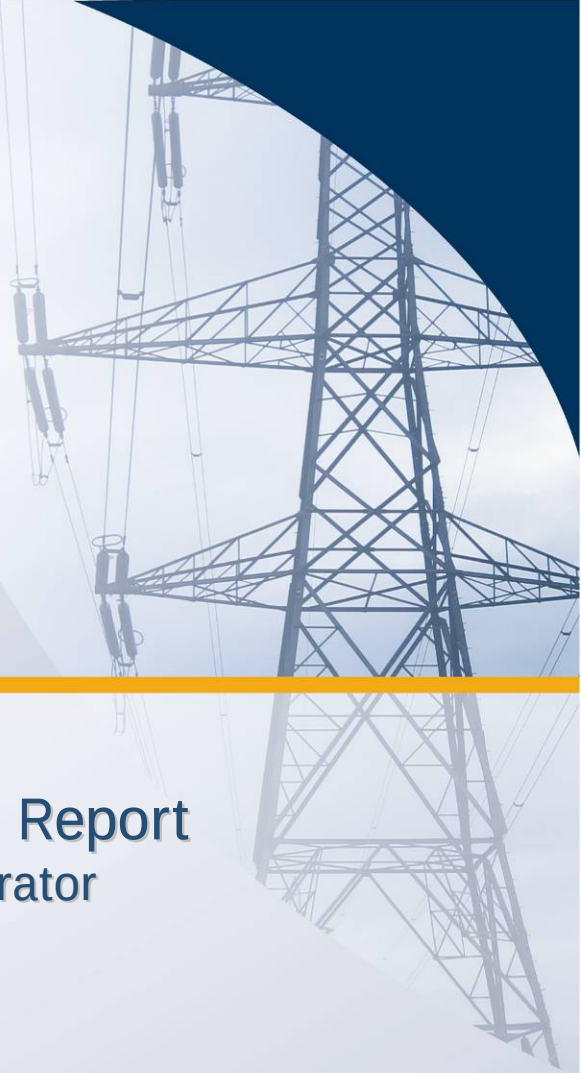
NERC

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION



# Reliability Readiness Evaluation Report

## Balancing Authority/Transmission Operator

## Duke Energy Carolinas, LLC

Charlotte, North Carolina

to ensure the reliability of the bulk power system

**December 10–13, 2007**

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

# Table of Contents

# Introduction and Evaluation Process

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.

NERC and the industry have been working collaboratively to enhance the program since its inception. The evaluation process is based on fundamental aspects of reliability: culture, operations, maintenance, planning, and training. Documents related to the program are available at http://www.nerc.com.

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 Duke Energy Carolinas, LLC (DUK) representatives on December 10–13, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of DUK to meet its responsibilities as a balancing authority and transmission operator.

# Evaluation Team

| | |
|---|---|
| Mitch Needham* | NERC |
| Ben Deutsch* | SERC Reliability Corporation |
| Patrick Brown | PJM Interconnection |
| Jeremy West | Entergy Services |
| Douglas Hohlbaugh | FirstEnergy Corporation |
| Bernita Clover | Duquesne Light |
| Thanh Luong | FERC |

*Team co-leader
**Observer

# Organization Profile

Duke Energy Carolinas, LLC (DUK), is part of Duke Energy, an electric power holding company headquartered in Charlotte, North Carolina. DUK is registered with SERC as a balancing authority, transmission owner, transmission service provider, transmission operator, transmission planner, resource planner, distribution provider, generator owner, generator operator, load-serving entity, purchasing-selling entity, planning authority, and reserve sharing group.

The DUK balancing area covers upstate South Carolina and central North Carolina, covering approximately 20,000 square miles. DUK is part of the VACAR-South reliability coordinator footprint, which covers most of North and South Carolina. The DUK system operating center primarily performs the balancing authority role. The transmission control center primarily performs the transmission operator role. The VACAR-South reliability coordinator role is performed by DUK system operations engineering personnel for 10-hour shifts, Monday through Friday, and is performed by the system operations center lead coordinator position on nights and weekends.

