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Critical Needs for Distribution System Operations

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Technical Update, December 2005

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ABSTRACT

The electric power distribution system (voltages up to 35 kV) is the most extensive network. While the operation of this system is of great importance from the reliability and safety point of view, managing this network varies among utilities from cases where modern distribution management systems are utilized to cases of minimal central operational capability. Distribution Management Systems (DMS) provide real time information to DSOs for the continuous moment by moment (24 hours a day, 7 days a week) operation of the system. The quality of the decisions made by the operating personnel at electric utilities depends upon the sophistication of the DMS, visibility of the distribution system via data acquisition, data processing algorithms and visualization software, and the applications software associated with the DMS. Many times the decisions may have to be taken quickly and affect the operating cost, system reliability and equipment life. An important task of the DSOs is the management of switching operations. The safety and reliability of switching operations has been an on-going concern in the utility industry. Improvements in management of switching operations are a critical need for DSOs. This project has identified specific improvements that will go beyond management of switching operations and they will drastically improve the overall operation of distribution systems.

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1 INTRODUCTION

DSOs are responsible for managing the day-to-day operations of our distribution systems, 24 hours a day, 7 days a week. Moment by moment every day, and often instantaneously, decisions are made in DSO centers that affect reliability, equipment life, and operating costs. The nature of the responsibility, potential for errors and the significant impact of missteps lead to the development of procedures, practices, and record keeping that are useful but often expensive. Companies have made varying improvements in the operation of DSOs, both in equipment and in adapting to the level of automation, and have continually updated procedures. However, they continue to seek ways to reduce costs and improve effectiveness. Further, practices, equipment, and tools, as well as the skills required in DSOs must advance as the distribution systems progresses toward the system of the future with expanded automation, eventually leading to advanced distribution automation.

This project has researched practices and equipment in current use at DSO centers to identify strategic opportunities to reduce costs, achieve efficiency gains, and further minimize the risks associated with DSOs. This has been done by conducting surveys on practices being used, identifying problems and providing potential solutions. The assessment will also consider preparation for future distribution systems, designs, and control equipment.

An important responsibility of DSOs is the management of switching operations. Switching safety and avoidance of switching incidents is an on-going concern for both transmission and distribution systems. The number of switching incidents is very small compared to the number of switching operations performed and, therefore, from a reliability point of view, the probability of a switching incident is very-very small. Yet, utilities strive for a perfect system. There is a tremendous amount of work and procedures already in place that minimize the possibility of errors. Yet, because many of the procedures rely on paper switching orders and communications among many participants, a very small probability exists for documentation errors and information discrepancy that may lead to a switching incident.

Sources of error can run all the way back to the availability of data to the system operators, whether its accuracy, timeliness or user-friendly presentation. During trigger events that call for so-called unscheduled activities, the amount of data that needs interpretation and solidification into tangible operating decisions and in some cases switching orders increases the opportunity for error.

The present research project addresses the following question: How can these influences and environments be improved to make the operator's efforts more efficient and accurate all the way down to the switchman in the field poised to perform a switching operation? This question is addressed in a multi-step procedure that includes: (a) review of EPRI's prior research in the area, (b) review of presentations and opinions of experts, (c) interviews with managers and engineers of systems operations, (d) review of capabilities of commercially available products for distribution management and (e) expressing our own proposal for improving the state of the art in the areas that have been identified as critical.

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2 CURRENT PRACTICES AND PAST RESEARCH REVIEW

There is a plethora of work relative to operating center, data acquisition, status identification and switching operations. EPRI has sponsored several programs for improving operations tasks and activities that span from procedures and documentation of steps to human behavior and acceptance of procedures. EPRI conferences have brought together folks from utilities, universities, vendors and consultants to discuss the issues involved, what leads to switching incidents and what steps need to be taken to improve performance. All of this work indicates that any utility willing to improve their performance relative to switching operations can find a plethora of information to do so. In addition, distribution management systems have improved and there are many vendors that offer sophisticated distribution management systems that have the capability to implement specific procedures for switching and tagging equipment. These systems require substantial instrumentation at the distribution level something that has great variability among utilities. One observation is that while the distribution management systems offer a good way to monitor the real time operation of the distribution system, the interaction with field personnel regarding switching is typically manual, by phone and by paperwork. This state-of-the-art generates opportunities for miscommunications, a frequent cause of switching incidents.

In this section we summarize the existing work with critical comments.

Review of Recent EPRI Research on Switching Safety and Reliability

Prior work by EPRI on switching incidents was reviewed. Specifically, the final reports for the following projects were reviewed:

1. EPRI Report 1011659, A Definition of "Switching Error": Toward a Common Nomenclature of Switching Incidents, Technical Update May 2005
2. EPRI Report 1011267, Switching and Tagging Performance Standards and On-the-Job Assessments, Technical Update October 2004
3. EPRI Report 1008692, Job and Task Analysis to Identify Failure Points in Switching Operations, Final Report October 2004
4. EPRI Report 1008685, Processing Outage Requests and Writing Switching Instructions, Technical Update October 2004
5. EPRI Report 1002077, Incident Investigation and Reporting, Final Report May 2003
6. EPRI Report 1001956, Collecting and Using Near-Miss Information, Level 2 Report September 2001
7. EPRI Report 1001789, Generic Job and Task Analysis: Handling Planned Outages and Hot Line Work, Final Report September 2002

8. EPRI Topical Report 1000123, Switching Practices Survey: Toward Improved Safety and Reliability, Topical Report June 2000

EPRI Report 1011659 focused on analyzing switching incidents from the participating utilities and provided definitions for common reporting practices. Note that reporting practices do vary substantially among utilities. There are three categories of switching incidents: (a) switching that leave the system in an unintended state and results in customer outages or other undesirable effects, (b) switching that leave the system in an unintended state but do not result in customer outages or other events, and (c) violations of clearances and tagging that do not result in an undesirable event but do have the potential for customer outages or undesirable events.

EPRI Report 1011267 describes "on-the-job performance" assessment techniques developed from experience from a large number of switching incidents. These techniques are very important for both field personnel and system operators to minimize the possibility of switching incidents and to maximize the safety of switching and tagging operations. The report provides useful performance assessment forms (for field switch-persons and system operators) that meet OSHA requirements.

EPRI Report 1008692 entitled "Job and Task Analysis to Identify Failure Points in Switching Operations" provides an analysis of the existing deficiencies and proposes a model of switching operations including the humans in the loop. The majority of identified deficiencies were in information gathering and planning tasks performed by the CCO involving use of documentation, though there were four cases of the most common of all errors, operating the wrong control. The proposed model (borrowed from other enterprises) of task analysis of human behavior is very helpful in analyzing switching operations for the purpose of identifying the weak links in the sense of risk for human error. Understanding the relationships between procedures and possibility of humans deviating from these procedures is useful information that can be utilized in modifying procedures that will be more robust and minimize human error. A large number of switching incidents were analyzed using this method. The most common human error was the operation of the wrong device. This suggests lapses in situational awareness in terms of the actual system and identification of equipment before execution of switching.

EPRI Report 1008685 entitled "Processing Outage Requests and Writing Switching Instructions" provides a methodology for writing switching instructions with safeguards to minimize switching incidents. Specifically, the proposed approach and specific switching order writing and procedures are based on previous EPRI research that identified the main reasons for switching incidents. The proposed switching procedures have incorporated specific steps that minimize the probability of these errors occurring. The proposed model defines the interactions and responsibilities among three entities involved in a switching operation: (a) field crew leader, (b) outage scheduler and (c) system operator. Each entity involved in the process has clear definition of tasks and responsibilities. The procedure is based on verification/impact study/coordination/approval/refusal of the requested order. The basic principles in designing the management system are: (a) the system should have the capability to identify conflicts with other switching orders, (b) the system should be capable to determine the correctness of a switching operation from real time data and (c) it should provide instant feedback to field personnel (new hardware) by analyzing impacts on the system and provide instant feedback.

EPRI Report 1002077 entitled "Incident Investigation and Reporting" provides systematic approaches to investigating the root causes of switching incidents. It provides useful aids for investigating incidents in the form of recommended procedural steps leading to the identification of the root cause. The objective of the proposed procedures is to identify specific improvements and best practices.

EPRI Report 1001956 entitled "Collecting and Using Near-Miss Information" focuses on retrieving near-miss incidents, analyzing them and determining the causes that brought the system near a switching incident. This information is equally useful as the information obtained from actual switching incidents.

EPRI Report 1001789 entitled "Generic Job and Task Analysis: Handling Planned Outages and Hot Line Work" focuses on developing a set of steps in any implementation of a planned outage (switching order) and a master set of knowledge areas required from all switching personnel.

EPRI Report 1001789 (June 2000) entitled "Switching Practices Survey: Towards Improved Safety and Reliability" includes the results of a survey of existing switching operation practices of that time. The report identifies the commonalities in the practice of switching operations and formulates the "best practice".

Review of Last EPRI Conference on Switching Safety and Reliability

In addition, the presentations at the recent EPRI 2005 Switching Safety and Reliability Conference were reviewed. The following persons have contributed to the background information and identification of problems.

1. Steven R. Hursh, Professor John Hopkins University, School of Medicine, "Managing Fatigue in 24/7 Operations".
2. Dennis Rasmusson, ALTA Link, "Reducing Human Error Through the Use of a Switching Simulator".
3. Jack Vranish, PacifiCorp, "Design and Implementation of Switching Program Improvements at PacifiCorp".
4. Dan Marble, BCTC, "Revitalizing Zero Interruptions due to Preventable Outages (ZIPO) Program".
5. Richard Dearman, TVA, "Changing the Culture: Engaging the Organization to Reduce Human Errors".
6. Maureen Long, Log Consulting, "Personal Barriers to Errors: One Dog-One Bone".
7. David Ziebell, Human Performance Technology, "Capturing Undocumented Knowledge: Situational Awareness for Sustained Performance".
8. Daniel Sun, Sun-Net Consulting Inc., "Enhance, Simplify and Streamline your Outage Coordination and Daily Operation".
9. Arthur Bear, Beare Ergonomics, "Study of Outage Requests & Clearance Forms – EPRI Research Report".

10. Chuck Owens, TVA, Conference Switching and How We Prepare and Perform It".
11. Marc Ronne, Nebraska Public Power District, "Challenges for Distribution Switching".
12. Steve Millica, Oklahoma Gas and Electric, "Error-Free Switching Team".
13. Pete Miller, WAPA, "Pre Switching Inspection".
14. Rudy Francin, Consolidated Edison Co., KY, "District Operator Qualification Program".
15. Nick Gill, Mid American, "Merging Switching Jurisdictions".
16. Arthur Bear, Beare Ergonomics, "42 Things You Can Do to Help Reduce Errors".
17. Eduardo Salas, University of Central Florida, "Establishing and Maintaining Individual and Team Situation Awareness: Observations and Tips".
18. Eric Linker, Duke, "Emergency Service Response: A Restoration Disaster".
19. Dennis Caufield, CenterPoint Energy, "Standards for One-Line Diagrams Used for Switching".
20. Pat Budler, Nebraska Public Power District, "A Lesson in Human Performance".
21. Milo Blair, Consolidated Edison of New York, "Operating Event Analysis Team".
22. Kevin Dunham, Chugach Electric Association, Inc., "Multiple Errors: When One Error Leads to Another".

