NERC

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Reliability Readiness Evaluation Report

Balancing Authority/Transmission Operator

Rocky Mountain/Desert Southwest

Loveland, Colorado

to ensure the reliability of the bulk power system

October 22–25, 2007

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

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Introduction and Evaluation Process

The North American Electric Reliability Corporation (NERC) Reliability Readiness Evaluation and Improvement Program is one of the commitments of NERC and the industry to strengthen the reliability of the North American bulk power system. The program conducts independent evaluations of balancing authorities, transmission operators, reliability coordinators, and other key entities that support the reliable operation of the bulk power system to assess their preparedness to meet their assigned reliability responsibilities. The evaluations identify strengths and areas for improvement in an effort to promote excellence in operations among these organizations.

Since its inception in 2004, NERC and the industry have been working collaboratively to enhance the program. The evaluation process is based on fundamental aspects of reliability: culture, operations, maintenance, planning, and training. The document *NERC Readiness Evaluation Procedure* describes and defines the process used for reliability readiness evaluations. This document and other documents related to the program are available at http://www.nerc.com/~rap/.

The reliability readiness evaluation teams, each led by a NERC staff member and a regional co-leader, include industry volunteers with considerable expertise selected to provide representation from other interconnections, other regions, and neighboring operating entities. The teams also typically include representatives from the Federal Energy Regulatory Commission (FERC) staff.

The public version of the reliability readiness evaluation report contains the majority of the evaluation team's findings. Any discussion of findings pertaining to critical infrastructure will be contained in Appendix 1, a confidential appendix to the report that is sent privately to the evaluated entity and is not included in the public version of the report.

An evaluation team met on-site with Rocky Mountain/Desert Southwest Reliability Coordinator (RDRC) representatives on October 22–25, 2007. This report reflects the views and recommendations of the evaluation team regarding the readiness of the RDRC to meet its responsibilities as a reliability coordinator.

Evaluation Team

Paul Reber*	NERC
Paul Rice*	Western Electricity Coordinating Council (WECC)
Mike Cooper	ATCO Electric
Mark Prosperi-Porta	British Columbia Transmission Corporation
John Spivak	Consolidated Edison
Ray Mason	Reliability*First* Corporation

Romulo Barreno	FERC
Syed Ahmad	FERC
AJ Connor	NERC
Eric Langhorst**	WECC

*Team co-leader

**Observer

Organization Profile

RDRC is part of the WECC organization and is one of three reliability coordinators in the Western Interconnection. RDRC provides reliability coordination for 19 balancing authorities and transmission providers in all or portions of the states of Arizona, California, Colorado, Nebraska, Nevada, New Mexico, South Dakota, Texas, and Wyoming.

RDRC's peak load of 39,556 MW occurred at 5:00 PM on July 16, 2007. The RDRC area contains 803 generators with a summer capacity of 49,854 MW and a winter capacity of 51,114 MW — the generation mix includes about 47% gas fired, 32% coal fired, and 10% hydro. The RDRC area has approximately 2,209 miles of 500 kV, 4,542 miles of 345 kV, 8,741 miles of 230 kV, and 11,063 miles of 115 to 161 kV transmission lines. Within the Western Interconnection, RDRC interfaces with the two other reliability coordinators, the Pacific Northwest Security Coordinator and the California-Mexico Reliability Coordinator. The RDRC has six dc ties with the Eastern Interconnection: three with the Midwest ISO (with 500 MW of interchange capacity) and three with the Southwest Power Pool (with 610 MW of interchange capacity).

RDRC is an independent organization with no financial interest in any other entity or marketing function and only performs reliability coordinating functions. RDRC has the responsibility for overall coordination of the phase shifters to control the flow on critical flow paths for the entire Western Interconnection. It monitors the Rocky Mountain Reserve Group and the Southwest Reserve Sharing Group. RDRC performs more detailed next-day planning studies its transmission providers that need the service.

RDRC is divided into two regions: the Rocky Mountain region and the Desert Southwest region. Originally, separate reliability coordinators served these two regions, but RDRC now operates these as one region. Some differences still remain, such as separate reserve sharing groups, separate restoration plans, and separate group meetings.

RDRC is funded by and operated under the direction and authority of WECC. RDRC is housed in the Western Area Power Administration (WAPA) facilities in a separate control room and receives energy management system (EMS) equipment and software, communications, security, and support from WAPA. Originally, the RDRC staff was all WAPA employees but RDRC is transitioning to all WECC employees. At present, some staff members are employed by WAPA and some by WECC. WECC is transitioning from three reliability coordination centers to two, but the final sites have not been announced. This uncertainty creates some staffing issues, including difficulty filling open positions. The need for replacement staff has been compounded by WAPA's recall of its entire staff from RDRC to work solely on WAPA responsibilities. The readiness evaluation team reviewed RDRC as it currently operates, and the observations and recommendations provided in this report do not take into consideration future initiatives or plans.

Executive Summary

The evaluation team found no significant operational problems and concluded that RDRC has adequate facilities, processes, plans, procedures, and tools to perform the reliability coordination functions necessary to maintain the reliable operation of the bulk power system. RDRC has competent, experienced, and knowledgeable personnel.

