduction plan is included in *System Alert Procedures — BPO-16*, which includes the procedures the evaluation team requested to review. The system operators at the Power Control Center would decide on the capacity and energy emergency plan, but the operators at the transmission control centers would actually implement the plan. The transmission control centers have a display to implement manual load reduction. The operator can specify an amount to be shed; the system will allocate the load shedding, or the operator can select specific loads if the location is critical. The plan also has voltage reduction. An operation planning evaluates the automatic underfrequency load shedding every five years and coordinates the load shedding with other utilities in SERC. The manual load shedding and automatic load shedding overlap, but the operators are aware of the overlap.

Southern has system restoration plans. The transmission control centers begin the restoration plan by starting blackstart units and adding load. The Power Control Center is responsible for adding transmission and tying electrical islands together. Though the responsibilities are divided between the Power Control Center and the transmission control centers, they are well documented and understood by the operators.

In reviewing the blackstart documentation, the evaluation team found that only the primary fuel was listed for blackstart and quick-start units. During a system emergency, the availability of alternate fuel types may be important information. The evaluation team recommends that Southern list both the primary and alternate fuels in the documentation for its blackstart units.

Southern has developed restoration drills for all the companies in the Southern subregion of SERC. For one drill, the companies sent operators to the Southern office for a large tabletop restoration exercise. The Southern training staff developed a restoration scenario, and the operators went through the steps to put the electrical system back together. Each company had

mock communications with neighboring operators. To add realism, the second drill was conducted with the operators participating from their own control rooms. Again, the Southern training staff developed scenarios, but this time added unexpected events, such as blackstart units not starting and lines not closing. The evaluation team commends Southern for developing and leading these restoration drills, which were praised by participants. The training staff is planning a future restoration drill that will use the simulators at each of the Southern control centers and other centers if available. The new computer system will facilitate this plan.

The operators are aware of nuclear power plant requirements. The contingency analysis evaluates the special voltage requirements of the nuclear plants, but Southern does not have the nuclear plant configurations and related parameters or requirements outlined on separate displays. Such displays may be useful for tracking the status of parameters critical to the nuclear plants and providing increased situational awareness to the system operators.

### 3. Fundamentals of Maintenance

#### 3.1 General

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

The system operators and operations planning staff review next-day and current-day outages prior to the start of the outages. The operators can delay the outage if it impacts system reliability. For example, outages were delayed during an extended period of hot weather this past summer. Operators can set a flag on the EMS to declare a moratorium on line work, including relays and control systems, when the security of the bulk power system could be at risk — during periods of high loading, large energy transfers, severe weather, or other system conditions. The evaluation team commends Southern for developing the EMS tool and procedure to assist the system operators in maintaining a secure system state when conditions require conservative operations.

Transmission line and relay protection work projects are scheduled and monitored. All transmission system trips are analyzed, and corrective actions are taken for any misoperation. Southern has an adequate number of disturbance monitors, and all are time-synchronized with a global time stamp.

#### 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 Southern system is designed to operate within equipment ratings under all conditions. Southern participates in a spare transformer consortium to share transformers with the members for the group.

The operators stated that the EMS is seldom down; availability is 99.945 percent.

### 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.*

The operators report equipment problems to the EMS Support Center, which is staffed at all times. The information technology staff there completes tracking logs for repairs and improvements. The logs, available to all staff, are reviewed to detect common problems or equipment that is developing a high repair rate. Operators are informed of any changes being made to the EMS.

## 4. Fundamentals of Operational Planning

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

The Southern planners complete studies with SERC's Intra-Regional Near-Term Study Group to establish the available transfer capability limits of its transmission paths while maintaining system integrity. From the regional model, Southern develops 13 monthly planning models to be used for outage evaluation and Open Access Same-time Information System, or OASIS, posting.

The system planning group also runs a summer assessment and identifies any issues for the upcoming peak season. Procedures are developed for the identified potential problem contingencies and shared with the operators. The operators evaluate the actual system conditions, consider the redeveloped plan, and take appropriate action based on current conditions and contingency analysis studies.