The presentations in this conference included experiences from utilities as well as with programs developed in utilities for the purpose of minimizing switching incidents. They also include work by consultants specializing in switching orders and development of procedures that minimize the probability of missteps and eventual switching incident. It also includes information regarding research into the human behavior and models that capture the relationship among fatigue due to long hours, sleepiness due to lack of enough bed time and human errors. Specific examples of switching incidents vividly provide the anatomy of switching incidents. Some utilities have systematic programs that aim at reducing or eradicating switching incidents.

Almost unanimously, it is believed that situational awareness is the single most important thing that prevents switching accidents, maximizes personal safety and maximizes system reliability. It is also recognized that achieving situational awareness may require inputs from other sources, for example, a situation where a switching may trigger a protective relay operation that cannot be predicted by the field crew or the system operator – a relay engineer may be needed to predict this response. One utility is experimenting with the "virtual switcher" a software package that tries to simulate switching operations and their effects. They also use this as a training tool. This approach is quite promising but the state of the art in this particular instance is not well developed. The presentations relay the message that improvements in the area of situational awareness are important and needed.

Another quite common belief, and justifiably so, is that field crew training is a very important deterrent of switching incidents. Indeed a well trained field crew is better equipped to assess field conditions, comprehend the situation, better identify equipment, better understand drawings and better execution of switching orders.

The anatomy of a switching incident, as in most accidents, is resembled to a sequence of events whereby many improbable events align to generate the conditions for the wrong "step" that will lead to an incident. This is a well accepted explanation of switching incidents or any other accidents. Given this theory, the best defense against switching incidents is to design and place in operation a number of barriers that will disrupt the alignment of missteps and therefore will avert switching incidents. The barriers to improbable errors are: (a) training of personnel both field crew and system operators, (b) tools for assessing the situation and help understand the effects of switching, (c) procedures whereby there is review of the various steps from other knowledgeable and experienced personnel and (c) work practices including proper rest, avoidance of distractions, double checking among field personnel, and communication skills. The models for proper switching procedures, from requesting a switching order to final execution of the switching operation are based on the previous mentioned barriers to errors.

The presentations at the EPRI conference are consistent with the comments provided by the interviewees – see section 4.

Review of Vendor Capability

The review of vendor capability in terms of control room data availability and presentation, switching monitoring, tagging and safeguards was based on an evaluation of vendor advertised capabilities, vendor presentations and user comments. Vendors have substantial web sites with much information about their systems posted on their web sites. It is important to note that there are many vendors with similar products and the survey was limited to only four (the major suppliers). To avoid any issues of equal treatment, claims of mischaracterization, etc. the specific names of the manufacturers will not be mentioned. Generic comments are provided that characterize the capability of available systems to help and improve the effectiveness of the operations room environment and downstream switching operations.

Distribution SCADA are available from a variety of vendors. The technology for distribution SCADA varies with some vendors offering the traditional approaches while others offer integration of non-conventional SCADA into the overall scheme such as capacitor controllers, feeder management relays, etc. The field is dynamic and there is a variety of systems and solutions with the generic name of distribution automation. Communications is the key parameter. Advances are being made and the developments are driven by new technologies. As these developments move forward, the amount and quality of available raw data will increase.

All major vendors provide the capability for including tagging within the SCADA database. User defined notes and forms can be implemented. Therefore the forms developed by previous EPRI research can be integrated into the existing tools of major vendors of distribution management systems. The major vendors also provide software for outage management or switching management (different vendors use different names). User interfaces for these products are in relatively good form. The important key issues are: (a) the degree of integration with the network model and the other application programs, (b) the level of filtering of raw data to detect, identify and correct bad data, and (c) the availability of this information to remote sites via corporate networks or internet, etc. Vendors vary in these three key issues. We believe that outage or switching management systems should be fully integrated and operate on the same real time data base as all other functions of the distribution management system. The state of the art in filtering distribution SCADA data is not as well developed as in the case of energy management systems

for transmission networks. One of the reasons is the distributed nature of the loads that makes the models for state estimation and filtering of data very complicated. Therefore improvements can be made in the area of integration and filtering of distribution SCADA data.

An important aspect of distribution management systems is the application software, such as fault analysis, switching order simulation, load forecast, voltage control, load management, load shedding, power factor control, and others. Uniformly, vendors use models based on symmetrical components for all these applications. The symmetrical components represent an approximation of the systems and result in less accurate representation of the actual system. This is also true for transmission systems. However, in the case of distribution systems the errors and differences with the real world can be substantial higher. This is an area where improvements will result in more accurate prediction of the effects of switching orders, and better management of the distribution system. In addition, the protective system is independent from the network model. Therefore any simulation of a switching order will not include an automatic evaluation of relay response. The prediction of the relay response can be made based on review of the analysis results, that is, a two step process with able opportunity of misinterpretation and incorrect decisions.

Another important aspect is the user interface. The major vendors have developed quite sophisticated user interfaces. Yet, this is an area of intense research and developmental efforts by many organizations. There is the potential for many improvements that will make the work of DSO much easier and much more robust and free of potential misinterpretation and errors. Recent activities on visualization and animation for transmission management systems should find its way to distribution management systems. The user interfaces should address the needs not only of the system operators but also of the field crews as the need for providing the same information to field crews is addressed.

3 INTERVIEWS – SUMMARY AND CONCLUSIONS

A total of 26 prospective utilities were contacted in regard to this survey. Responses were obtained from 18 from this pool (69%). This section presents a summary of the responses. Observations and conclusions are provided on the overall responses. The survey/interview sample is found in Appendix A – Interview/Survey Questionaire. The respondents to the interview are shown in Appendix B – Interview/Survey Responses. The interview data sheets are also found in Interview Responses

The companies represented by the interviewees range from small to very large in size. Comparison statistics from the reporting group are as follows:

- MW Load ranged from 100 MW to 31,000 MW
- Customer types included all retail, all wholesale and a mixture of both
- Customer counts ranged from 45,000 to 8,500,000
- Number of circuits operated ranged from 26 to 3,500
- Circuit operating voltages ranged from 4.8 kV to 500 kV

The track records of switching incidents are as follows:

- Minimum number in any year (per 1000 MW): 0
- Maximum number in any year (per 1000 MW): 1
- Average number per year (per 1000 MW): <1

The switching incidents that were reported had the following results:

- Produced outages from 0 to 150,000 customers per incident
- No associated cost impact, up to $7 million in replacement power cost
- Two incidents involved grounding switches

The switching procedures ranged from informal to formal; the common themes are represented by the following responses of one utility:

- "Switching orders are drawn up by the system control center. The system control center operator instructs the field switchmen on a step by step basis to execute each switching order".
- Lock-Out/Tag-Out procedures are relied upon

A majority of the responders relied upon repeating/reading-back of the orders as a measure to assure proper understanding of the orders. Most reviewed, after the fact, the switching to ascertain the compliance of the switching procedures.

The prevalent grounding procedure adhered to by most respondents was to follow formalized "Lock-Out/Tag-Out" rules and to use the old stand-by of "if it isn't grounded it isn't de-energized".

Training provided to system operators and switching personnel varied but was undertaken by most utilities. Training was often noted as a key need for improvement in the operations environment. Some of the common responses were:

- Formal transmission operator and electrician / operator training class with pass / fail requirements.
- On the job training (OJT)
- Training provided by wholesale power provider

Remote information gathering and control were available to several of the responding utilities; the percentages that had such are as follows:

- SCADA ~ 85%
- Distribution Automation (DA) ~ 50% reported some DA

Most of the 11 utilities reporting SCADA said that they had the following "real-time" information available:

- Circuit/line loading
- Open Switches
- Tagged Switches
- Transformer loading

All but one of the utilities that operated distribution reported operating only 1 Distribution Operation Center (DOC). When transmission was also a component of the utility, the DOC was common to the TOC in a majority of the companies.

In dealing with major events most of the responding utilities did not operate differently other than activating additional dispatchers. The majority also indicated that a priority list for restoration is available via comments such as:

- "Yes, a "priority loads" list, which identifies primary and secondary critical loads for the safety of the community. Also, we prioritize switching loads back on by magnitude of customers that could be returned to service, i.e. switch a transmission circuit back on first, then a feeder, then a lateral".

About 50% of the respondents indicated that they were aware of the Annual Power Switching and Reliability Conference with the same percentage saying that they have attended at least one of the conferences. The larger of the utilities were mostly the ones that made use of the conferences.

Almost unanimous was the comment that additional training would be very useful. Other suggestions were for more down-line information/automation and three respondents said the following:

- "In our case, we have a Distribution SCADA system and an OMS system that we operate. In addition, we have our Transmission SCADA system that we can see but do not operate. None of these systems are interfaced with each other. So, in some cases we need to address the same issue with all three systems".
- Technology: The integration of system operations tools, real time data, and switching information is currently the biggest challenge. This needs to be pulled together and presented to the operator in a simple and easy to use platform to allow the system operators to make better decisions. Real time versus system planning data readily available for on-the-fly what-if's to determine how effectively to pick up load.
- Company is introducing switching simulator software as a different approach to switchmen training. This tool is also able to permit a qualified switchman to practice switching in a virtual environment at any time.

Note that above comments indicate the recognition that technology in the form of an integrated information system with system simulation capabilities and accessible by both the system operator and the field switchman is the key in improving situational awareness and minimizing switching incidents.

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4 PROPOSED IMPROVEMENTS

The objectives of distribution system operators are to operate the system in a highly reliable manner, maintain proper voltage profile throughout the system, minimize operating cost and safely and reliably manage the day to day switching operations. In this report we focus on the safe and reliable management of daily switching operations. However the proposed improvements also form the basis for improvements in the other objectives of the distribution system operation.

The recurring issues/causes in switching incidents can be classified into the following categories:

(a) Field conditions different from documented in instructions.

(b) Incorrect instructions/information to switching personnel

(c) Incorrect designation of equipment leading to switching wrong device

(d) Human failure to follow switching instructions (complacency)

(e) Unintended operation of protective devices due to a switching

In addition, one item that has not been mentioned in the work relative to switching is grounding. Specifically, two issues are involved: (a) hand operated switches should require that field persons inspect the grounding around the switch to make sure it is safe to operate the switch prior to the execution of the switching order, and (b) in case that the reason for switching is to perform maintenance on a piece of equipment, it is then necessary to install temporary grounds prior to the commencement of maintenance. It may be advisable to integrate these procedures in to the switching protocol.

Switching procedures are typically well thought out based on standard protocols. Switching incidents generally occur because of lapses in execution. Therefore, the issue becomes one of what safeguards can be developed to avoid these "lapses" that may be in the form of (a) wrong identification of switching device, (b) incorrect information about status of devices, etc.

The previous analysis of existing procedures and performance indicates that the majority of utilities are (a) content with the procedures they have in place, (b) they will evaluate any new methodologies for improving switching operations and (c) they tend to believe that new technology may help to alleviate and possibly eliminate switching incidents.

Our review of the state-of-the-art tends to agree with the notion that switching procedures are well thought out, the number of switching incidents is relatively very low and that new technology may help to further minimize switching incidents and possibly eliminate them. Along these lines we propose two directions that will respond to this need: (a) improvements in

distribution management systems and (b) use of new technology that transmits the real time information of the distribution management system to field personnel and new technology that identifies any discrepancies and issues warnings and initiates procedures for correcting the real time information. The proposed improvements are discussed next.

Improvements in Distribution Management Systems

The state-of-the-art in distribution management systems has enjoyed great advances lately. Systems have been developed that represent the topology of the network in geographic coordinates (GIS), they manage switching orders and keep track of tags, simulate switching orders to evaluate the effects, the information is available over corporate networks (or reluctantly on the internet), they automatically generate appropriate paperwork, etc. Yet, there is plenty of room for improvements.