The DUK transmission system consists of 660 miles of 500 kV; 2,907 miles of 230 kV; 147 miles of 161 kV; 6.5 miles of 138 kV; 61 miles of 115 kV; 6,087 miles of 100 kV; 120 miles of 66 kV; and 2,760 miles of 44 kV. DUK has interconnection points with multiple entities, ranging from 100 to 500 kV:

- PJM Interconnection — 500 kV and 138 kV
- Progress Energy Carolinas — 500 kV, 230 kV(6), 115 kV(2), and 100 kV
- South Carolina Electric & Gas — 230 kV and 115 kV
- South Carolina Public Service Authority — 230 kV(2)
- Southeastern Electric Power Administration — 230 kV and 115 kV
- Southern Company — 500 kV
- Tennessee Valley Authority — 161 kV
- Yadkin — 100 kV(2)

DUK established an all-time integrated hourly peak load of 20,628 MW on August 8, 2007 at 4:00 p.m. The DUK power supply totals 21,183 MW — 6,996 MW nuclear; 7,754 MW coal; 1,128 MW conventional hydro; 2,040 MW pumped storage hydro; and 3,266 MW oil or gas combustion turbines.

# Executive Summary

The evaluation team found no significant operational problems and concluded that DUK 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 the DUK staff to be an actively engaged group both at the management and employee levels. The team noted a sense of openness among the DUK staff; communications were continuous and done with ease. DUK approaches its functions in a manner that promotes improvement both of processes as well as human performance.

The team identified one potential example of excellence — relating to the methodology employed by DUK to notify appropriate parties of steps taken for an emergency evacuation. DUK employs a "blast call" system that includes the use of telephones and facsimile devices coupled with positive response from the recipient. The system is used both for the start of and completion of an evacuation.

The evaluation team identified a number of recommendations. Two key recommendations were jointly identified by DUK and lead evaluator as being most effective in improving power system reliability: 1) specific additional training needs for system operators and 2) providing the system operators with a load-shedding guide in the event that the automated program should fail.

Overall, the evaluation team identified 11 positive observations and one potential example of excellence. In addition, the team offers 10 recommendations that, if implemented, will enhance DUK's readiness to operate reliably and maintain the reliability of the bulk power system. The recommendations are listed in order of importance.

# Potential Examples of Excellence

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

1. DUK uses blast-call notification for system operations center evacuation scenarios. The process includes the use of both phone calls and faxes to indicate the start and finish of evacuation process and requires feedback from the notification recipients (Section 2.4).

## Positive Observations

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

1. The power flow program has a display that replicates the dynamic mapboard, and it can be used to specify outage parameters for study by system operators (Section 2.3).
2. Duke's CIP implementation is thorough and contains specific accountabilities for various requirements (Section 1.2.3).
3. Training personnel have the ability to fill in on the operating desks, which helps keep up their operations skill sets and eases staffing requirements (Section 5.1).
4. A number of energy management system (EMS) support personnel and management are NERC certified and have operations experience (Section 2.2.3).
5. Duke has a team of in-house meteorologists for load forecasting (Section 4).
6. Operators have other career opportunities in Duke — for example, moving into other corporate functions such as information technology (IT) or communications support (Section 1.2.4).
7. A color-coded menu system is available for use by balancing authority system operators as a guideline when a decreased capacity or tight energy situation occurs (Section 2.4).
8. The system operations center and transmission control center use a new front-end entry application for all non-EMS applications (Section 2.1).
9. The "TrackIT" software system provides for good control and follow-through of IT issues, including EMS model updates and computer problems (Section 3.2.2).
10. Duke uses an in-house developed application called MiniACE to monitor independent power producer and load-serving entity performance and compliance (Section 2.2.2).
11. Duke has developed dashboard displays for the balancing authority, transmission operator, and reliability coordinator that are easy to interpret and provide greater detail of system conditions (Section 2.1).