RDRC and WECC, which directs and funds RDRC, are in the process of implementing significant changes to RDRC and the reliability coordinators in the Western Interconnection that will consolidate the three reliability centers into two. RDRC operates under the *Western Electricity Coordinating Council Reliability Coordinator Plan*. WECC is implementing a plan to operate the Western Interconnection reliability coordinators with common equipment, uniform procedures, and a single model of the interconnection. With the information provided, the evaluation team understands that the WECC plan is to have the Western Interconnection reliability coordinators operate together as parts of one coordinated unit and provide backup services for each other. WAPA is cooperating with WECC in maintaining staff for RDRC during the transition period.

While the change shows that WECC has the vision and desire to improve operations, it affects RDRC's culture today. RDRC is in flux, and employees are unsure of the future they have at RDRC. With the job in doubt and the future reliability center location unknown, potential employees are hesitant to accept positions at RDRC, resulting in job vacancies. While WECC has implemented employment policies to help alleviate the employee concerns, the uncertainty remains unsettling.

RDRC developed a *Strategic Plan*, which is a critical self-evaluation, and the team found this to be a useful document. The process of developing the *Strategic Plan* included RDRC staff, and the balancing authorities and transmission providers in the RDRC area. RDRC is working on most of the objectives developed in the *Strategic Plan* and includes them in employee goals.

The state estimator solves 80 percent of the time and should provide more consistent results to the reliability coordinators. The poor state estimator performance affects the accuracy of the real-time contingency analysis, and the operators do not depend on or trust the results. The state estimator and real-time contingency analysis application performance is not satisfactory.

The evaluation team found that the RDRC training program provided for the minimum requirements. While the current training program is providing for NERC requirements, further development will provide training focused on the needs of the organization, including reliability needs. RDRC does not have a formal documented training program for either its experienced operators or its new operator trainees. As the evaluation team reviewed the training program, it found several areas for recommendations, particularly the need to hire a training coordinator.

Overall, the evaluation team identified 14 positive observations. In addition, the team offers 19 recommendations that, if implemented, will enhance RDRC's readiness to operate reliably and maintain the reliability of the bulk power system. The recommendations are listed in order of importance.

Positive Observations

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

1. RDRC has developed a comprehensive *Strategic Plan* with input from its employees and reliability authorities in the RDRC area and is implementing the plan's objectives (Sections 1.1, 1.2.1, 1.2.2 and 1.2.3).
2. RDRC has an experienced and knowledgeable staff (Section 2.2.1).
3. RDRC staff members are employed by either WAPA or WECC, but the employees function as a unit and work well together (Section 1.1).
4. Confidential information on EMS redacted from public report. See discussion in Appendix 1.
5. RDRC has a wide-area view of the entire Western Interconnection with many data points, including frequency indication, voltage, and load shedding steps (Section 2.1).
6. The RDRC document control system tracks document update requirements, notifies document owners of review dates, tracks individual review of document changes, and provides easy document access for operators (Section 2.2.3).
7. Confidential information on computer updates redacted from public report. See discussion in Appendix 1.
8. RDRC effectively coordinates operations with the two other Western Interconnection reliability coordinators (Sections 1.2.5 and 2.3).
9. RDRC provides training to and communicates with its member balancing authorities and transmission operators to provide high reliability and support area needs (Section 2.3).
10. The reliability coordinators play an active role in determining their individual training (Section 5.1).
11. Confidential information on backup control center redacted from public report. See discussion in Appendix 1.
12. The operators are familiar with RDRC's trending application and have developed many useful trend charts (Section 2.3).
13. The operators are knowledgeable and aware of remedial action schemes and status (Section 2.3).
14. RDRC conducts annual restoration drills for both Rocky Mountain and Desert/Southwest areas with full participation from the balancing authorities and transmission operators in both areas (Sections 2.4 and 5).

Recommendations

The evaluation team offers the following recommendations:

1. Fill vacant positions in a timely manner to ensure reliable system operation and proper staffing levels (Section 1.2.4).*

2. Improve state estimator performance to solve at least 95% of the time so that the operators will trust and use the applications that depend on the state estimator results (Section 2.3).*
3. Add trainer responsibilities to a staff position to coordinate and improve training (Section 5.1).*
4. Formalize the training program to ensure training is meeting organizational needs (Section 5.1).
5. Provide training on advanced applications to help operators gain a better understanding of capabilities and make use of the technology (Section 2.3).
6. Provide more training on study applications for support engineers, especially for new hires, to enable better use of the tools and provide planning insights for staff with limited industry experience (Section 4).
7. Obtain required nuclear plant substation voltage limits and minimum transmission system configuration requirements so the operators can evaluate post-contingency requirements (Section 2.3).
8. Obtain information on new facility installations in time to add to the system models so the state estimator will provide more consistent and accurate results (Section 2.3).*
9. Require system restoration drills for each operator every year to ensure that all operators are familiar with their execution (Section 5.1).
10. Obtain hourly load and individual generator unit dispatch information for next-day studies to enhance study capability and improve accuracy (Section 4).
11. Add a heartbeat monitor (or similar function) to the control room to ensure safety of reliability coordinator (Section 2.2.1).
12. Provide simulator experience with various RDRC scenarios to enhance operator training in responding to emergency and abnormal situations (Section 5.1).*
13. Add a large mapboard video screen to give the operators better wide-area visibility of the system (Section 2.3).
14. Add a second display for graphical information so the operators can have a better indication of system conditions by viewing more of RDRC's charts (Section 2.3).
15. Develop a succession plan that includes reliability coordinators to ensure meeting future staffing needs (Section 1.2.4).
16. Confidential information on power supply redacted from public report. See discussion in Appendix 1.
17. Confidential information on power supply redacted from public report. See discussion in Appendix 1.
18. Confidential information on power supply redacted from public report. See discussion in Appendix 1.
19. Confidential information on security redacted from public report. See discussion in Appendix 1.