Presently, three phase models of distribution systems depend on positive, negative and zero sequence components. This approach results in an abstract representation of the distribution system which is also an approximation of the real world. One solution is to move to physically based modeling that simply represents the actual construction of the circuit, substation, type and size of conductors, switches, breakers, fuses, etc. This approach should be linked to Geographical Information Systems (GIS) so that locating equipment, sending linemen to equipment, etc. can be automated. Examples of what can be developed by this modeling approach are shown in Figures 4.1, 4.2 and 4.3. The importance of this approach is that it will enable system operators and field personnel to view and understand the same model. As a matter of fact, technology exists today to move this modeling approach into a "virtual reality" environment. The virtual reality will allow the user to navigate through the three dimensional model, to inspect the status of a switch, etc. much the same way as the video games. At the same time, the proposed model is a very accurate and realistic representation of the power system. The electrical parameters and the overall mathematical model can be computed from the physical construction of the system without any approximations (such as the symmetrical components) and most importantly, the mathematical model will be transparent to the user. Since the physical model or the "virtual reality" model is "what you see is what you get" it helps eliminate any modeling errors. Actual pictures of the facility can be imbedded in this system for inspection of the model and verification. Another advantage of the proposed modeling approach is the ability to include the grounding model of the system. This is very important in the analysis of distribution systems as many times fault currents and the response of the system to other disturbances depends on the grounding arrangements and parameters of the grounds.

Another issue that contributes to switching incidents is the unintended operation of protective devices. A solution to this problem is to integrate the protective system model into the physically based model. The virtual reality environment will permit the user to visualize the operation of the relays and inspect the readings of the relays and any flag, trip signal, etc. Thus the virtual system will act as an expert reviewer of a switching order.

At first glance, this modeling approach and virtual reality environment may appear to be an extremely manpower intensive process. In reality it is not much more time consuming than the present approach for building databases. The advantages will be tremendous. The system

operator and field personnel will be viewing practically the same system and they will "talk the same language" so to speak. This is very important since presently system operators are in general more trained in understanding the typical single line diagrams that are modeled in terms of mathematically abstract impedances while field personnel are not so well trained in this area. By making the mathematical model transparent to the system operator and field personnel alike and providing a physically based model the two groups will communicate on the basis of the physical system. This approach practically eliminates the training gap between the two groups.

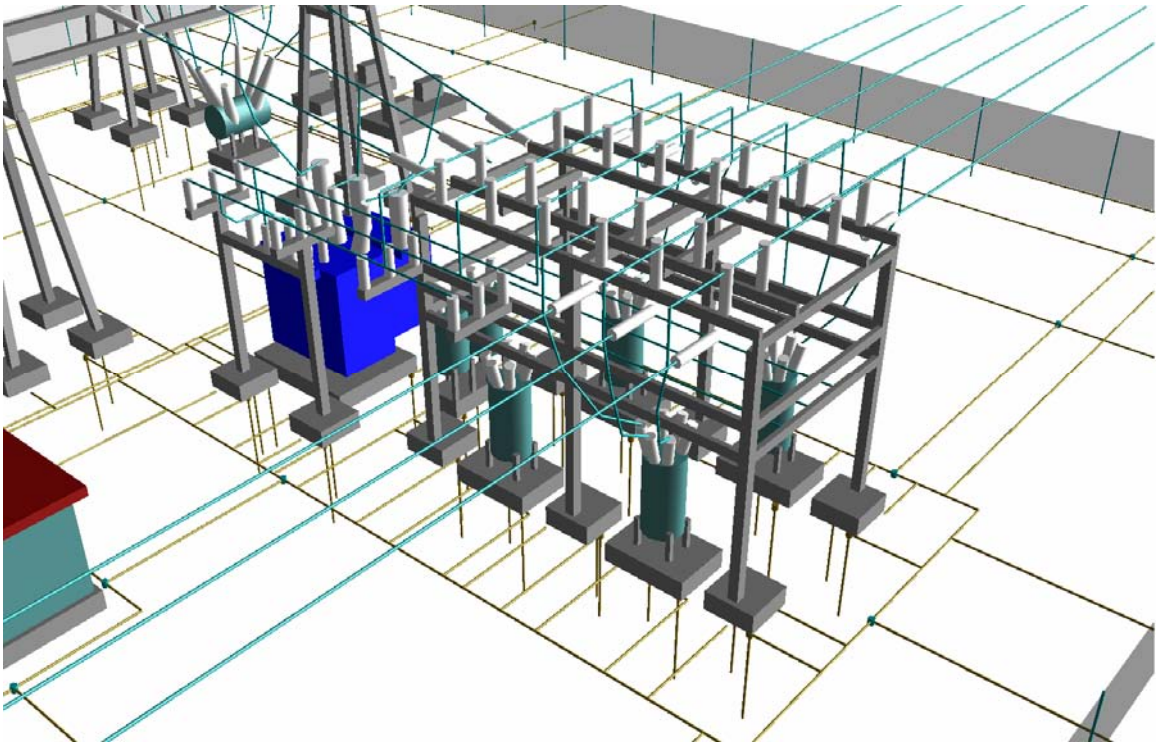

Figure 4-1
Example of Physically Based Modeling of a Substation

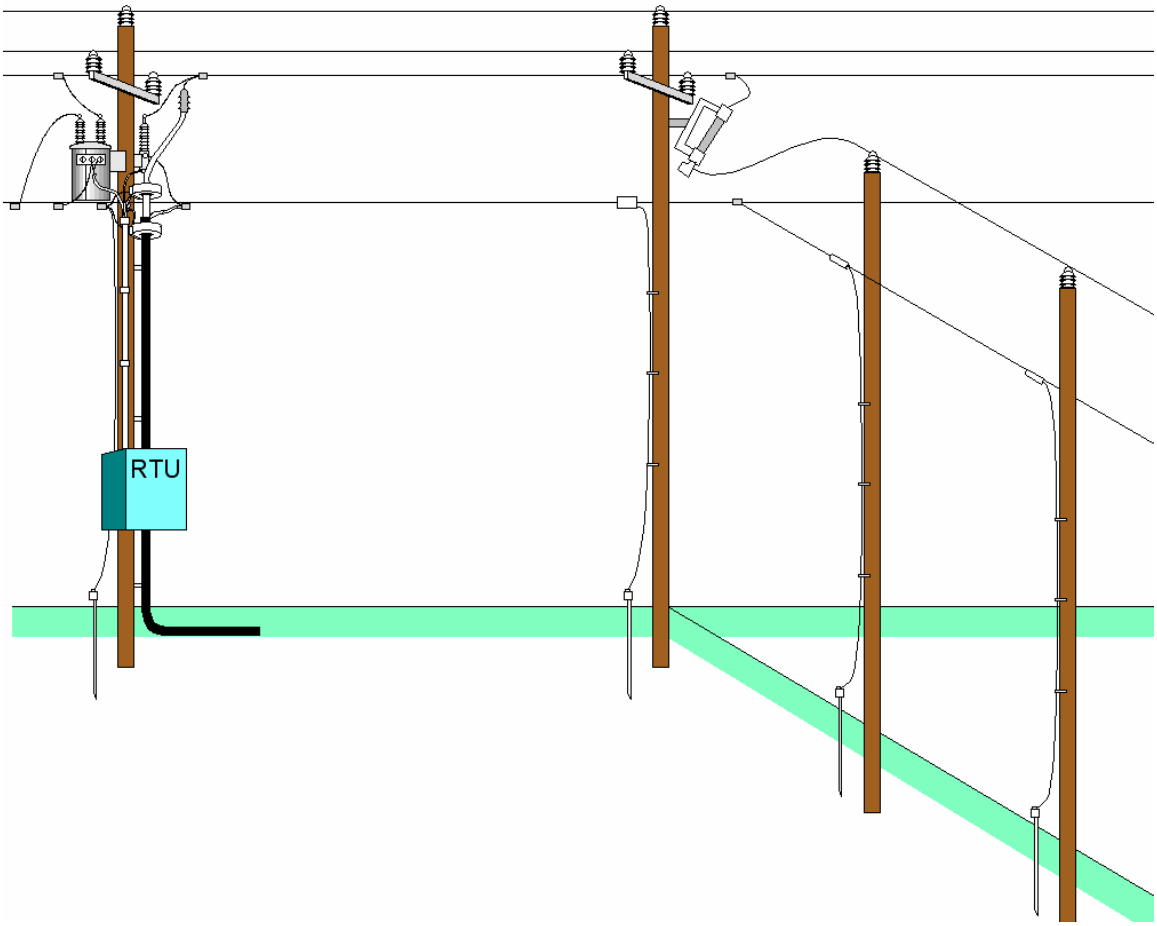

Figure 4-2
Example of Physically Based Modeling of a Distribution Line with URD Cable and Single Phase Lateral

A very important benefit from this modeling approach is the ability to extract the real time operating model of the system from measurements at the substation and along the distribution system. For example, cases of a stuck pole in a breaker or switch can be identified. The physically-based model approach is a step-up from existing state estimation methods for distribution systems. The end result will be the condition of each switch, breaker, fuse, recloser, etc. in the system with specific information for each phase, in case of three phase system. This information is extremely valuable to system operators who are responsible for coordinating switching operations, authorizing such operations and monitoring the work in the field. For example in case of a field error such as switching the wrong equipment, the system operator will have this information within a matter of seconds that the wrong equipment has been switched. This information will permit quick correction by communicating with the field personnel.

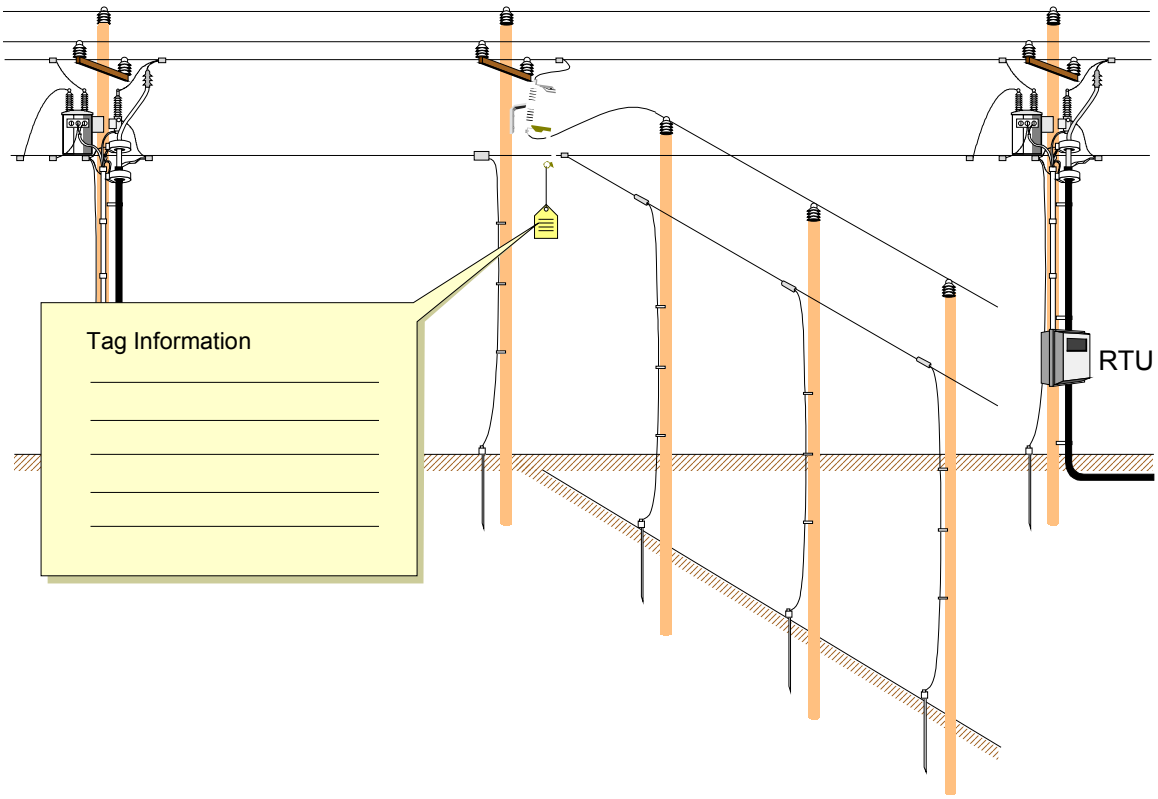

Figure 4-3
Example of Tag Representation in a Physically Based Virtual Environment

The physically-based model has another advantage. It can provide an accurate simulation of switching orders, much more realistically than existing models, and the effects on the system. Note that since the physically based model will integrate the models of protective devices, the simulation will provide information about the response of the relays, fuses, etc. Any unintended operations will be caught by simulation and the switching order may be adjusted or modified to avoid such undesirable effects. For any approved switching order, the expected response of the system can be integrated in the switching order. In this way, field personnel will have an idea of what is the expected outcome of the switching operation. Note in the next section, field personnel will have access to the response of the system in the field and therefore additional feedback about the correctness of the operation.