## 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. Increase the real-time contingency analysis frequency commensurate with the new equipment capabilities to provide contingency study results more often than every eight plus minutes (Section 4).
3. Confidential information on cyber security redacted from public report. See discussion in Appendix 1.
4. Improve the training program as follows to heighten operator awareness and knowledge (Section 5.1)*
    a. Provide system operators with training regarding the high and low contingency voltages used to trigger alarms.
    b. Provide system operators with training regarding underfrequency load drop amounts and any intentional delay times.
    c. Increase the use of the dispatcher training simulator, including realistic scenarios.
    d. Provide system operators with training regarding steps to be taken upon the loss of EMS applications.
5. Provide the system operators with additional day-ahead planning scenarios (i.e. actual anticipated loads) instead of providing only "worst-case" peak conditions to improve their confidence in the decision-making process (Section 4).
6. Provide the system operators with a load shed table and guide in case the load shedding application fails so that they will have explicit guidance in this area (Section 2.2.2).*
7. Confidential information on physical security redacted from public report. See discussion in Appendix 1.
8. Confidential information on plans for loss of control facilities redacted from public report. See discussion in Appendix 1.
9. Develop and implement a formal shift-turnover process, including a list of items that must be covered, to ensure consistency among all system operators (Section 2.3).
10. Verify that the results from the 1995 Transmission Planning System Voltage Quality Improvement Team effort (used to set DUK's contingency voltage limits) are still valid so that system operators have up-to-date voltage limits and alarms (Section 4).*

*Jointly identified by the company and co-lead evaluators as a key recommendation

# Discussion

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

The evaluation team met with both management and system operations staff to discuss corporate goals and objectives and their impact on reliability. The team found DUK to have a high level of engagement and understanding of the workforce and management with respect to corporate goals that are directly impacted by reliability objectives. DUK reported that objectives established within the corporation have direct ties to both system operations center and transmission control center employees. Within the DUK compensation system, the employees in these two operating centers have goals specific to their work tasks that play a part in the determination of year-end bonuses and compensation. The evaluation team found it particularly interesting that the bonus criteria also apply to support personnel assigned to activities related to the control centers.

The evaluation team noted that DUK has a highly experienced staff in its system operations group. This situation provides certain challenges for DUK in the future, particularly with regard to filling vacancies within the system operator ranks. DUK uses a variety of methods for employee retention, one of which is scheduling. Discussions with system operators indicated that some system operations teams are essentially self-directed with regard to scheduling. The system operators work with one another to determine a fair allocation of vacation time within the calendar year and approach overall scheduling with the understanding that all employees are valuable assets to the overall team. The operators indicated that this self-scheduling mechanism works well, even with occasional illness or unexpected absences.

### 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 evaluation team examined documents at the corporate level that discussed the relative importance of power system reliability within the company. The team noted a specific corporate emphasis on reliability as a primary objective. DUK management personnel indicated that

system reliability issues are discussed with corporate executives on a regular basis. These discussions have led to executive knowledge of and involvement with the transmission (and distribution) organizations.

### 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.*

As discussed previously, the support personnel are aligned with the system operations centers in terms of goals and objectives. This alignment facilitates a knowledgeable support staff that is dedicated to ensuring reliability as a top priority. The support personnel indicated they frequently discuss any issues with system operators and management, and that the focus on reliability remains constant from their perspective.

The evaluation team discussed the relationships between support staff personnel and the system operators and found that many of the support personnel are NERC certified as system operators and that they also have actual operations experience. The evaluation team noted that this provides for an ingrained understanding of system operator needs and priorities within the support organizations, improving response times and overall effectiveness.

Throughout the system operations organization, including both the system operations center and transmission control center, exists an open-door policy for employees to discuss any and all issues with appropriate management. Discussions with the system operators indicated that the group makes use of this on a consistent basis, and that there is value in having this policy in place. The evaluation team noted that there is a friendly, open atmosphere in both control facilities.

### 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.*

DUK has appointed a specific individual to be accountable for the implementation of NERC reliability standards related to critical infrastructure protection. DUK reported being on schedule for timely implementation of the standards, and that it uses several methods internally to ensure accountability at all levels, including management meetings with executive briefing and careful tracking of individual requirements. The team notes DUK's approach to the implementation of the critical infrastructure protection reliability standards as a positive observation.