*Jointly identified by the company and lead evaluator as a key recommendation. The team and the company agree that all training recommendations listed could be considered key recommendations, but the company believes, and the lead evaluator agrees, that Recommendation 3 is instrumental in achieving all the training recommendations.

Discussion

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

1. Culture

1.1 General

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

RDRC is functioning satisfactorily while facing a difficult and uncertain future. As WECC transitions from three reliability coordination centers to two, the future of RDRC is in question. The location of the two sites has not been determined, and this makes hiring operators difficult. WAPA has informed RDRC that it no longer is willing to supply personnel to RDRC and is working with RDRC to develop a schedule to replace the staff with WECC employees.

RDRC has set high standards and expectations for its reliability coordinators and staff. Performance goals are included in the annual performance appraisals. Some of the performance goals are derived from the RDRC *Strategic Plan*. The RDRC staff is made of both WECC and WAPA employees. While both WECC and WAPA strive to provide uniform expectations, different employment policies make it difficult to have uniform procedures. These differences affect the shift schedule, evaluations, salary, and discipline when necessary. RDRC, WECC, and WAPA have effectively handled these issues.

While the differences between WAPA and WECC employees may create some issues, the operators and operations engineers all work well together as a single unit. The evaluation team commends RDRC's WECC and WAPA staff for the joint dedication to reliable operation.

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.

RDRC has developed a comprehensive *Strategic Plan*. The *Strategic Plan* was developed with input from management, operating staff, and the balancing authorities and transmission operators within the reliability coordination footprint. Some operating staff members indicated a desire to have had more input into the strategic planning process. The *Strategic Plan* includes RDRC values of integrity, accountability, and independence. Under integrity, RDRC includes maintaining highest ethical standards and creating an environment of trust and respect. RDRC states that all levels of the organization are accountable for meeting goals and maintaining

reliability with an environment of mutual accountability. The independence value states that it must remain independent from all transmission operators, balancing authorities, and generation operators to accomplish its goal of maintaining system reliability. The team found that these values of integrity, accountability, and independence are understood and practiced by RDRC staff.

The *Strategic Plan* also includes the RDRC vision statement, mission statement, and goals. To develop the goals, RDRC conducted an internal assessment of its strengths, weaknesses, opportunities, and threats. The balancing authorities and transmission operators under RDRC reliability coordination also provided input to this analysis. RDRC developed specific goals to complete the findings of the assessment. The team reviewed these goals. While many are complete or currently being pursued some will not be completed in the time allotted in the goal. The goals are included in the operator's evaluation and are an example of the company initiative of making all staff mutually accountable. Many of the findings of this evaluation team are similar to those contained in the *Strategic Plan*. In general, the staff supports the plan objectives. Some of the staff, however, do not support all the objectives, such as some associated with Goal 8, Improved Overall Advanced Applications Usefulness. The team was impressed with the effort and vision provided by this strategic plan and commends RDRC for this effort.

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.

Management has set clear direction and priorities that are understood by the staff. As previously mentioned RDRC developed a set of corporate goals and communicated them to the staff, whose individual goals are used to meet the corporate goals. The status of the goals is discussed in monthly staff meetings, and management develops, assigns, and tracks the goals to completion.

The uncertainty of the RDRC's future as a WECC reliability coordinator is an issue that management is addressing. RDRC has difficulty filling vacant positions, but management is working on initiatives to attract and retain personal (see Section 1.2.4 for more details).

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.

Monthly meetings are used to review any close calls and lessons learned, and RDRC operators present a lessons learned session at the annual Rocky Mountain Power Pool sessions. The Desert Southwest region, however, does not have a similar plan to review the lessons learned or other operating issues. The evaluation team believes providing this review in a similar forum would benefit reliable operations.

The staff accountability for goals associated with the *Strategic Plan* is an example of keeping system reliability under constant scrutiny through self-assessments and individual performance indicators.

1.2.4 Human Resources

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

Staffing is an issue at RDRC. RDRC has three vacant positions and the potential to lose three reliability coordinators as WAPA ceases supplying staff to RDRC. WECC is adding positions, such as the training coordinators, that have been difficult to fill because of the uncertain future of the RDRC operations. The Human Resources department has recently taken several actions to help fill vacant positions and has offered a retention program. Through the retention program, employees have been assured that they will be relocated, if necessary, to one of the two WECC reliability coordination centers and compensated for relocation. The evaluation team recommends that RDRC increase the priority on filling vacant staff positions.

RDRC has maintained a policy to hire only experienced operators for reliability coordinator positions, and this experience has typically been provided from the pool of operators within its footprint. RDRC has not hired experienced support staff to perform the day-ahead studies; therefore, the evaluation team recommends formal training on study applications for support engineers.