The proposed model, state estimation and user interface in terms of the physically-based model has additional benefits. All applications programs such as feeder optimization, voltage control, feeder reconfiguration, fault locating, etc. can be based on this improved model.

Above discussion simply highlights the possibilities. Implementation details are not discussed.

Use of New Information Technology in the Field

The improved distribution management system information can be the basis for developing a system that makes the same information available in the field. There is technology for inexpensive access of the information in the distribution management system from field personnel. Specifically, field personnel can use small personal computers equipment with cellphone based technology and GPS receivers to view automatically the operating state of the system at the location of work in a virtual reality environment. There is possibility to embed this technology in a helmet that field personnel will put on while they work in the field – similar to what jet fighter pilots have. Note that the GPS receiver knows the location of the field personnel and therefore it will retrieve and display the system near the vicinity of the field personnel. We have investigated the state-of-the-art and it is clear that the technology exists to develop a system like this. The system will work in all areas where cellphone access is available.

The advantages of such a system are multiple: (a) field personnel will have quick access to the present operating conditions of the system. If they have an order that does not match the existing operating condition they will be immediately alerted, discuss it with the system operator and resolve the problem. Note that this is a recurrent cause of switching incidents. (b) Field personnel know what the intended result from a switching order is. Upon execution of the switching order they will view within seconds the new operating conditions of the system. Therefore they will receive almost instant feedback of the results of their action. (c) Field personnel can inspect the system and viewing the physical model of same system can report to system operators any discrepancies. For example, it can be recommended to take digital photographs of the work area and later provide these photographs to the system operator for model upgrades, etc. (d) the system can be used to view switching orders, generate reports, etc. (this last part is nothing new as there are today commercially available products capable of providing this capability. However, there were some very good suggestions as to what the switching orders and reports should include in previous EPRI reports and any new system should incorporate the recommended forms and reporting procedures).

Security is an issue since the communications are via cellphone technology. This problem can be easily resolved by two approaches: (a) using a sophisticated scheme for accessing the field computers, and (b) permitting only information access from the field computers (one way communication). This will not be a problem since field persons are not authorized to enter data into the system operations anyway.

Implementation of such a system will require training of field personnel. Since the modeling is physically based and 3-D the training and ability of field personnel to use the use the system will be quick.

Temporary Grounding for Switching Operations

In general the system should be so designed that the switching operator is “safely grounded”. The practice involves ground mats under switches, proper design of the grounding system, etc. It is also important to recognize that the practice varies among utilities. For example, many times the ground mat under the switches may be very small and as the operator moves the lever he steps off of the ground mat and on to soil. Following a switching order, in case of maintenance work on a de-energized piece of equipment, proper temporary grounding should be provided. The need for temporary grounding during maintenance work is not very well understood. For example a de-energized piece of equipment may be subject to relatively high voltages from another circuit via induction. It is proposed that a thou rough study of the requirements for temporary grounding at maintenance sites be performed. Then this information should be used for (a) training field personnel and (b) integrating the requirements for temporary grounding in the switching orders.

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5 SUMMARY AND CONCLUSIONS

The project has critically evaluated the state of art in distribution system operations and in particular management of switching operations.

There is a plethora of prior work in this area by EPRI. EPRI organized conferences have attracted many other experts that have provided information on all aspects of switching operation management. A critical summary of this work is included in this report.

Over two dozen organizations have been contacted for interviews and eighteen interviews have been contacted. The interviews provided valuable information about the present practices as well as identified critical needs in the operation of distribution system.

The present state of the art in tools for distribution system operations have been assessed by reviewing the products of four major vendors. The tools have been improved over the last decade. However additional improvements are needed to address the identified critical needs.

Based on the above referenced work, several specific improvements have been recommended to address the critical needs. The recommended improvements are: (a) use of physically-based models (breaker and switch oriented, three phase models), (b) utilize virtual reality environments for user interface, and (c) make this technology available to field crews via inexpensive cellphone technology.

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6 REFERENCES

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3. EPRI Report 1008692, *Job and Task Analysis to Identify Failure Points in Switching Operations*, Final Report October 2004
4. EPRI Report 1008685, *Processing Outage Requests and Writing Switching Instructions*, Technical Update October 2004
5. EPRI Report 1002077, *Incident Investigation and Reporting*, Final Report May 2003
6. EPRI Report 1001956, *Collecting and Using Near-Miss Information*, Level 2 Report September 2001
7. EPRI Report 1001789, *Generic Job and Task Analysis: Handling Planned Outages and Hot Line Work*, Final Report September 2002
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A APPENDIX A – INTERVIEW/SURVEY QUESTIONAIRE

The following initial set of questions is a starting point.

1. Please provide information about yourself – name, position, responsibilities.
2. Please provide information about company – size of system (MW, circuits), customers, etc.
3. What is the track record of the company in terms of switching incidents?
4. Are there any specific incidents that you can share with us? Description, customers affected injuries if any, etc.
5. Information about company switching procedures. Brief descriptions. What safeguards are implemented? Please elaborate.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented?
7. Are switching orders and procedures formal? Standard paperwork, supervision, etc. How do you monitor compliance to procedures?
8. What are the practices for temporary grounding at work sites? Any documentation that can be shared with us?
9. What are the procedures for securing relays, reclosers, sectionalizers? What are the procedures for training personnel on proper procedures? Who reviews switching orders? Are protective relaying people involved?
10. What is the level of monitoring at the distribution level? Distribution SCADA? Distribution Automation? Is it uniform throughout the company? What are the plans?
11. How many Distribution Operations Centers operate on your system?
12. Are the DOC's co-located with your Transmission OC offices? System OC?
13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	**Offline / Realtime**	**Missing Information**	**etc**
Circuit/line loading	•	•	•	•
Open Switches	•	•	•	•
Tagged Switches	•	•	•	•
Transformer loading	•	•	•	•
Overloads by type	•	•	•	•
etc	•	•	•	•

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Do you have specific policies for processing and monitoring switching orders under these conditions? Do you have priority lists? Is information flow adequate under these conditions? What are the issues?

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.)

16. Have you participated in the EPRI program?

17. Have you attended any of the 9 annual conferences

18. Are your responsibilities D, T or T&D?

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.?

Interview Responses

A total number of 26 persons/organizations were contacted for an interview. The following persons/organizations responded and provided their comments.

1. Alfonso Juarez,	IID
2. Allen Sturgill,	Blue Grass Energy (KY)
3. Andy Dodge,	Baltimore Gas and Electric
4. Barry Warner,	EKPC
5. Brent A Stegner,	AEP
6. D. Kevin Dunham,	Chugach Electric Association
7. Dennis Rasmusson,	Alta Link
8. Dewayne McDonald,	Warren RECC (KY)
9. Frank Doherty,	Consolidated Edison
10. Joe Crain,	Delta Montrose Electric
11. John Wheeler,	Pennyrile RECC
12. Lauren Stuckenschmidt, Laurie Gregg,	Lincoln Electric System
13. Loy M. (Chuck) Owens Jr.,	TVA
14. Marc Ronne,	Nebraska Public Power District
15. Pete Miller,	WAPA
16. Ralph Law,	Tri-County EMC (TN)
17. Tom Burke,	KCP&L
18. W. Kyle Allison,	Southern Company

The raw data of these interviews are listed in this Appendix. A summary of these responses is provided in section 4.

B APPENDIX B – INTERVIEW/SURVEY RESPONSES

Each response is provided in its entirety without company affiliation information.

INTERVIEW # 1

1. Please provide information about yourself:
    a. Name:
    b. E-mail:
    c. Phone:
    d. Position:
    e. Responsibilities: All line work, 6 area supervisors
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 300
    b. Number of circuits: 55
    c. Number customers: 50000
3. What is the track record of the company in terms of switching incidents? Good
4. Are there any specific switching incidents that you can share?
    a. Description: None
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: Pre-written procedures for substations, line switching procedures are written before work is done.
    b. Elaborate on safeguards: The Director of Engineering, Director of Operations and the Supervisor for the area write or review the procedures before the switching is done.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Written procedures for all switching, audits and after-the-fact reviews.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Written and reviewed
    a. How do you monitor compliance to procedures? No monitoring
8. What are the practices for temporary grounding at work sites? Work between grounds
    a. Any documentation that can be shared with us? None
9. What are the procedures for securing relays, reclosers, sectionalizers? Lockout Tag with control door locked.
    a. What are the procedures for training personnel on proper procedures? TVA substation training ever two years, in-house training for the substations in operational area.
    b. Who reviews switching orders? Substation switching orders are pre-written and filed at each station.
    c. Are protective relaying people involved? Yes
10. What is the level of monitoring at the distribution level:
    a. Distribution SCADA? None
    b. Distribution Automation? None

c. Other? Some load and power quality, setting of relays

d. Is it uniform throughout the company? Only on new substations

e. What are the plans? None

11. How many Distribution Operations Centers ('DOC') operate on your system? 8

12. Are the DOC's co-located with your Transmission OC offices? Yes

a. System OC? No

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☐	☐	☐	☐
Open Switches	☐	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☐	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? By operational area.

a. Do you have specific policies for processing and monitoring switching orders under these conditions? No

b. Do you have priority lists? Yes

c. Is information flow adequate under these conditions? Fair

d. What are the issues? None

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) No

16. Have you participated in the EPRI program? No

17. Have you attended any of the 9 annual conferences No

18. Are your responsibilities:

a. Distribution? ☒

b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Completing our mapping.