DUK uses a document-sharing technology designed to ensure proper attention is given to new or revised documents, such as operating procedures and reliability standards. DUK has developed a log-in mechanism that makes such information available to system operators as they begin work at every shift. The mechanism involves a user-interface front end that must be accessed prior to logging in to other non-EMS operator applications. Effectively, the front-end displays information regarding new or altered documents and is capable of tracking document access by

system operators. DUK management and system operators acknowledged that it is an expectation for system operators to use online resources in most instances, if available. DUK management reported that performance indicators relating to corporate goals are reviewed on a weekly basis, with performance gaps identified during the review. The team found that DUK immediately develops the needed strategy to close any identified discrepancies and that both management and staff are empowered to make any necessary changes or adjustments to processes.

### 1.2.4 Human Resources

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

DUK administers human resources at the corporate level, and has staff members who are familiar with the requirements for system operations. DUK management indicated a healthy relationship exists between system operations and the corporate human resources group, providing good support for filling vacancies. In addition, the DUK corporate human resources group is available to assist in coaching activities for improving individual human performance.

The evaluation team discussed the methods for filling vacant system operator positions and found that DUK has an ongoing effort to streamline this process. The individual system operator job-vacancy announcements typically indicate organizations from which it is expected successful candidates might come. This list of potential candidate locations and capabilities can include technicians, electrical engineers, field support personnel, and others.

The evaluation team observed that DUK has succession plans in place for individuals in key positions, both in system operations as well as support services. As mentioned earlier, some of the support staff positions are filled by individuals that have previously been involved in system operations, and those individuals are retaining their NERC certifications to allow for flexibility during unforeseen events. The team found that system operators have other career opportunities in DUK — for example moving into other corporate functions such as information technology or communications support. The team finds this to be a positive observation, keeping system operators interested and knowledgeable about other corporate functions.

### 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.*

Corporate communications within DUK occur frequently, both on periodic and as needed bases. Typical periodic communications include company newsletters and memoranda regarding overall industry events and specific DUK information. DUK management also indicated that employee opinion surveys are conducted, which can have a profound impact on internal processes and communications.

The opinion surveys are conducted on a confidential basis, and results can be tabulated to several different levels within the organization, taking care to maintain the anonymity of the respondent.

DUK indicated that results stratification takes place only to levels where there were at least eight responses.

E-mail is typically used in system operations and may have information regarding system events, anticipated weather patterns, and other operations information.

# 2. Fundamentals of Operations

## 2.1 General

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

DUK uses an industry-standard supervisory control and data acquisition (SCADA)/EMS for its monitoring and system operations functions. Discussions with the system operators indicated satisfaction with the SCADA/EMS and its associated training. DUK indicated that plans are in place to move the operating system onto new servers with much greater computational capability in the near future.

As noted earlier, both the system operations center and the transmission control center are using a front-end entry application for all non-EMS applications. This front end serves as a gateway to non-EMS applications such as e-mail, timesheets, and the Internet.

The evaluation team observed DUK system operators accessing the tools provided through the SCADA/EMS and found the system operators to be adept at performing any needed tasks. Duke has developed high-level dashboard displays for the system operators performing balancing authority and transmission operator functions (as well as reliability coordinator functions) that are easy to interpret and provide greater detail of system conditions. The team examined these dashboard displays and observed the ease with which system operators could quickly assess problem areas using features that allow them to effectively zoom in on and isolate problem areas. The team notes the development and usage of these dashboard displays as a positive observation.

DUK system operators are trained to use advanced applications, such as state estimator and real-time contingency analysis. There is additional discussion about DUK's use of these tools in Section 4, Fundamentals of Operational Planning.

DUK uses a wide-area view as shared by the reliability coordinator. The evaluation team found that this is common among the neighboring systems. The wide-area view provides the system operators with information regarding scenarios that might be developing beyond their normal balancing or transmission operations areas and helps them to be prepared to take action if needed.

## 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.*

The evaluation team met with DUK system operators with regard to internally developed operating procedures. The system operators indicated that there are procedures developed for areas with operational concerns, such as the IROL mentioned earlier. DUK indicated there are no special protection schemes associated with the power system.

Discussions with operations management and system operators indicated there are developed procedures with scripts denoting communications requirements for the nuclear facilities within the footprint. These procedures contain both action steps as well as the communications steps and are generally written for low-voltage scenarios where off-site power supplies might be at risk.