RDRC does not have a succession plan but hopes to develop one when staff vacancies are filled. The evaluation team recommends that RDRC develop a succession plan that includes the reliability coordinators.

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.

With the small staff, communication at RDRC is largely informal, with employees regularly talking to one other. The planning engineers talk to the reliability coordinators every day when the studies are completed. The supervisor regularly stops in the control room. While the director, reliability coordination from WECC does not have scheduled routine visits, she visits the control center at least every few months.

RDRC has a monthly “all staff” meeting, with the operators on shift teleconferenced into the meeting. This meeting covers many important topics, and the operators state that it is a worthwhile meeting. The evaluation team found that the subjects and communications at the meeting are valuable to the successful operation of RDRC.

RDRC works on communication, but the operators stated they do not always receive feedback on issues they bring to the attention of management. Being away from the WECC office in Salt Lake City, they don't feel connected to the organization. Attention to these areas of concern may improve employee morale.

The director, reliability coordination participates in a weekly conference call with the operational management of the other WECC reliability coordinators and the WECC staff. This call is a forum for resolving operational issues and sharing information between organizations. The evaluation team commends RDRC for its part of the effective coordination of operations among the Western Interconnection reliability coordinators.

2. Fundamentals of Operations

2.1 General

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

RDRC has a modern EMS to monitor the portion of the interconnection for which it provides reliability coordination. RDRC collects information from the balancing authorities and transmission operators in its footprint through the communications system provided by WAPA using the intercontrol center communications protocol (ICCP). RDRC and its neighboring reliability coordinators share data over the Reliability Coordinator Information System, also via ICCP.

RDRC monitors all line flows above 100 kV in its footprint and all flows above 230 kV in the other areas in the Western Interconnection. The evaluation team finds this level acceptable. Key lower voltage lines are also monitored, and RDRC has voltage indication for most high voltage substations. RDRC collects data from the entire interconnection, including line flows, path limits, frequency points, voltage, and load shedding steps. The evaluation team commends RDRC for this wide-area view.

RDRC has graphical displays of the voltage trends for key substations but does not have a display of voltage profiles for the RDRC area. RDRC is monitoring reactive reserves in the Rocky Mountain area and developing displays for the Desert/Southwest region. The evaluation team finds this to be a critical application and supports completion of this project. While RDRC is monitoring the reactive reserves, it does not evaluate the adequacy of those reserves in real time since the real-time contingency analysis does not run consistently. The WECC seasonal studies show that the post-contingency reserves are adequate for the conditions studied. The real-time contingency analysis program evaluates post-contingency voltages, a measure of var reserve adequacy, but the program does run consistently. RDRC monitors enough frequency points to identify the expected island interfaces if the interconnection would separate and monitors frequency points outside its footprint.

RDRC monitors the real power reserves for each of the two reserve sharing groups in its footprint. It measures actual reserves against the required reserves in real time. RDRC also

monitors the performance of the reserve sharing groups during the loss of a resource but does not monitor either group's NERC disturbance control standard performance.

RDRC has an alarm system capable of establishing eight priorities but has not needed to assign all priorities. RDRC alarms for low voltage or when a line is taken out of service. The alarm system capability is well above RDRC's highest number of alarms event. RDRC monitors traffic on the EMS and has a separate system to alarm if the EMS traffic is down. The displays also change colors if data are old. The alarm monitor is not as robust as monitors in many other installations.

RDRC has signed the *NERC Reliability Coordinator Standards of Conduct* and the *NERC Reliability Data Confidentiality Agreement.* Integrity is one of the values from the *RDRC Strategic Plan*, and the team found that the staff embraces integrity, confidentiality, and the standards of conduct. RDRC maintains the level of reliability coordinator independence required by the standards of conduct. RDRC operates within WAPA, but the control room is completely separated from all WAPA operations, including any marketing functions WAPA may have. WAPA does provide the monitoring equipment, communications, and support, but the WAPA operators do not have any additional access to data than any other similar organization in the Western Interconnection. This physical separation of operators helps to ensure the independence of the RDRC.

RDRC has two daily conference calls with the two other reliability coordination centers in the Western Interconnection. RDRC does not conduct scheduled calls with the two reliability coordination centers in the Eastern Interconnection to which it has dc ties. RDRC should verify that it has necessary communication contacts and phone numbers so that it can complete such calls, if necessary, as outlined in the RDRC's agreements with the Midwest ISO and SPP. Balancing authorities and transmission operators within RDRC all regularly participate in two daily calls with the RDRC.

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.

RDRC does not own or operate electrical system components. The reliability coordinators are not responsible for switching or tagging of electrical equipment for employee or public safety. RDRC staff is in an office environment with limited exposure to safety issues. During "off hours," a single reliability coordinator works alone behind a locked door and has limited physical interaction with other employees in the building. The evaluation team recommends that RDRC add a "heart beat" monitor to verify to a second person that the reliability coordinator is safe and able to perform his or her job duties.

RDRC reviews scheduled outages for the current day and the next day to make sure that they will not have an impact on the reliable operation of the system. The reliability coordinators understand the remedial action schemes in the RDRC area. The status of each scheme is monitored on the EMS, and the operators are aware of the status. The evaluation team commends RDRC and its operators for the attention given to these important protections schemes.