INTERVIEW # 2

1. Please provide information about yourself:
    a. Name:
    b. Position: Supervisor, Transmission & Distribution Dispatch and Manager, System Control
    c. Responsibilities: Switching coordination, outage management and dispatching
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 757 MW ~ summer 2005 peak
    b. Number of circuits: 210 ~ 12kV circuits, 5 ~ 35kV circuits, 41 ~ 115kV circuits, 1 ~ 161kV circuit, 3 ~ 345 kV circuits
    c. Number customers: 121,500 retail
3. What is the track record of the company in terms of switching incidents? Excellent
4. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: Crews and Dispatching both have copies of switching orders.
    b. Elaborate on safeguards: Two dispatchers go over each distribution order. In addition, an engineer reviews all transmission order. All orders are then reviewed with the crews using maps and a mimic board before they are issued. A computerized system is used to write switchouts, clearances and standbys, and switchbacks. Only in an emergencies are switching orders given out verbally.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? SCADA, radio and phone communication, pinning the mimic board for open/close switches, and crews call in to Dispatching after every step of a switching order with a completion time.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? Start and completion times, documentation, SCADA
8. What are the practices for temporary grounding at work sites? Clearance orders issued; if it is not grounded it is not considered de-energized.
    a. Any documentation that can be shared with us? Crews and Dispatch have copies
9. What are the procedures for securing relays, reclosers, sectionalizers? Standard orders, tags hung on these elements out in the field and also on SCADA.
    a. What are the procedures for training personnel on proper procedures? SCADA training, relay engineers, manuals and hands-outs.
    b. Who reviews switching orders? 115kV and above ~ Senior dispatchers and engineers. 35kV and below ~ two senior dispatchers.
    c. Are protective relaying people involved? Yes, the engineers are system protective engineers.
10. What is the level of monitoring at the distribution level:

a. Distribution SCADA? Yes

b. Distribution Automation? Some

c. Other? N/A

d. Is it uniform throughout the company? Yes

e. What are the plans? N/A

11. How many Distribution Operations Centers ('DOC') operate on your system? One ~ our Operations Center handles distribution, transmission, and generation.

12. Are the DOC's co-located with your Transmission OC offices? Yes

    a. System OC? Yes

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☒	☐	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Prioritize switching, call in more dispatchers, and multi task.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? Yes, the same as normal. We still review switching orders if possible.

    b. Do you have priority lists? Yes, a "priority loads" list, which identifies primary and secondary critical loads for the safety of the community. Also, we prioritize switching loads back on by magnitude of customers that could be returned to service, i.e. switch a transmission circuit back on first, then a feeder, then a lateral.

    c. Is information flow adequate under these conditions? Yes, although fast-paced.

    d. What are the issues? Making sure nothing gets overlooked. Communication is faster, and therefore more can be misunderstood.

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes, we attended one last year or the year before.

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences Yes ~ one

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Verbally reviewing switching orders with crews in front of maps before sending them out to do the switching. Any questions are brought up at that time and explained ~ no guessing necessary. This has served us extremely well in the past, and in talking with other utilities, it seems that it has greatly improved our switching safety, reliability and decisions. We are able to improve our switching orders based on comments from the crews. Faxing switching orders to vehicle computers would be an improvement for emergencies, although we do not presently have this capability.

INTERVIEW # 3

1. Please provide information about yourself:
    a. Name:
    b. E-Mail Address
    c. Phone
    d. Position: Vice President of Engineering
    e. Responsibilities: Oversee distribution planning and design, substation maintenance and system protection
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 250 MW
    b. Number of circuits: 67 ~ 12 & 25 KV
    c. Number customers: 45,000
3. What is the track record of the company in terms of switching incidents? Minimal problems
4. Are there any specific switching incidents that you can share?
    a. Description: One phase of a three phase line switch failed to open during switching, because it had "welded" shut due to inproper seating in the "jaws" connection. No problems related to the actual switching procedures.
    b. Customers affected: 300
    c. Injuries, if any: None
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: See answer to question 7
    b. Elaborate on safeguards: N/A
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Read back the procedures…….no SCADA
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Most distribution switching procedures are informal. Typically, for line switching, the Substation Technician and Operations Personnel work together to perform line swiching procedures (grounding, setting the automatic switch of a breaker, pulling relay grounds). If a line is being worked on, the Substation Technician or Operations Personnel will set the protective device to lock out after one operation, and they will write a red tag, or hold card. If switching is performed on G&T COMPANY equipment (subtation or transmission), formal switching orders are issued by the G&T COMPANY System Operator and followed by Operations personnel.
    a. How do you monitor compliance to procedures? Review of procedures after the switching is complete.
8. What are the practices for temporary grounding at work sites? The company has the philosophy/procedure: "If it's not grounded, it's not dead." Therefore, when working on energized circuits, the circuit in question is grounded.
    a. Any documentation that can be shared with us? N/A

9. What are the procedures for securing relays, reclosers, sectionalizers? These are typically performed by Substation Technicians. Operations Personnel are able to secure three phase elctronic line reclosers. In all instances, when a line is being worked on, the protective device is set to lock out after one operation. Red tags (hold cards) are written by those performing the switching.

    a. What are the procedures for training personnel on proper procedures? The Substation Technicians, in their monthly substation inspections, take Operations Personnel with them and go through proper switching procedures within the distribution substations; G&T COMPANY System Operation personnel annually train the employees on switching and tagging procedures within a classroom setting.

    b. Who reviews switching orders? VP of Engineering, Substation Technician, Operations Manager or Line Foreman

    c. Are protective relaying people involved? Yes - Substation Technician

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? N/A

    b. Distribution Automation? N/A

    c. Other?

    d. Is it uniform throughout the company? Yes

    e. What are the plans?

11. How many Distribution Operations Centers ('DOC') operate on your system? 4 District Offices

12. Are the DOC's co-located with your Transmission OC offices?N/A

    a. System OC?

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Real-time	Offline / Real-time	Missing Information	etc
Circuit/line loading	☐	☐	☒	☐
Open Switches	☐	☐	☒	☐
Tagged Switches	☐	☐	☒	☐
Transformer loading	☐	☐	☒	☐
Overloads by type	☐	☐	☒	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? We do not have an Operations Dispatcher at This location. Switching orders are handled locally by the Substaion and Operations personnel.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? No

b. Do you have priority lists? Yes

c. Is information flow adequate under these conditions? No

d. What are the issues? Need more training and procedures estabilished.

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) No

16. Have you participated in the EPRI program? No

17. Have you attended any of the 9 annual conferences No

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? The implementation of SCADA and Operations Dispatchers who are intimately familiar with the system.

INTERVIEW # 4

1. Please provide information about yourself:
    a. Name:
    b. E-mail Address:
    c. Phone Number:
    d. Position: Transmission Operations Manager
    e. Responsibilities: Supervise Transmission Operations assigned to The Southwest area. Oversee daily operations of same. Coordinate outage schedule.
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 31,000 MW
    b. Number of circuits: 17,000 circuit miles and 535 stations
    c. Number customers: 8.5 million
3. What is the track record of the company in terms of switching incidents? 13/2003, 5/2004, 11/2005
4. Are there any specific switching incidents that you can share?
    a. Description: Tested a 500kv line from a nuclear plant with a ground switch closed on the other end of line…..tripped 1150 mw unit off.
    b. Customers affected: No customer outages….. many power quality issues to direct served industries
    c. Injuries, if any: 0
    d. Other info: Cost estimated at $7 million for power replacement.
5. Information about company switching procedures.
    a. Brief descriptions: We use a hold order clearance system…. transmission operators control said system…. transmission operators write and issue switching orders.

    Elaborate on safeguards: N/A
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Read back the orders.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes

    How do you monitor compliance to procedures? Audits
8. What are the practices for temporary grounding at work sites? Ground…… record card proecedure used in conjunction with hold order procedure.

    Any documentation that can be shared with us? Yes
9. What are the procedures for securing relays, reclosers, sectionalizers? They are part of the switching orders issued.

    What are the procedures for training personnel on proper procedures? Formal transmission operator and electrician / operator training class with pass / fail requirements.

    Who reviews switching orders? Transmission operators / field personnel

    Are protective relaying people involved? Not in reviewing switching

10. What is the level of monitoring at the distribution level:

    Distribution SCADA? Some

    Distribution Automation? Some

    Other? Status only at some locations

    Is it uniform throughout the company? No

    What are the plans? Future power system optimization project.

11. How many Distribution Operations Centers ('DOC') operate on your system? 158 distributors customers (Co-Ops and Municipals) but they operate indepentantly

12. Are the DOC's co-located with your Transmission OC offices?No ~ see #11

    System OC? No ~ see #11

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☐	☒	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☒	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Do not deviate from process normal procedures.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? We maintain a second party verification process.

    b. Do you have priority lists? No

    c. Is information flow adequate under these conditions? Yes

    d. What are the issues? None

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences 2

18. Are your responsibilities:

a. Distribution? ☐

b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Training and real-time accurate data.

INTERVIEW # 5

1. Please provide information about yourself:
    a. Name:
    b. Position: Dispatcher
    c. Responsibilities: System Operation
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 100
    b. Number of circuits: 46
    c. Number customers: 30045
3. What is the track record of the company in terms of switching incidents? We have never had a switching error resulting in injury. We have had four errors in the past ten years; two were failure to bypass inline protection resulting in overload, one was issuing Hot Line Order on an incorrect circuit and one was failure to verify relay setting on newly delivered porwe transformer.
4. Are there any specific switching incidents that you can share?
    a. Description: A new circuit had been constructed and the feed changed; the in-line 65 amp fuses were not removed and melted when the load increased.
    b. Customers affected: 375
    c. Injuries, if any: None
    d. Other info: This had happened before in paralleling circuits and failure to bypass in-line OCR's.
5. Information about company switching procedures.
    a. Brief descriptions: We have a safety manual and Standard Operating Procedures that are reviewed monthly and anytime new equipment or an error occurs or at the request of any employee. Switching is written in the dispatch office and e-mailed to the enigeering department, the substation manager and crew, the lineman managers and foremen and to all other dispatchers. Switching orders are prenumber, as are revisions, so everyone is on the same order.
    b. Elaborate on safeguards: We review each order and reread it in the field.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? The orders are maintained in dispatch, written onto our a daily operations report, e-mailed nitely for review by all and posted to the company intranet.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes ~ all switching is done via switching orders with numbers from both the dispatcher and crew. Crew switching order books are kept in the trucks and then returned to the supervisor when completed. List and updates of qualified switchmen are kept. Dispatch is a 24/7 operation.
    a. How do you monitor compliance of procedures? SOP are reviewed and all qualified personnel updated yearly; dispatch records all switching and any errors are reviewed by all operations personnel.
8. What are the practices for temporary grounding at work sites? If it is not grounded it is not dead and must be worked hot. All ground placement and removal is recored by dispatch and no clearance is issued without grounding
    a. Any documentation that can be shared with us? All grounding is recorded.
9. What are the procedures for securing relays, reclosers, sectionalizers? All switching for relays, reclosers and sectionalizers are recorded and done under switching orders. All substation operations of reclosers (79

devices), ground trips or other relays are done by or under orders from dispatchers (by SCADA if available).

a. What are the procedures for training personnel on proper procedures? All qualified switchmen have training in all equipment; new training is done when new types or upgraded equipment are installed.

b. Who reviews switching orders? All dispatchers, dispatch supervisor, the engineer, the substation manager and line supervisors and all linemen that will be involved in the switching.

c. Are protective relaying people involved? Yes

10. What is the level of monitoring at the distribution level:

a. Distribution SCADA? Yes ~ on all but two remote substations

b. Distribution Automation? Yes ~ only two circuits so far but the budget has been approved for the entire system.

c. Other? All poles and other equipment have been GPS located and we have a complete land base GIS. GPS system is being tied to OMS and BIS at this time.

d. Is it uniform throughout the company? Yes

e. What are the plans? New OMS, DSM. ARM systems are under way.