In the development of switching procedures and orders, DUK management indicated an expectation and policy that all such orders will receive at least one level of peer review. For unusual circumstances where switching orders might be more involved, it is not unusual for a switching order to receive multiple reviews. All reviewers record their concurrence.

### 2.2.2 Operational Decision-Making

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

DUK system operators stated they have a conservative approach to system operations, using generally worst-case scenarios to determine possible adverse consequences. The reliability coordinator for the DUK power system is generally accessible if needed to verify any unusual study results or for additional collaboration, which is encouraged. DUK management indicated that reliability coordinator involvement in operational decisions is routine but is not required by any policy.

In monitoring independent power producers and load serving entities, DUK uses an in-house developed software application called MiniACE to determine operational performance and compliance with anticipated schedules. The evaluation team notes this application as a positive observation, giving system operators a tool at the macro level to monitor these specific activities.

DUK system operators stated they would use a load-shedding software application in the event load shedding became necessary. The application allows a system operator to specify a certain amount of load to be shed on a geographical basis, and the application determines which circuits must be de-energized to achieve the desired result. The system operators interviewed were unsure of the exact protocol they would use should the load shedding application fail. The evaluation team recommends that DUK provide the system operators with a load shedding table and guide in case the load shedding application fails, allowing the system operators to make critical decisions in the absence of the software application.

### 2.2.3 Operational Alignment

*Organizational structure supports safe and reliable system operation.*

The evaluation team examined the organizational structure for system operations and discussed the internal linkages with system operators. Operations management noted that operating

procedures are typically developed with extensive input from system operators, and the operators indicated that any problems identified can be internally resolved.

The DUK reliability coordinator performs coordination services for a total of six balancing areas: Duke Energy Carolinas, Progress Energy Carolinas, South Carolina Electric and Gas Company, South Carolina Public Service Authority, the Southeastern Power Administration, and the Yadkin Division of Alcoa Power Generating, Inc. In the system operations center, the DUK lead coordinator also performs the reliability coordinator function as a collateral duty during evenings and weekends. The evaluation team discussed the workload associated with performing both balancing and reliability coordinator duties, and the DUK operations management team indicated that there are plans to adjust staff in the future for continuous reliability coordinator staffing.

The document that describes the relationship between the reliability coordinator and the balancing areas does not make exception for the reporting requirements, either for DUK or for the other participants. The evaluation team understands that the internal reporting requirements, such as data related to the reliable operations of the power system, may be somewhat different given the location and proximity of the reliability coordinator to the DUK system operations group.

Discussions with DUK management and support personnel revealed that a number of EMS support personnel and management are NERC certified (with operations experience). The evaluation team notes this as a positive observation, providing multiple career opportunities for the DUK system operator work force. In addition, the experience level of the support personnel provides for improved knowledge of the system operators' needs and helps in provision of timely support activities.

The evaluation team did not note any delegated functions, either in the system operations center or the transmission control center, regarding DUK's requirements to perform as a balancing authority and transmission 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 evaluation team examined tools and displays used by DUK system operators in performing their reliability functions and found them to be adequate and complete. DUK system operators have a number of advanced network applications, such as the state estimator and contingency analysis, and the team observed their ability to successfully run and interpret the results of these tools.

DUK monitors reactive reserves by region and voltages at key facilities, providing the system operators with a display that shows all reactive components according to availability (such as capacitors available for service or remaining reactive support from generation units). DUK noted that there is a policy in place regarding overall regulation reserves, and the company's

performance has resulted in no compliance problems with associated reliability standards. DUK is a member of the VACAR Reserve Sharing Group for system events related to the loss of large generation units.

As discussed earlier, DUK is a de facto participant in reliability coordinator conference calls involving other balancing areas. Neighboring systems reported through questionnaire responses that the DUK system operators are active in resolving any developing regional problems.

The evaluation team observed the shift-turnover process and noted DUK does not use a formal procedure but rather relies extensively on the skills of the incoming and outgoing system operators to effect the changes. The team was not comfortable with the approach and recommends that DUK develop and implement a formal shift-turnover process, including a list of items that must be covered. If DUK adopts this recommendation, the team believes it will improve system reliability by enforcing a consistent approach to the shift-turnover process. Discussions with operations management indicated that such a procedure has been used in the past and that its reintroduction could be quickly accomplished.