The operational planner completes the day-ahead study using the offline power network analysis program and the model from the summer assessment. Equipment ratings are adjusted for the temperature forecast. Planners input the expected system configuration into a case that is similar to the expected weather and load pattern for the period to be studied. If a real-time case is captured for use as the base case, the operational planner then adjusts the loading for the expected peak or for the expected conditions for the time being studied. If the operational planner finds a problem, the system operator will resolve it.

The planners completed a comprehensive review of the electrical system and reactive support requirements. Without enough dynamic reactive reserve available, the Atlanta area can experience post-contingency voltage problems. The planners studied a slow voltage recovery after a fault and developed a program titled Fault Induced Delayed Voltage Recovery to evaluate dynamic reactive availability. The operators use this program to maintain adequate dynamic reactive power reserves.

Southern has also implemented an online transient stability analysis program. The program uses a snapshot of the real-time system and runs the stability analysis approximately hourly. The team commends Southern for developing this online stability analysis; Southern is ahead of most other transmission operators in using this application.

Southern procedures ensure it receives all the necessary data for planning studies from generators, including independent power producers.

## 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.*

Southern has an extensive training program with a designated training staff. In addition to the training staff and simulator for the Power Control Center, each of the four operating companies has a training staff and simulator for its control center. Southern has approximately 14 staff performing training at the various control centers. While each simulator is driven off the same EMS platform, each has a different view with scenarios developed for the specific requirements of that control center. The evaluation team commends Southern for committing the training resources with a staff and simulator at each subsidiary.

As a NERC-approved continuing education provider, Southern offers NERC-approved continuing education learning activities.

Southern has developed an internal training program for new system operator candidates. The preparation for a new operator includes both classroom and on-the-job training, beginning with a one-week orientation program on power system basics. The trainee is given a course on the NERC standards to prepare for the certification exam. Southern has a detailed checklist for each of the three control room positions requiring NERC certification. Class time includes simulator exercises to verify that the candidate can properly respond to abnormal operating conditions.

After the trainee has completed the necessary training and feels ready to assume independent shift operation, a team including the supervisor, a training staff member, and a senior operator interviews the trainee to make a final determination. The team questions the trainee on all aspects of operation and the response to hypothetical operating conditions. If the operator successfully completes this interview, the he or she can begin independent shift operation. During the operator's initial shifts, Southern provides on-call staff to provide assistance if needed.

Most continuing education activities are developed by the Southern training staff using the formalized ADDIE (analyze, develop, design, implement, and evaluate) approach. Each year, the training department reviews past practice and the upcoming year to determine what training is needed. Southern then develops a training agenda to meet the identified needs along with a training schedule — trainers are selected, resources are assigned, and courses are designed to meet objectives. The operations courses are developed to meet the requirements for NERC approved continuing education hours. Southern offers other courses on such subjects as safety and code of conduct training that do not meet the NERC continuing education hour requirements.

Southern offers annual courses on relevant operating subjects, such as transmission line loading relief, joint contingency response with neighboring companies, area stability, and seasonal planning study updates. The training coordinators interview with the supervisors and operators to determine other topics needed in the program for the next year. The trainers also observe operator performance to determine needed topics. After the analysis is completed, the trainers develop a preliminary training schedule for review and comment from the operating areas. The final schedule is distributed by December for the upcoming year.

The Southern operators have a six-week shift schedule with one week in the rotation devoted to training. The training team develops the training program around the available scheduled time. Courses are repeated six times to allow for scheduled participation by all operators. Since the training schedule is developed during the prior year, the training time is committed and operators know when they need to be available for training. The evaluation team commends Southern for developing the full training schedule during the prior year so that the operators make their personal plans around the training. Each operator will complete 70 to 80 NERC-approved continuing education hours each year. The trainers will work with individual operators to complete any course they miss because of scheduling conflicts.