11. How many Distribution Operations Centers ('DOC') operate on your system? Only one for our company but we operate as the DOC for four other cooperativies with an additional 60,000 meters and two SCADA systems.

12. Are the DOC's co-located with your Transmission OC offices? Yes ~ we operate only a small amount of 115 kV.

a. System OC? Yes

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Real-time	Offline / Real-time	Missing Information	etc
Circuit/line loading	☒	☒	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☒	☐	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☒	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event with a multitude of alarms and a very busy time in the control center, how do you handle switching orders? Emergency switching only as the distribution rotinue would be cancelled.

a. Do you have specific policies for processing and monitoring switching orders under these conditions? Same policy ~ additional dispatch console is availabe complete with second monitor, radio and control. More dispatchers would be called in.

b. Do you have priority lists? Yes

c. Is information flow adequate under these conditions? Yes ~ it has been in past situations.

d. What are the issues? Hopefully, the new OMS will handle the functions for call-out and phone management.

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) No

16. Have you participated in the EPRI program? No

17. Have you attended any of the 9 annual conferences No

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? More training and more review….

INTERVIEW # 6

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: Manager, Operations
    e. Responsibilities: Const, ROW, Dispatch and Purchasing.
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 290
    b. Number of circuits: 115
    c. Number customers: 56,000
3. What is the track record of the company in terms of switching incidents? Very good
4. Are there any specific switching incidents that you can share?
    a. Description: None
    b. Customers affected: N/A
    c. Injuries, if any: No
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: Switching procedures are approved by Operations and Engineering then carried out by our Line Technicians and Dispatch Center.
    b. Elaborate on safeguards: Pre-switching meetings are held to discuss safety, responsibilities and switch locations, all switching instructions are repeated back to the dispatch center for verification.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Our Dispatch Center verifies switching instructions with the Technicians completing the switching in the field.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes ~ Switching orders are written and approved.
    a. How do you monitor compliance to procedures? Switching is supervised at all times.
8. What are the practices for temporary grounding at work sites? Grounds must be installed within sight on both sides of the work zone unless there is a visible opening within sight.
    a. Any documentation that can be shared with us? N/A
9. What are the procedures for securing relays, reclosers, sectionalizers? Hold cards
    a. What are the procedures for training personnel on proper procedures? Safety meetings and on-the-job training.
    b. Who reviews switching orders? Operations and Engineering
    c. Are protective relaying people involved? N/A
10. What is the level of monitoring at the distribution level:
    a. Distribution SCADA? Yes

b. Distribution Automation? N/A

c. Other? N/A

d. Is it uniform throughout the company? Yes

e. What are the plans? N/A

11. How many Distribution Operations Centers ('DOC') operate on your system? 1

12. Are the DOC's co-located with your Transmission OC offices? N/A

a. System OC? Yes

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☐	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☐	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Use additional personnel to handle switching.

a. Do you have specific policies for processing and monitoring switching orders under these conditions? Yes

b. Do you have priority lists? Yes

c. Is information flow adequate under these conditions? Yes

d. What are the issues? N/A

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences Yes

18. Are your responsibilities:

a. Distribution? ☒

b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Real time down line SCADA systems and DA.

INTERVIEW # 7

2. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: Sub-transmission and Distribution System Control Supervisor
    e. Responsibilities: Sub-transmission and Distribution
3. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): ?
    b. Number of circuits: 348
    c. Number customers: 980,000 (Wholesale) and 90,000 (Retail)
4. What is the track record of the company in terms of switching incidents? N/A

1. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
2. Information about company switching procedures.
    a. Brief descriptions: We have documented proceedures relating to switching. Any switching on the system requires an order from System Control.
    b. Elaborate on safeguards: No switching without a start time issued from System Control. Each step is repeated back to switch person. When step is completed, System Control repeats back the step to switch person along with the time executed.
3. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Verbal communication…..each step is repeated.
4. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes, there is a standard switching order that is used. Field personnel are required to review the order before starting.
    a. How do you monitor compliance to procedures? Audits and reviews after-the-fact.
5. What are the practices for temporary grounding at work sites? A de-energized clearance must be issued prior to grounding. Each source of potential must be a visible open and have a tag placed on the locking mechanism.
    a. Any documentation that can be shared with us? N/A
6. What are the procedures for securing relays, reclosers, sectionalizers? DC is disabled on relays, and the disconnects are opened and tagged on reclosers. We do not have any sectionalizers.
    a. What are the procedures for training personnel on proper procedures? On the job training. In addition, each switch person must be a certified switch person. They have passed a written exam, and demonstrated profiecieny in the field during a review by specialized trainers.
    b. Who reviews switching orders? Operators, we have a select few that must approve planned switching before it is sent.

c. Are protective relaying people involved? No

7. What is the level of monitoring at the distribution level:
   a. Distribution SCADA? Yes
   b. Distribution Automation? No
   c. Other? N/A
   d. Is it uniform throughout the company? Yes
   e. What are the plans? N/A
8. How many Distribution Operations Centers ('DOC') operate on your system? One
9. Are the DOC's co-located with your Transmission OC offices? No
   a. System OC? No
10. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☐	☐	☒	☐
Tagged Switches	☒	☐	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☐	☐	☒	☐
etc	☐	☐	☐	☐

11. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Each of our desks is responsible for a specific area in the state. During normal times, any of the Operators may work in any area of the state.
    a. Do you have specific policies for processing and monitoring switching orders under these conditions? No
    b. Do you have priority lists? No
    c. Is information flow adequate under these conditions? Usually
    d. What are the issues? In a lot of these cases, there is an information overload, with all the alarms going off.
12. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes
13. Have you participated in the EPRI program? Yes

14. Have you attended any of the 9 annual conferences Yes

15. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

16. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? In our case, we have a Distribution SCADA system and an OMS system that we operate. In addition, we have our Transmission SCADA system that we can see but do not operate. None of these systems are interfaced with each other. So, in some cases we need to address the same issue with all three systems.

INTERVIEW # 8

1. Please provide information about yourself:
    a. Name:
    b. E-mail:
    c. Phone:
    d. Position: Supervisor, System Operations
    e. Responsibilities: Supervise dispatch of Generation, Transmission, Distribution & Fuel Supply
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 450 MW winter peak, 550 MW generation capability
    b. Number of circuits: 83 distribution feeders @ 12.5 & 25 kV
    c. Number customers: 77,000
3. What is the track record of the company in terms of switching incidents? Pretty good, average one or less per year.
4. Are there any specific switching incidents that you can share?
    a. Description: Lineman closed a 69 kV switch that he was ordered to check open while establishing a clearance. Closing the switch energized 50 miles of line. When the switchman realized his error he tried to open the switch, but the arc from dropping the line was so great he closed it again.
    b. Customers affected: None, but one of our small hydro plants was affected.
    c. Injuries, if any: None
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: Formal switchman certification program, written safety rules that touch on switching scenarios. Are currently in the process of developing standardized switching instructions.
    b. Elaborate on safeguards: Switching orders reviewed and initialed by at least one other dispatcher. Strict adherence to visible opens and making sure grounds have been removed before a clearance is released. Any switching request for equipment of 69 kV and above must be approved by management before being scheduled.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? The dispatcher reads the step, including the switching order number, step number, name of the device, and the action to be completed. The switchman then responds by repeating the instructions verbatim and stating that they understand the step. After the step has been completed the switchman then reads to the dispatcher the entire step again and states that the action has been completed and the time of completion. Lastly the dispatcher reads the entire step again stating he understands the step was completed and records the time and the switchman's name on the switching form.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? After clearances are released, tags from the field are delivered to dispatch and accounted for before the clearance is filed. The files are kept for five years and then stored.

8. What are the practices for temporary grounding at work sites? Once a clearance is issued to a workman, it is his responsibility to ground as he sees fit. The compliance of grounding proceedures is outside of the dispatch center's jurisdiction.

    a. Any documentation that can be shared with us? N/A

9. What are the procedures for securing relays, reclosers, sectionalizers? Any substation switching requires review of the prints, any questions or concerns about proceedures will be reviewed by the relay department personell.

    a. What are the procedures for training personnel on proper procedures? New hires are trained by senior personnel.

    b. Who reviews switching orders? At least one other dispatcher, the foreman that requested the switching, and for all transmission switching, the dispatch supervisor.

    c. Are protective relaying people involved? Only if there is a question about the prints in the dispatch center on distribution switching. On transmission switching they are normally always involved in the review process.

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? 3 phase amps & volts plus MVA and MVAR on the bus. Each feeder breaker has 3 phase amps, MW, MVAR & ground amp readings.

    b. Distribution Automation? Besides reclosers we have a few automatic switch cabinets to isolate critical loops.

    c. Other? N/A

    d. Is it uniform throughout the company? As uniform as you can get with low-bid requirements. There are a few older distribution sites that have not been modernized. (High side fused instead of breakers or circuit switchers installed, etc.)

    e. What are the plans? Ongoing 5 year plans to keep ahead of system growth. Distribution planning at Chugach is excellent, although there have been a few areas that have turned into bottlenecks before the upgrades were budgeted.

11. How many Distribution Operations Centers ('DOC') operate on your system? Only a single dispatch center for generation, transmission, distribution. Two dispatchers on shift 24/7.

12. Are the DOC's co-located with your Transmission OC offices? see above

    a. System OC? No

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☐	☒	☐	☐
Tagged Switches	☒	☒	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Will stop all non-critical switching. Often call in extra dispatchers to help.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? No different than normal, except emergency switching is allowed to be "Written on the fly."

    b. Do you have priority lists? Yes, critical loads are restored first. Hospitals, Anchorage International Airport, etc.

    c. Is information flow adequate under these conditions? Yes.

    d. What are the issues? We have very good to excellent storm handling proceedures. We are also in the process of establishing a back-up dispatch center and preparing for an earthquake - just in case. Southcentral Alaska is way overdue for a magnitude 7 or larger quake so we are taking the appropriate action to be as ready as possible. If anyone can ever be ready for something like that.

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences Two

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Openly reviewing every switching error with all employees that are involved in switching.

INTERVIEW # 9

1. Please provide information about yourself:
    a. Name:
    b. E-mail:
    c. Phone:
    d. Position: Manager of Operational Services
    e. Responsibilities: Oversees Substation Maintenance, System Control Center, Meter Reading, Metering, Fleet Maintenance & Line Devices
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 350
    b. Number of circuits: 119
    c. Number customers: 56,000
3. What is the track record of the company in terms of switching incidents? Very good
4. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: All transmission & substation switching is done through our system control center.
    b. Elaborate on safeguards: We have lockout/tagout procedures.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? SCADA, lockout/tagout procedures, writted switching orders.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? System control center logs and operators, audits and after-the-fact reviews.
8. What are the practices for temporary grounding at work sites? Trucks ground to system neutral if possible.
    a. Any documentation that can be shared with us? N/A
9. What are the procedures for securing relays, reclosers, sectionalizers? We do not rely on open reclosers, we will open a switch or disconnect stingers and ground before working on a line as deenergzied.
    a. What are the procedures for training personnel on proper procedures? In-house lockout/tagout training, substation/relaying/control training
    b. Who reviews switching orders? System Operator, Manager of Operational Services and Manager of Engineering.
    c. Are protective relaying people involved? Yes
10. What is the level of monitoring at the distribution level:

a. Distribution SCADA? Yes

b. Distribution Automation? No

c. Other? N/A

d. Is it uniform throughout the company? Yes

e. What are the plans? N/A

11. How many Distribution Operations Centers ('DOC') operate on your system? 4

12. Are the DOC's co-located with your Transmission OC offices?No

    a. System OC? Yes

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Real-time	Offline / Real-time	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☒	☐	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? We have a file of preplanned switching orders, however not all situations will be covered, in emergency cases switching orders will be writted as needed.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? No

    b. Do you have priority lists? Yes

    c. Is information flow adequate under these conditions? Upgrading of emergency procedures in progress.

    d. What are the issues? We have just recently changed from four districts working thier own outages in a storm to the system control center handling all outages.