DUK system operators expressed satisfaction with their tools and study capabilities. The operational platform includes a dispatcher load flow program that has a display replicating the dynamic mapboard. As part of the studies process available to the operators, this display can be used to specify outage parameters for study by system operators by selecting the graphical representation of any transmission facility and removing it from the model. The evaluation team notes this graphical approach to a studies interface as a positive observation, giving the system operators a quick method of setting up needed load-flow studies for abnormal system conditions.

The evaluation team discussed the outage coordination process used by DUK system operators. For the DUK balancing and transmission system footprint, outage planning is controlled by the transmission control center and the system operations center using the transmission outage scheduling system. The system gathers information regarding needed outages for maintenance or construction and allows the system operators and reliability coordinator to conduct continuing studies. Discussions with the operations planning staff indicated that outages may be cancelled if system conditions warrant, giving flexibility in operations for unexpected outages.

The system operators indicated they receive day-ahead studies results from operations planning engineers that bound system conditions by using the worst-case scenario of system loading. This scenario ensures a most conservative approach to proceeding with outages. The system operators noted that they felt the process could be improved by providing study results that include anticipated loads to give them a better understanding of changes to expect as switching occurs.

## 2.4 Emergency Preparedness

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

The evaluation team understands through discussions with system operators and operations management that overall emergency plans are in place for a number of potential scenarios. The

team observed the system operations center evacuation plan that is currently in place and found it to be easily understood. DUK indicated that the evacuation plans are the subject of regular emergency drills, some of which are unannounced.

If emergency evacuation is required, DUK makes use of a blast-call notification system that utilizes both phone calls and faxes (used to show start and finish of process) to all parties that require such notification. The system also requires feedback from the recipient of the information. DUK indicated it intends to implement the same system for evacuation of the transmission control center in the future. The evaluation team was impressed by the DUK commitment to early and accurate communication of these emergency scenarios and identifies the use of the blast call notification system as a potential example of excellence.

System operators have certain tools for use during power system emergencies, such as capacity and energy emergencies. The team noted particularly that the operators make use of a colorful, laminated guide sheet to assist them in moving through such scenarios. The guide sheet has three defined alert levels (yellow, orange, red) that are aligned with NERC Energy Emergency Alert levels. For each level, the guide shows potential activities are based on available reserve levels. The system operators understand the use of this guide and know under what circumstances it would be accessed. The evaluation team identifies this use of a color coded menu system by system operators (responsible for balancing load and generation) as a positive observation, improving the response time and understanding during capacity emergencies or tight energy situations.

The evaluation team discussed DUK's load-shedding process with both operations planning and the system operators and was not comfortable that there was mutual understanding of steps to be taken should the automated process and its two backup levels fail. The evaluation team believes the system operators need additional information and guidance from DUK operations planning to make a fully informed decision in such a scenario. The evaluation team recommends DUK provide the system operators with a load shed table and guide in case the load shedding application fails so that they will have explicit guidance in this area.

Within DUK, emergency coordination of activities during system events makes use of a "tailgate" team that involves multiple organizations throughout the company. In particular, the tailgate team includes corporate communications personnel who are responsible for interface with news media and other reporting obligations within DUK. During system restoration activities, the transmission control center is tasked with overall responsibility of the system configuration with approval and oversight from the reliability coordinator. This arrangement results in thorough understanding and planning between the system operations center performing generation/load balancing and the transmission control center. The DUK blackstart plan is fully developed and documented.

# 3. Fundamentals of Maintenance

## 3.1 General

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

The evaluation team met with members of DUK's staff who provide maintenance and support of the computer and communications systems. The individuals are well versed in the needs of system operators and respond well to any requirements for assistance, according to system operators.

DUK has had EMS minimal outage time over the past year, and all outages were planned in advance to provide for updates to relevant databases. DUK support personnel indicated this was a result of using the redundant servers in an appropriate manner to stage all such changes and test them prior to implementation on the production machines. As a result of this minimal downtime and overall operator satisfaction, DUK indicated that it does not actively track the amount of time that the EMS is unavailable.