The RDRC staff is experienced and has extensive knowledge of the system and the contingencies that affect its operation. The evaluation team commends the RDRC staff for its knowledge of the electrical system and its operating characteristics.

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 responsibilities of the reliability coordinators are understood and well documented. RDRC has a procedure to alleviate operating transfer capability limits on thermally limited paths within 30 minutes and stability limited paths within 20 minutes. The procedure has detailed scripts and a timeline for actions to resolve the operating transfer capability limits. RDRC also has procedures with specific scripts for capacity (reserve) deficiencies.

2.2.3 Operational Alignment

Organizational structure supports safe and reliable system operation.

RDRC was created to perform reliability coordination functions and has no other responsibilities. Functions include monitoring the reserve sharing groups and coordinating the phase shifters in the Western Interconnection.

Outage schedules are reported to the reliability coordinators by e-mail or phone. The reliability coordinator enters the schedule into an outage reporting system, which then forwards it to WECC and the other reliability coordinators. WECC is developing an advanced Coordinated Outage System report based on the existing Northwest Power Pool system for all reliability coordinators. This automated reporting system will be an improvement over the existing manual system.

RDRC has necessary operating policies and procedures. The operators were familiar with the procedures and could locate the documents quickly. RDRC primarily uses online versions of the documents and keeps few paper copies. The online documents are easier to locate, control, and keep current. RDRC has a shift-change process that includes the use of a check-off sheet. While the documentation for the shift change is brief, it is adequate.

RDRC has purchased and implemented a software database program to manage its documentation. The database enforces operator review of new documentation and changes to existing documentation, tracks documentation change status, highlights documentation changes for operator review, and provides a method for operator testing to verify that new documentation or changes to existing documentation are understood by the operators. This process is coordinated with the other Western Interconnection reliability coordinators so documentation can be shared and easily referenced. This will assist in joint document development and help reduce the differences between the reliability coordinators. The evaluation team commends RDRC for the purchase and implementation of the document management system. While the document control database has tracking features, RDRC management does not verify that the documents have been reviewed by the operators. The WECC reliability coordinator administrative assistant in Salt Lake City is the administrator of the document control database and verifies that all documents are reviewed.

The evaluation team reviewed many of the documents in the online document management system. Those in the system have been recently reviewed and updated. RDRC is in the process of putting most of the remaining documents in the system and is updating them as they are put into the system.

The evaluation team reviewed the agreements RDRC has with its balancing authorities, transmission operators, neighboring reliability coordinators, and the host services provider. The team found that RDRC had the necessary agreements, and they were up to date. The agreements establish the reliability coordinator authority with each of the entities.

The evaluation team reviewed the reliability coordinator job description and found that it provided the operator with the necessary authority to perform his or her duties. RDRC has also issued a letter of authority to the operators stating that they had authority to take all actions necessary to maintain system reliability, including interrupting firm load. The authority statement is posted in the control room. It is not posted at the backup control center.

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.

RDRC uses the Western Interconnection Path Management Process as its primary tool for congestion management. RDRC monitors the flows on the established paths and takes action when the flows exceed the limits established in the system planning studies performed by the region. The path operators determine the limits based on the conditions in the WECC seasonal studies and provide revised limits in real time to RDRC as conditions change. The limits are monitored against both scheduled and actual flows. The EMS alarms when a path reaches 95 percent of its rating and again at 100 percent. RDRC monitors the actual flows on the path and works with the path operator to reduce flows that exceed limits. The path operators will usually assist RDRC in reducing the flows, but RDRC has the authority to reduce flows and on occasion has issued a directive to do so. RDRC's cooperative relationship with the balancing authorities

and transmission operators in its footprint helps in the timely reduction of path flows to bring them within pre-established limits. The evaluation team commends RDRC for maintaining this cooperative relationship, which was verified in the questionnaire provided by the balancing authorities and transmission operators.

As part of the path management, RDRC coordinates the use of all the Western Interconnection phase shifters to control the flow on qualified paths. WECC has a process for determining qualified paths, and the companies and the region have designated RDRC to use the region phase shifter to assist in controlling the path flows.

The evaluation team recognized good coordination among the three Western Interconnection reliability coordinators and commends the reliability coordinators for working together to resolve problems. Managing the path flows and coordinating the operation of the phase shifters are examples of the cooperative relationship.

RDRC uses a state estimator with over 230 modeled contingencies and real-time contingency analysis to help find potential system problems. Since the state estimator and real time contingency analysis do not consistently solve, the operators do not trust the results and do not depend on these applications. The state estimator solves 80% of the time having recently been improved from 70%. Problems with the state estimator include a lack of timely model updates and real-time data issues. The evaluation team recommends that RDRC resolve the problems preventing the state estimator from solving in order to provide consistent and accurate real-time contingency analysis. The team also finds that the operators are not fully aware of the benefits of the real-time contingency analysis program and do not know how to correct deficiencies to help the program solve. The evaluation team recommends that RDRC provide training on the state estimator and the real-time contingency analysis program to help the operators gain familiarity with them.