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) No

16. Have you participated in the EPRI program? No

17. Have you attended any of the 9 annual conferences No

18. Are your responsibilities:

a. Distribution? ☒

b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Keeping new employees educated and system automation (being able to accurately/remotely control equipment).

INTERVIEW # 10

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: Director Environment, Health and Safety
    e. Responsibilities: Environ., Safety, Field Technical Training, Quality Mgt
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 49,000 GWH of energy transmitted
    b. Number of circuits: 250 transmission/distrubution substations (points of delivery to the distribution utility) and 11, 600 km of transmission lines.
    c. Number customers: Indirectly serve about 980,000 retail customers. through the transmission system. There are about 75 direct connect industrial customers connect to the transmission system. We deliever energy to distributioon companies.
3. What is the track record of the company in terms of switching incidents? We have about 10 switching incidents per year. Most are minor with no seroius consequence. Company has been focusing on reduce / eliminating these error over the past two years.
4. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: Most common switching incidents result from the switchmen losing their orientation within the substation and opening an incorrect switch, performing the switching steps out of sequence, and not understanding the correct operation of substation equipment (understanding the how airbreak decouplers work, know where the mechanical indicators are on breakers, not placing regulator transformers on the correct tap before by-passing).
5. Information about company switching procedures.
    a. Brief descriptions: Switching orders are drawn up by the system control center. System control center operator instructs a field switchman on a step by step basis to execute a switching order.
    b. Elaborate on safeguards: Switching programs are checked three time in control center before being issued. Field switchmen are training to perform switching and are also training to be able to delevlop (or understand) a switching order. Generally switching orders are emailed or faxed out ahead of time for the switchman to review. During the switching process the communications protocol is that the control center operator verbally instructs the switchman on a switching order step and the switchman repeats back the instruction that he heard. Upon completion of switching instruction the switchman verbally communicates what was done and control center operator then repeats back what he heard.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Step be step instructions during execution of the switching order. Two switchmen are utilized when ever resources permit. All breaker and motorized air breaks are monitored via SCADA. All line and transformers have SCADA monitored metering.

7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes

    a. How do you monitor compliance to procedures? Switchmen are observered by their supervisor annually to verify their competencies. Switchmen are initially trained & tested. Switchmen must requalify on a three year basis.

8. What are the practices for temporary grounding at work sites? A potential tester is used before the installation of grounds. Grounding is performer by specifically training and qualified power system electricians and linemen. Equipotential Bonding and Grounding methods are used for the installation temporary worker protective grounds. Appling work protective grounds is not considered part of the switching process.

    a. Any documentation that can be shared with us? N/A

9. What are the procedures for securing relays, reclosers, sectionalizers? Relays, reclosers and sectionalizers that are part of the switching order and are required to be secured are tagged with "do not operate" tags on the field panels and are blocked in the SCADA system and a software tag is applied.

    a. What are the procedures for training personnel on proper procedures? Switchman must be at least a second year apprentice. They must switch under the supervison of qualified switchmen for six months. Initial training is a 10 day course on switching (this include distrirubtion line switching and substation switching). Upon sucessful completion of the training the switchmen must be field observed by their supervisor to compete their qualifications. Re-certification and training occurs on three year basis.

    b. Who reviews switching orders? An outage scheduler and two control center operators.

    c. Are protective relaying people involved? Upon request….. Operations engineering is also called in on request.

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? Transmission/distrubution substations all have SCADA on breakers, tapchangers, airbreaks and metering points.

    b. Distribution Automation? Company is a transmission utility only.

    c. Other? N/A

    d. Is it uniform throughout the company? Yes

    e. What are the plans? Not sure

11. How many Distribution Operations Centers (‘DOC’) operate on your system? one transmission system control center

12. Are the DOC's co-located with your Transmission OC offices?No

    a. System OC? No

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☐	☒	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type	☐	☐	☒	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Same methods are used. Additional opertors and supoerviosors are called in as required.
    a. Do you have specific policies for processing and monitoring switching orders under these conditions? No
    b. Do you have priority lists? Restoration plan have been developed and list power system priorities.
    c. Is information flow adequate under these conditions? Yes……..have not indentified any issues.
    d. What are the issues? Corrdination with other transmission and distrubution utilities.
15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes
16. Have you participated in the EPRI program? No
17. Have you attended any of the 9 annual conferences 2
18. Are your responsibilities:
    a. Distribution? ☐
    b. Transmission? ☒
19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Company is introducing switching simulator software as a different approach to switchmen training. This tool is also able to permit a qualified switchman to practice switching in a virtual environment at any time.

INTERVIEW # 11

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: Superintendent of Operations
    e. Responsibilities: Supervisor over 4 Dispatch supervisors and 17 dispatchers for approaximately 500,000 customers
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 3800 MW
    b. Number of circuits: 625
    c. Number customers: 495,000
3. What is the track record of the company in terms of switching incidents? I am new in this position, but I would estimate one incident every one to two years. 99.97 error free as of 2 years ago when we stopped tracking stats.
4. Are there any specific switching incidents that you can share?
    a. Description: S&C Highbay called to be recoupled and switched. However, the decoupling step was missed and although the field 'closed' the switch, the blades did not actually engage.
    b. Customers affected: 1
    c. Injuries, if any: None
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: N/A
    b. Elaborate on safeguards: All indoor switching is done with two personnel on site.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Tong readings, potential checks or seeing load changes on the EMS
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes, standard forms, formats and check by a second dispatcher or supervisor
    a. How do you monitor compliance to procedures? Through a double check system prior to issueing. Also, the field personnel are trained/tested anually.
8. What are the practices for temporary grounding at work sites? Outlined in Safety SOP. I can mail you one if you would like.
    b. Any documentation that can be shared with us? See above
9. What are the procedures for securing relays, reclosers, sectionalizers? In the field, they must have a physical disconnet.
    a. What are the procedures for training personnel on proper procedures? We have anual training/tests for hold-procedures and switching for field personnel. Our dispatchers go through a 6 month training program prior to working as a dispatcher
    b. Who reviews switching orders? Another dispatcher or Supervisor

c. Are protective relaying people involved? No

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? At the substation breaker only for about 90 percent of our circuits (in our metro area; some rural areas do not have SCADA).

    b. Distribution Automation? We use capacitor automation (remote control in our metro area); Secondary network automation (V,A, Temp, etc) and some limited apprications of S&C Scadamate gear

    c. Other? n/a

    d. Is it uniform throughout the company?

    e. What are the plans? We have three networks and have just completed one of the installations. The other two are now being worked.

11. How many Distribution Operations Centers ('DOC') operate on your system? One

12. Are the DOC's co-located with your Transmission OC offices? It is in another walled office adjacent to our DOC

    a. System OC? It a totally different building

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☐	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☐	☐	☐	☐
Overloads by type	☒	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? N/A

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? We have Standard Operating Porceedures for switching that includes double check before issuing and read backs from the field.

    b. Do you have priority lists? Yes; Emergency facilities.

    c. Is information flow adequate under these conditions? Yes. We have an Outage Management System (CES/SPL) that has our circuits shown on a viewer. We operate the switches in the computer at the same time as the field. This allows us to see what has been opened/closed/de-energized. We can also print a report that shows what switches are in the abnormal state so we can ensure we restore to normal configuration after a storm/major event.

    d. What are the issues? N/A

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.)
    Somewhat familiar

16. Have you participated in the EPRI program? I believe our engineering group is participating.

17. Have you attended any of the 9 annual conferences No

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? We are seeing the most benefit to safety and reliability of the system from our secondary network automation project.

INTERVIEW # 12

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Name:
    d. Position:
    e. Responsibilities: Electrical Distribution
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 13,059 MW peak 2005
    b. Number of circuits: 1,998 distribution
    c. Number customers: 3,161,384 (electric)
3. What is the track record of the company in terms of switching incidents? Good, ~ 99.997% incident-free
4. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: We have a comprehensive and coherent set of rules, instructions, procedures and training for operating requirements associated with construction, maintenance, testing and repair work on system electrical equipment that ensure safety to employees and other individuals, continuity of service to customers and prevention of damage to equipment.
    b. Elaborate on safeguards: Training for initial certification includes formal classroom training and on-site OJT with testing. Refresher training, supervisory follow-up and oversight, expanding digital order preparation, delivery and completion, process automation, sequence warning tool work to weave the safety fabric of our operations.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Explicit order completion and reporting back, supervisory oversight in operating centers and the field, and observance and confirmation via SCADA are among the methods.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? Supervisory oversight in operating centers and the field
8. What are the practices for temporary grounding at work sites? In most cases in distribution substations and on any of the 25,000 distribution network transformers and on the underground feeders that serve them, temporary grounding is via identified, fixed ground switches that are specially locked and controlled. In special cases in substations, portable grounds may be applied using high current ball and socket connectors applied via hot stick while wearing full personnel protective equipment. In the overhead open wire system, work is largely under strict live-line work procedures.
    a. Any documentation that can be shared with us? N/A

9. What are the procedures for securing relays, reclosers, sectionalizers? Underground distribution network feeders (13kV & 27kV) do not have auto reclosing, and they are switched using SCADA, local control and separate ground and test devices that are racked in place of the feeder circuit breaker. Open wire feeders (4kV, 13kV and 27kV) have auto reclosing disabled at reclosers (4, 13 & 27kV) and at unit substations (4kV) during work on the open wire feeder section.

    a. What are the procedures for training personnel on proper procedures? Training for initial certification includes formal classroom training and on-site OJT with testing. Refresher training, and supervisory follow-up and oversight continue the training sequence. Additional training is created as new equipment and procedures are added.

    b. Who reviews switching orders? The operator having jurisdiction who writes an order, each operator having jurisdiction who performs a part of the order, the authorized employee/operator who carries out the order all review the order as part of his/her responsibility.

    c. Are protective relaying people involved? Generally not in switching orders.

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? We have SCADA on all 23-33kV, 309-27kV, 929-13kv and 737-4kV distribution feeders

    b. Distribution Automation? We have SCADA on ~150 open wire auto-loops (3,4,5 & 6 recloser loops at 4, 13 & 27kV).

    c. Other? We monitor the load and network protector position on ~ 25,000 underground network transformers

    d. Is it uniform throughout the company? Largely

    e. What are the plans? Enhance monitoring & control, and prediction & prevention of operating failures

11. How many Distribution Operations Centers ('DOC') operate on your system?

12. Are the DOC's co-located with your Transmission OC offices? 1 is….

    a. System OC? The same 1 is….

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☒	☐	☐	☐
Overloads by type?	☒	☐	☐	☐
Voltage	☒	☐	☐	☐
Network transformer loading	☒	☐	☐	☐
Status of SCADA	☒	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Carefully

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? Yes

    b. Do you have priority lists? Not lists, but rather a hierarchical processing based on risk and impact

    c. Is information flow adequate under these conditions? Yes (but not to say that it can't be improved).

    d. What are the issues? N/A

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences? Yes

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Process automation to guide mortal operators, and ultimately machine learning and machine intelligence to operate electric systems.