The DUK EMS is continuously monitored for correct execution and data flow for all critical applications. Alarms are provided directly to support personnel as well as system operators so that they are aware of any EMS problems. Overall, DUK is continuing efforts to improve the initial triage of system alarms to minimize the impact on the system operators, making use of the many levels and types of alarms possible with the system.

## 3.2 Equipment Reliability

### 3.2.1 Equipment Performance

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

As mentioned above, the DUK system operators are satisfied with the overall response and availability of the EMS for their monitoring and operating needs. The operators stated that when problems do occur, the support personnel are normally aware of the problem immediately and begin recovery or repair activities without operator intervention.

### 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.*

DUK carefully controls work that could impact system operators both at the system operating center and the transmission control center. Work is planned well in advance, and notice is always given to the operations staff prior to commencing work. This step allows the system operator to stop or postpone any planned activities due to workload or abnormal system conditions.

For needs identified by the system operators, DUK uses a software application called TrackIT to ensure all items are correctly prioritized and completed. The evaluation team notes this application as a positive observation, providing for good control and tracking of information technology issues including EMS model updates and associated computer problems.

In addition to having good control of activities inside the control facilities, the DUK system operators also have an active voice in outages to equipment on the transmission system. Prior to any outage or switching work actually beginning, the system operator has the decision responsibility whether to proceed with the work or to postpone or cancel it based on emergent system conditions.

## 4. Fundamentals of Operational Planning

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

The evaluation team conducted interviews with the operational planning personnel for DUK and found them to be knowledgeable with regard to their software applications and system needs. The operations planning personnel are located adjacent to the system operators in the system operations center, but are also available for consultation by the transmission system operators by phone or through setting a meeting schedule. The operations planning engineers also fulfill the role of reliability coordinator during normal day-shift times as mentioned earlier.

The operations planning engineers stated that transmission system models are developed for both the EMS integrated power flow applications as well as an off-line power flow program used to study proposed outages in the future. The model parameters are updated seasonally or anytime major changes are made using a process of e-mail exchanges and notifications as documented in the *VACAR South Next Day Study Procedure*. The system operators indicated that this process is adequate, and the evaluation team observed e-mails typically exchanged in the process. Changes to the DUK system model are also uploaded to the regional entity via a protected portal for sharing with others in the region.

In the development of day-ahead and future studies, DUK stated that it relies on weather forecasts (as well as known load growth) to determine system loading characteristics. DUK utilizes a team of in-house meteorologists for this critical step of load forecasting, particularly day-ahead loads, and the evaluation team notes this staffing model as a positive observation. The DUK meteorologists have data available to them from a wide range of sources, and their more localized experience helps to better pinpoint loads based on the area weather patterns. For longer-range studies, DUK system operators stated they have extensive review expectations, ensuring that all known outages are accurately modeled.

Interviews with the DUK system operators who perform the balancing function indicated that they receive day-ahead study results from operations planning in order to prepare for upcoming work, such as outages and reconfiguration of the system. The studies provide a conservative bounding mechanism in that they are based on maximum expected load levels. The system operators stated that while this is a conservative approach, they are not always comfortable that the results of actual switching and outage activities were as expected. When asked how this could be improved, the operators said they could use both this conservative study result as well as actual anticipated hourly loads to validate the system models. The evaluation team recommends that, for day-ahead planning studies, DUK provide the system operators with additional scenarios (actual anticipated loads) instead of providing only worst-case peak

conditions, allowing the system operators to have a more realistic perspective of loading on the transmission system.

DUK utilizes a state estimator as required for its real-time contingency analysis work, and the combined software presently runs on an eight-minute cycle. DUK is currently in the process of installing new EMS servers, which will have improved computational abilities. The evaluation team discussed the overall contingency analysis process and noted that it can likely be improved to provide study results more often in the future. The evaluation team recommends that DUK increase the real-time contingency analysis frequency commensurate with the new equipment capabilities to provide contingency study results more often than every eight plus minutes. The evaluation team believes this will improve the DUK system reliability and provide a more reasonable snapshot for analysis by the system operators.

DUK system operators have received training for and routinely utilize the system operator load flow application, which is included in its EMS. DUK has developed an intuitive, graphically based method by which the system operators are able to quickly set specifics for a desired study and see the results.