RDRC does not always receive timely notification of updates to the electrical system to keep the state estimator model updated. System improvements are often completed before RDRC is notified of the change. Since this information is not available for the computer model, the model is trying to solve for the incorrect system configuration. In addition, RDRC is not always informed of rating changes. The evaluation team recommends that RDRC obtain information on new facility installations in time to add it to the model to ensure the model is correct when the equipment is put into service.

The reliability coordinators use a historical database with graphical capabilities to develop many trending displays. The operators were able to show trends for every data point the evaluation team requested to review. The operators developed the trend charts and use them to help monitor the system and evaluate system security. This graphical display of the trending is a valuable aid to the operators in performing the reliability coordinator function, and the team commends RDRC for this extensive use of the database and its trending capabilities. The trends are displayed on a large wide-screen wall monitor. Because of the operators' extensive use of trending and number of points analyzed, the evaluation team recommends that RDRC add a second monitor so the operators can display more points concurrently.

The control room has a large static map of the reliability coordination area. This map is useful in analyzing and tracking system disturbances, though it does not give the operators any indication of current system conditions. While the operators have adequate voltage indications and display them with the historical database graphical interface, they do not have a graphical view of the voltage profile. The EMS has line flows on a system overview, but it is limited by the size of the monitors. The overview can show real and reactive power flows and voltages but becomes too cluttered to provide a good overview display when looking at the entire system with all values shown. The evaluation team recommends that RDRC add a large monitor with graphical indications of the voltage profile and line flows to provide a system overview to help the operators assess the condition of the RDRC area.

RDRC has developed a graphical indication of available reserves for the Rocky Mountain area of its footprint. The evaluation team finds this helpful in evaluating reactive reserves. These displays are being developed for the Desert/Southwest area, and the evaluation team encourages RDRC to complete this addition.

Status changes to the generator automatic voltage regulators and power system stabilizers are reported to the reliability coordinator. These devices are normally enabled and seldom out of service. Any outages have been brief, so the reliability coordinator has not modeled the devices out of service in the EMS.

The reliability coordinators do not have the voltage requirements for the nuclear power plant in its footprint. The evaluation team recommends that RDRC obtain the required nuclear plant substation voltage limits and minimum transmission system configuration requirements and update voltage monitoring in the EMS accordingly, so RDRC can evaluate post-contingency conditions.

A list of key facilities has been determined. RDRC monitors and analyzes the flows and voltages on these key facilities to ensure they are operated within their limits.

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.

RDRC is prepared to manage and mitigate the impact of system emergencies in order to preserve the reliability of the electric system. RDRC has the necessary procedures and documentation for emergency events. The operators were familiar with the processes and could quickly access the emergency procedures. All emergency procedures were current, each having been reviewed or updated in the past 12 months.

RDRC has a system operating limit/interconnection reliability operating limit management procedure that requires the system loading to be brought within the limit in 20 minutes for stability and 30 minutes for thermal loading.

RDRC has two comprehensive system restoration plans: one for the Rocky Mountain area and one for the Desert/Southwest area. The plans assign responsibilities to the reliability coordinators, balancing authority operators, and transmission operators. The individual transmission operators are largely responsible for developing islands, and the reliability coordinator coordinates the connection of islands. RDRC approves all energizing of lines 345 kV and higher. The plans did not have guidelines for tying islands together. The operators have knowledge of the required conditions for synchronizing islands and used these during the restoration drills, but they are not documented. The team suggests developing guidelines around the operators' knowledge and reviewing other available resources, such as the NERC training document *Synchronizing Islands Overview*.

RDRC conducts two annual restoration drills: one for the Rocky Mountain region and one for the Desert/Southwest. The training for the drills includes review of the restoration procedures. The evaluation team commends RDRC for conducting and leading these drills. RDRC operators are not required to participate in an annual restoration drill.

RDRC monitors the area control error for all the balancing authorities and the entire footprint, and has defined actions to take for individual and region supply deficiencies. Each balancing authority has a capacity and energy emergency plan, and RDRC has procedures to require implementation of the plan if necessary after reviewing other potential actions, such as supplying power from other areas. RDRC also monitors the reserves for each of the two reserve sharing groups to verify adequate capacity for its region. RDRC issues emergency energy adequacy alerts if capacity is deficient.

3. Fundamentals of Maintenance

3.1 General

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

RDRC is not responsible for any electrical maintenance. RDRC can obtain relay and fault recorder information, but the region perform studies or investigations and would be more likely to request the information. The reliability coordinator can suspend maintenance if necessary to protect system reliability. The reliability coordinator would look at delaying the outages for maintenance in the next-day or current-day time frame.

3.2 Equipment Reliability

3.2.1 Equipment Performance

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

The EMS has an availability of over 99.99%, and the evaluation team found that to be acceptable. The operators were satisfied with the EMS availability. The state estimator solves only 80% of the time, which is not acceptable. The evaluation team believes that the state estimator and real-time contingency analysis are valuable in determining the security of the electric system, especially after a disturbance. Real-time contingency analysis would provide the RDRC reliability coordinators with the contingency line loading prior to the revised path limit posting.

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.