The effectiveness of the training is determined by testing or observation. Southern has developed a checklist of operator actions and responses for system simulated events and monitors the operators against the list. Southern also collects feedback from the individuals completing training to evaluate the effectiveness and gather suggestions to improve future courses.

Operators also receive training from outside sources. Southern works with SERC to provide input for content of system operator seminars each year. Southern supports the American Power Dispatch Association and host training sessions for the group each year. Southern training staff also develops subregional restoration drills, which receive wide participation.

The evaluation team reviewed the ongoing training program records and found them to be complete. Each operator has a list of individual training goals. Southern has records of courses completed by each operator and the results of the test taken to verify that the operators understood the material. The evaluation team reviewed records for several courses and found they included a course outline, objective, material reviewed, verification tests, answer keys, and individual results.

The evaluation team reviewed the training records for initial operator training. The records consisted of a single document that outlined broad areas that the trainee successfully completed in order to start independent shift operation. The records did not show individual skills mastered or individual test scores showing successful completion of developmental modules. The evaluation team recommends that Southern maintain more complete initial training records similar to the current ongoing training records.

All Southern trainers are NERC-certified operators with the reliability operator credential and participate in several activities to enhance their skills and improve the Southern training program. The trainers attend NERC, SERC, and vendor train-the-trainer programs. The

Southern Operator Training Work Group is made up of trainers of all the Southern Company operating companies and meets to unify the training programs to meet overall company objectives.

Southern uses simulators and tabletop exercises to enhance training. Southern has added simulators at the Power Coordination Center and at the transmission control centers. Model updates for the simulator can take several weeks to install so the simulator is normally operating off older system conditions. This does not cause serious problems since the training does not duplicate the real system conditions. The new EMS will include a simulator that will update to the same real-time electrical system model and data.

The trainers use actual events and potential circumstances to develop scenarios for the simulator training. To incorporate actual operating experience into the training program, the training staff develops at least one new training module each year based on an actual event from the past year. Both the training staff and the operations staff rate the simulator training very highly. The simulator allows operators to train and practice on real-life scenarios that would normally take years for them to experience.

From observing operators responding to system scenarios on the simulator, trainers have developed forms and procedures to assist in actual operating responses. The trainers developed a program to derive required generation shifts for line loading relief to aid the operators in determining and documenting the proper generation dispatch to relieve the loaded line.

Operators review their individual training plans with their supervisor twice each year, and training performance is included in performance appraisals. If an operator does not successfully complete a training course, he or she will go through the training again until successful.

Southern hired staff to begin training to prepare operator trainees for anticipated staffing needs. This program allows time for initial training and for current operators to train for other control room positions. The evaluation team commends Southern for hiring operators before actual vacancies to allow time for initial and advanced training.

Southern is planning to increase its training staff and provide additional training activities. Additional space will be needed for the expanded support staff.

The evaluation team reviewed the staff certification records and the shift schedule. Southern keeps a record of the certified operators and the name, certificate number, date tested, and expiration date. All Power Control Center operators are certified through next year. All shift positions requiring certification at the Power Control Center were NERC certified.

Operators at the transmission control centers must become NERC certified within two years of accepting a position. At least half of the operators on area desks and all system security operators must be certified. The system security operators perform the contingency analysis and develop operating solutions for identified contingency loading issues. The system security operator communicates with the Power Coordination Center.

## 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.*

Operators are trained to understand what may go wrong on the system and how to make quick decisions with limited information. This training provides the foundational knowledge designed to enable operators to make good decisions. Southern uses the simulator to develop skills to minimize human error, and the operators' use three-way communications to make sure operating instructions are understood.

Southern does not, however, offer specific human error prevention training. The evaluation team recommends that Southern add an annual class on human performance into the operator-training program.

## APPENDIX 1: Critical Infrastructure

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## APPENDIX 2: Entity Participants

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## APPENDIX 3: Documents Reviewed

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