DUK indicated in its documentation that contingency voltage levels used to provide alarms to the system operators have been in use for a number of years. The actual study used to determine these alarm levels was the result of a large internal effort several years in the past. The evaluation team was not comfortable that the results of that study are still being used for this critical application and recommends that DUK verify the results from the 1995 Transmission Planning System Voltage Quality Improvement Team effort, making any changes as indicated to improve the response possibilities of the system operators.

# 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.*

Members of the evaluation team met with DUK's training personnel with regard to the training afforded system operators as well as other support or planning personnel. DUK has a formalized training program that has been in existence for over 10 years in its current form. The overall goal is to provide training on a timely basis to maintain system operator skill sets, certification, and knowledge of the DUK power system. The training program conducts activities for 10 months of the year, having classes available in six- to eight-hour increments. Since the program covers both the balancing and transmission system operators who are located in different facilities, DUK makes special arrangements three times yearly for joint training activities.

The training coordinator stated that DUK provides training to a new system operator prior to the operator taking a shift position and that the training is tailored to the individual's abilities and previous experience and training. The individual needs are identified through the application and interview process, and knowledge exercises are conducted during the applicant's training period.

DUK typically makes use of its dispatcher training simulator to provide training and to create a realistic testing atmosphere. DUK personnel stated that a new trainee typically completes the necessary training with respect to the DUK power system in approximately 90 days.

Prior to a new system operator assuming a shift position, his or her performance in training activities is reviewed and discussed by the management team. The DUK training coordinator indicated that the final assessment of an operator candidate relies heavily on the senior or lead system operators who have been working most intently with the candidate.

In addition to initial training, DUK system operators take part in regional exercises coordinated with SERC on an ongoing basis. The evaluation team noted that all internally taught classes relating to appropriate subject materials are certified for NERC continuing education requirements. DUK system operators stated that evacuation and backup center activation drills (for both the system operations center and the transmission control center) are conducted regularly, with actual system operations conducted from the respective backup site. DUK management also noted that such operations have not always been associated with a drill; there was an actual evacuation due to local construction activities.

With regard to training metrics, DUK has established goals based largely on retention of operator certification credentials. The goals also include a number of DUK system-specific activities, which are scheduled and taught in addition to the basic credentialing curriculum. The evaluation team examined the documentation used in support of the training program and found it to be in order, meeting expectations for regular reviews with employees and reporting to management.

DUK, like many other larger utilities, relies on support staff and dedicated training personnel to conduct training activities. The evaluation team found that a number of DUK's internal educators have come from the actual operating organization and have operating experience. DUK management indicated that these credentialed individuals have the ability to provide temporary relief in the system operator positions. The team also understands that this contributes to maintaining the operational skill sets for these individuals and notes this use of experienced operating personnel as a positive observation.

Discussions with DUK system operators revealed training improvement possibilities in several operational areas. Specifically, the evaluation team recommends that DUK improve the system operator training program by

1. providing training regarding the high and low contingency voltages used to trigger alarms;
2. providing training regarding underfrequency load drop amounts and any intentional delay times;
3. increasing the use of the dispatcher training simulator including realistic scenarios;
4. providing system operators with training regarding steps to be taken upon the loss of EMS applications.

## 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.*

DUK operations management and system operators were interviewed by members of the evaluation team with respect to the corporate approach to improving human performance. DUK has organizational initiatives in place for the reduction of human errors, including training with regard to error precursors and other root-cause factors.

For transmission switching orders, DUK uses an approval process that requires, at a minimum, second-party review and verification. Discussions with DUK personnel indicated that for unusually complex switching orders or when system conditions are particularly stressed, a switching order may receive multiple reviews, from peers as well as supervisors. DUK operations management indicated that "canned" or previously executed switching orders are not used unless they also receive the complete review cycle prior to issuance.

It was noted earlier that in some instances training personnel may be called upon to actually work an occasional shift if needed for relief or emergency purposes, but this is not normally a collateral duty. The evaluation team discussed this involvement of the training personnel in actual operations and believes it can lead to effective training with respect to human performance events.

# APPENDIX 1: Critical Infrastructure

# APPENDIX 2: Entity Participants

# APPENDIX 3: Documents Reviewed