Computer hardware and software repair and improvement projects, other than the EMS, are tracked with trouble tickets. The trouble tickets monitor the progress of the work and are logged when the project is completed. EMS quick-fixes are implemented when a problem is found or an improvement suggested. EMS longer-term fixes are initiated and completed with an e-mail record. Tracking of these EMS changes is fairly informal.

Telephone and communication equipment is checked daily and repaired as needed.

4. Fundamentals of Operational Planning

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

The operations engineers study the system conditions for the next day and current day to evaluate for post-contingency thermal overloads and voltages. RDRC does not have a voltage stability tool to evaluate potential issues. The RDRC staff indicated that obtaining the stability study software is not a high priority since studies do not show that the RDRC area has stability or voltage problems at this time.

The operations engineers use the EMS state estimator model and contingency analysis for the current-day and next-day planning studies. The engineering staff is able to use a solved case from the saved cases to run the studies. The expected system configuration is entered into a saved case with a similar expected weather and load pattern. The operations engineer adjusts the loading for the expected peak or expected conditions for the time he is studying. If the operations engineer finds a problem, the reliability coordinator will work with the balancing authorities and transmission providers to resolve it.

This process produces satisfactory results most of the time. Often, the operations engineer finds contingency overloads on the system using the saved case only to find that the transmission operator is aware of the problem and plans a different unit dispatch than in the saved case. This occurs because the operational planners are using the saved case unit dispatches adjusted to meet the forecasted peak. The evaluation team recommends that RDRC obtain forecasted hourly load and generation dispatch schedules to improve the accuracy of its studies. The operation planners are only running the study for the peak case. Hourly information would allow additional daily

studies for various hours during the upcoming day. RDRC has had high flows during non-peak hours because of economic transfers, and hourly information would allow RDRC to better evaluate the system security at these times.

Portions of the state estimator model are not accurate. RDRC does not always obtain information on electrical system modifications or rating changes until after the changes are made, sometimes discovering this when the model fails to solve because of the changes. This causes problems for the study applications in addition to the real-time contingency analysis. Portions of the model have not been updated recently, and this affects the accuracy of the state estimator solutions and the contingency analysis. Rating changes are to be communicated on the daily conference call, but this method has not proved to be reliable. The evaluation team recommends that the state estimator performance data be improved for greater accuracy of the next-day and current-day study results. The Western Interconnection reliability coordinators are developing an interconnection-wide planning model, called the West Wide Model, to use in planning studies, which should resolve many of the problems with the current model.

RDRC gets timely outage information. Outage schedules are required to be provided to RDRC at least seven days prior to the outage. The outages are sent by e-mail to a posted location and are then manually entered into a database by the operations engineers. RDRC is implementing an automated system, similar to one used by the Northwest Power Pool. The team supports automating this process to reduce engineer time required, increase accuracy, and make it more readily available to other reliability entities. Entities do not get approval from RDRC to start an outage. Unless RDRC or another entity finds a problem with a planned outage, the outage will proceed as scheduled.

Outage schedules and study results are shared with the transmission operators and neighboring Western Interconnection reliability coordinators. RDRC has arrangements for the neighboring reliability coordinators to provide backup capability to perform the current and next-day studies, but the neighboring reliability coordinators do not have all the contingencies modeled. RDRC, who would provide backup for the other reliability coordinators, does not have the other reliability area's model as detailed or all the contingencies included. The team does not believe that the reliability coordinators study backup capability is adequate to backup the operations planning. However the evaluation team did not find an issue with this since full backup of day-ahead study capability is not required in WECC reliability coordinator agreements. RDRC staff has a good relation with the neighboring reliability coordinators as demonstrated by the backup functions they perform for each other.

Seasonal and longer-term planning studies are not performed by RDRC. WECC performs summer, winter, and spring/fall planning studies, and study results are available to RDRC. The WECC studies include sensitivity studies and are used to set the path limits. RDRC operations engineers participate in the WECC study groups.

The operations engineers perform after-the-fact studies using saved system data from emergency or other abnormal operating conditions. The operations engineers have added contingencies to the real-time analysis based on these studies.

The operations engineers and the reliability coordinators feel that they are doing a good job with limited time and tools. Due to staffing limitations, the operations engineers indicated that they do not have enough time to verify and update the model and have not recently compared the state estimator results to actual flows. The operators notify operations engineers of differences between the state estimator and actual flows or differences between post-contingency flows and real-time contingency results. The operations engineers have limited experience and have not received formal training on the study tools and applications. The engineers have reviewed the documentation and are largely self-taught on the tools. The evaluation team recommends that RDRC provide operations engineers with training on the study tools and EMS advanced applications.

RDRC is in the process of adding an off-line power system load flow program to its suite of study tools to further enhance the operations engineers' evaluation capabilities.

The operations engineers work closely with the reliability coordinators, jointly reviewing the current-day and next-day study results daily.

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.

While the evaluation team finds that the training program provides for the minimum requirements, it is largely informal and not well defined. As the evaluation team reviewed the training program, it found several areas for recommendations, but the need for a training coordinator is at the top of the list. At the time of the readiness evaluation, no one was assigned the duties of a trainer. The person handling training as part of his position recently left the company. WECC is attempting to fill the position; a job listing is posted and interviews have taken place. The evaluation team believes that the person filling this position will address the other training recommendations listed in the report. The team considers filling this position a key recommendation for RDRC. While many of the training recommendations could be key recommendations, the trainer WECC is planning to hire will address the other training recommendations. Therefore, RDRC and the team lead agreed that obtaining a trainer is a key recommendation.

RDRC does not have a formal documented training program for either its experienced operators or new operator trainees. RDRC keeps employee training records in a spreadsheet; however, the remaining annual training scheduled is not clear, and the supervisor did not readily know what training remained to be completed. Training objectives are not clearly defined, and training goals are not included in individual performance appraisals. The supervisor stated that differences between WECC and WAPA make it difficult to include training goals in the appraisal process. The operators decide on most of their training to meet NERC certification requirements.

The initial preparation for a new reliability coordinator is largely on-the-job training. RDRC has developed a sign-off sheet for the skills and knowledge new operators must have, but the sheet does not have details nor are the job and task needs clearly defined. Training does include RDRC values, vision, and mission. All current operators must approve the trainee for independent shift operations before the duties are assigned. The time for training new operators has been recently been shortened to about 60 days from 120 days. Some current operators are concerned that the training time allowed is marginal. RDRC management should evaluate the actual time needed and establish this in formal initial training guidelines.

RDRC does not use testing or any other formal process to verify that the operators or trainees have learned the material presented in its internal training programs. The company depends largely on operators' feedback to determine if training is effective.

After reviewing the training for both experienced and new operators, the evaluation team recommends that RDRC develop a formal training program that includes goals, objectives, and training subject matter designed to meet organizational needs, and that RDRC measure initial and continuing training programs against a systematic approach to a training model to ensure that the training program is meeting its objectives. WECC has contracted an individual to perform job and task analyses.

RDRC hosts an annual training conference that includes system restoration drills in both the Rocky Mountain and the Desert/Southwest areas for all the balancing authority and transmission operator personnel. This training is well received, and the evaluation team commends RDRC for providing this training. The reliability coordinators develop and conduct individual training sessions at this conference, including lessons learned. While most of the reliability coordinators have participated in this drill and training, the evaluation team recommends that participation be required for each reliability coordinator.

RDRC does not have a training staff, and third party providers meet most of its training requirements. The operators participate in the Pacific Northwest Security Coordinator restoration drills, the Rocky Mountain Power Pool and Desert/Southwest Power Pool training, California ISO-sponsored events, WECC training courses, and vendor training classes. The operators and support staff determine training beyond the various regional and organizational scheduled training. Since RDRC does not have a trainer, the operators are actively involved in selecting and arranging their individual training, including the required training to maintain NERC certification. The evaluation team commends the RDRC operators for their involvement in determining their training needs and arranging the training to meet these needs. After a training coordinator is hired, the operators should continue to be involved in this process.

The evaluation team recommends that the ongoing training program include the following:

- Operator training on advanced EMS applications (See Section 2.3)
- Operating engineer training on study applications (See Section 4)
- Required operator participation in annual system restoration drills

RDRC does not have access to a simulator based on its system, but RDRC employees participate in the Pacific Northwest Security Coordinator restoration drills that include training on a dispatcher training simulator. The operators and the evaluation team believe this training is valuable. However, it does not contain many scenarios of potential events on the RDRC portion of the grid. The evaluation team finds that additional simulator training would be beneficial and recommends that RDRC provide additional simulator training for its operators.

RDRC normally hires operators with extensive industry experience and an understanding of electric system operations. All recent new hires have been NERC certified with the reliability operator credential. The evaluation team reviewed the shift schedule and confirmed that all shifts are operated by a reliability coordinator with proper certification. RDRC uses a six-person rotation with a shift scheduled for relief (for vacation, holidays and sickness) and one week in six scheduled for training. This shift schedule allows for enough training time, and operators use minimal overtime for training.

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.

RDRC uses processes to reduce human errors. For example, the CAD (consults, advice, and direct) process encourages two-way communication. With this process, the reliability coordinators are encouraged to first consult with the balancing authority and transmission operators to find out information the reliability coordinators may not have. This helps them obtain all the information before making decisions. The second step in to advise the operator. In this way, the reliability and the balancing authority or transmission operator are both part of the decision-making process and both have ownership in the decision. Again, with two agreeing on the decision, the probability of error or faulty judgment is reduced. After the above steps, the reliability coordinator will issue a directive if necessary. The reliability coordinators keep the final authority necessary for reliable operation of the electric system.

A second process involves three-way communications with the directive issued by the reliability coordinator, repeated back by the operators, and then reaffirmed by the reliability coordinator. This minimizes the potential for misunderstanding. The protocol is reviewed in actual events, and RDRC has determined that proper protocol is normally, but not always, used. RDRC is emphasizing the use of proper protocol.

RDRC covers lessons learned in its monthly staff meetings and the Rocky Mountain Power Pool operator annual training sessions. RDRC does not offer risk-analysis training or have risk-analysis procedures.

APPENDIX 1: Critical Infrastructure

The following discussion will be presented under private letter to the evaluated entity only and will not be included within the public version of the report.

APPENDIX 2: Entity Participants

The following will be presented under private letter to the evaluated entity only and will not be included within the public version of the report.

APPENDIX 3: Documents Reviewed

The following will be presented under private letter to the evaluated entity only and will not be included within the public version of the report.