INTERVIEW # 13

1. Please provide information about yourself:
    a. Name:
    b. E-mail:
    c. Phone:
    d. Position: Dispatch Trainer
    e. Responsibilities: Training dispatchers and field switchmen, (linemen, electricians etc…)
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): Installed capacity of 2200 MW
    b. Number of circuits: 2 ~ 500kv lines, 18 ~ 230kv lines & 6 ~ 69kv lines
    c. Number customers: 92
3. What is the track record of the company in terms of switching incidents? About 2 a year over the last 7 years. There were a couple years in there where we had none.
4. Are there any specific switching incidents that you can share?
    a. Description: Dispatcher forgot to order the ground switches closed
    b. Customers affected: 0
    c. Injuries, if any: 0
    d. Other info: The last step on the program was to close the station ground swtich. the bottom of the program said continued, the last step on the last page (the only step on that page) was to close the station ground discs.
5. Information about company switching procedures.
    a. Brief descriptions: PSOM Chapter 1 is our switching bible
    b. Elaborate on safeguards: 6 basiscs steps of switching, it applies to switchmen and disapatcher on all switching programs.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? 2 dispatchers check it and the switchmen check it, before starting the program. (hopefully days before switching starts)
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? The switchmen only switch on approved programs….except in emergency.
8. What are the practices for temporary grounding at work sites? I don't know
    b. Any documentation that can be shared with us? N/A
9. What are the procedures for securing relays, reclosers, sectionalizers? We don't have sectionalizers. For relays the techs have there own craft tags that they place on relays after they get permission froms the dispatchers. On reclosers they are controlled and tagged by the dispatcher (HLO tags)
    a. What are the procedures for training personnel on proper procedures? Switchmen training is conducted on an annual basis, because of our error rate we are conducting training every six months, in January 8 hour class that includes switching for each crew (including dispatchers) and in July a 4 hour refresher.

b. Who reviews switching orders? Dispatchers, operations planning and switchmen.

c. Are protective relaying people involved? Yes

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? N/A

    b. Distribution Automation? N/A

    c. Other? N/A

    d. Is it uniform throughout the company? N/A

    e. What are the plans? N/A

11. How many Distribution Operations Centers ('DOC') operate on your system? 0

12. Are the DOC's co-located with your Transmission OC offices? N/A

    a. System OC? N/A

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☐	☐	☐	☐
Open Switches	☐	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☐	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? N/A

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? N/A

    b. Do you have priority lists? N/A

    c. Is information flow adequate under these conditions? N/A

    d. What are the issues? N/A

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes, I am WAPA's committee memeber

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences Yes, most of them

18. Are your responsibilities:

    a. Distribution? ☐

    b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Use your time correctly, slow down and pay attention.

INTERVIEW # 14

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: Supt. Distribution Operations
    e. Responsibilities: Responsible for the operations staff of the IID Electrical Distribution System.
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 899 MW ~ 07/18/05
    b. Number of circuits: 338
    c. Number customers: 127,000
3. What is the track record of the company in terms of switching incidents? Excellent
4. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: Switching procedure are in place and used by the Dispatcher. These are the only official documents related to the issuing of Clearances and Hot Line orders in that are up to date. There are older (out of date) documents that are in the process of being updated. Operations has taken the lead in maintaining the procedures related closely to the duties of the Dispatcher.
    b. Elaborate on safeguards: Specific procedures have been drafted and used to define the action that the Dispatcher must take when issuing Clearances and Hot Line Orders. Other procedures dictate the action needed to be followed when drafting the switching orders that are used to change the configuration of the Distribution System and its associated equipment. Although the procedures did not initially involve input from field personnel, the actions performed by them is spelled in the procedures. Copies have been forwarded to the field personnel for their information so that they understand what is expected from Operations when switching is performed.

6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? All switching is performed according to a written document that describes the action(steps) to be taken to remove or place equipment into or out of service. The Dispatcher gives the instructions verbaly and the person performing the switching repeats, verbatum each step back to the Dispatcher prior to changing the status of the equipment. When the person performing the switching receives the authorization from the Dispatcher to proceed, the person does the following; 1) Reviews the switching order and visually verifies that existing status of the equipment, 2) verifies that equipment on the switching order is the equipment that he is going to siwtch, 3) performs the switching and hangs the appropriate tags to identify the boundaries of the Clearance, 4) After each step has been completed, the time is entered into the switching order that is in the possion of the person performing the switching. After completion of the switching steps, the person performing the switching will report the times and status of

the equipment to the Dispatcher. If there are no other steps to be performed, the Dispatcher will place tags on the SCADA System according to the steps in the switching order. If the equipment is not controlled by SCADA, no tags will be placed on SCADA. At that point, the Dispatcher will notify the person waiting to receive the Clearance that the switching has been completed. The Dispatcher will proceed to define the boundaries of the Clearance, placement of grounds and will issue the Clearance to the person authorized to take the Clearance.

7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes, all switching is drafted in electronic form and E-mailed to all parties involved in the switching process. The electronic form is a identical copy of the original handwritten form.

    a. How do you monitor compliance to procedures? Each switching procedure is reviewed by at least two dispatchers and one representative from the field before the day that the switching is to be performed.

8. What are the practices for temporary grounding at work sites? Each person taking Clearance is responsible for installing personal grounds and foes so by notifying the Dispatcher. This installation of the grounds are logged into the swithcing order which defines the time, date and location of the grounds and who installed them. When the grounds are removed, the removal of the grounds is recorded in the same manner. The installing and removal of the grounds are also logged into the shift log.

    a. Any documentation that can be shared with us? N/A

9. What are the procedures for securing relays, reclosers, sectionalizers?

    RECLOSERS ~ All functionality to reclose are disabled on the device that feeds the circuit where the field personnel will be working on energized equipment. At any time that the personnel make contact with the circuit and the circuit relays, the circuit breaker will not close back in for a test. The Dispatcher is required to make contact with the person holding the permit (Hot Line Order) to work on energized equipment to verify if the crew is in the clear and that it is ok, to close the circuit breaker in for a test. Prior to re-energizing the circuit the person holding the Hot Line Order, must release it back to the Dispatcher. The Dispatcher will then, remove the HLO tag on SCADA, contact the field personnel working on the circuit that the circuit breaker will be tested and then, close the circuit breaker in for a test. If the circuit breaker holds, then the Dispatcher will re-issue the Hot Line Order to the personnel and re-tag the device on SCADA.

    RELAYS ~ Ground Relays are blocked when load is transferred between two circuits together. In addition, the Load Tap Changers and/or Voltage Regulators are manipulated so the voltage on both circuits is matcher prior to the closing of the tie switch in the field. This action is taken when transferring load between two circuits that are fed from different transformers in the same substation or two circuits fed from a different transformer from another substation. The load transfer involves the use of gang operated tie switches.

    There is still some discussion on whether the Ground Relay should be blocked when moving jumpers (single-phase) to transfer load when attempting to balance the load by phase. Another, concern is the blocking of the Recloser when transferring single phase load through the use of jumpers. The thought is; having blocked both the Ground Relay and the Recloser simultaneously, put our personnel at risk in the attempt to protect reliability. So at this time, we only block the recloser so that in the event of accidental contact is made when transferring load, the circuit breaker will not close back in on the personnel. Therefore, the personnel transferring single-phase load through the use of jumpers, are issued Hot Line Orders for their protection and safety.

    a. What are the procedures for training personnel on proper procedures?

        Typically, the Dispatchers have specific procedures related to Switching Orders, Clearances, Hot Line Orders, Blocking Reclosers, and Blocking Ground Relays. The field personnel do not have documented procedures at this time. There is an effort to standardize and maintain official company-wide procedures associated with the issues mentioned.

    b. Who reviews switching orders?

The Switching order is typically drafted by the Dispatcher after reviewing the request for Clearance or Hot Line work. After the Dispatcher has drafted the switching order, the order is forwarded to the Outage Coordinator, the Troubleshooters and Engineering for review and field inspection. After the field review has been performed, and no errors are found, the switching order is returned to the Dispatcher to be finalized.

If there are discrepancies, they are identified for the Dispatcher by the field personnel and the corrections are made. Some of the typical discrepancies include the circuit map not matching the existing field conditions or circuit configurations. Other issues include overload conditions and unbalance phase loading. These issues are resolved prior to issuing the switching order.

If at any time anyone involved with the switching believes that it is not safe to proceed with the switching, he/she may stop the process and meet with the Dispatcher to identify and correct the issue. If the issue has been corrected the switching may continue.

c. Are protective relaying people involved?

Yes, Relay Personnel are included when the blocking of certain schemes or adjustments to settings is required in order for the protection to meet the operating changes of the system.

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? 90%

    b. Distribution Automation? 0%

    c. Other? N/A

    d. Is it uniform throughout the company? Yes

    e. What are the plans? The future plans include migrating towards a GIS System over the next 3-4 years, followed by an Outage Management System and implementation of Distribution Automation on a limited basis over the next 5 – 6 years followed by increased implementation of Distribution Automation within the next 10 years.

11. How many Distribution Operations Centers ('DOC') operate on your system?

    At this time all control of the Distribution System is located at one facility. The plan is to have two independent operating centers by fall of 2006. Each operating center will support each other as a back-up center in the event that one becomes incapacitated.

12. Are the DOC's co-located with your Transmission OC offices? No

    a. System OC? Yes

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Real-time	Offline / Real-time	Missing Information	etc
Circuit/line loading	☒	☐	☐	☐
Open Switches	☐	☐	☒	☐
Circuit Breaker Tagged	☒	☐	☐	☐
Status Switches (Distribution Feeder)	☒	☐	☐	☐
Transformer loading	☒	☐	☐	☐
Voltage Overloads by (Distribution Type Bus)	☒	☐	☐	☐
3-Phase Capacitor Bank Breaker Status	☒	☐	☐	☐
Loading of Circuits	☒	☐	☐	☐
Load Tap Changer Indication (Transformers)	☒	☐	☐	☐
2-phase Amps	☒	☐	☐	☐
Differential Alarms (Transformer & Buss)	☒	☐	☐	☐
3-Phase Voltage (Transformer)	☒	☐	☐	☐
Recloser Status	☒	☐	☐	☐
Ground Relay Status	☒	☐	☐	☐
Substation Entry Alarms	☒	☐	☐	☐
Equipment Limit Alarms (Voltage, Amps)	☒	☐	☐	☐
RTU Communication Error %	☒	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? During periods of increased activity on the system, additional personnel are brought in to assist the existing staff on duty. This may include Dispatchers that are off duty and/or supervision.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? Yes, we have a procedure that outlines the function of each Dispatcher that is called in for emergency duty. Each Dispatcher is given a specific duty so that radio traffic, customer calls and switching and operating the system may continue.

The personnel coming in to relieve the present shift are called in next if they are needed.

Supervision may be called in at anytime depending on the requirements to maintain the operation of the system. We have practiced this in our drills of our Emergency Disaster Procedure this month.

b. Do you have priority lists? Yes. Typically the list draws from the personnel that are off duty to respond. Personnel off-duty is selected as not to affect the rest periods of the personnel that will be coming in on the next shift.

c. Is information flow adequate under these conditions? Sometimes ~ we prioritize our activities in the Dispatching Center according to the level of available staff. Communication with the field personnel is number one along with safety. Communication of the outages and system status is handled on a need to know basis many times due to insufficient staff to support this function. Briefings are provided to personnel as soon as possible and where practical.

d. What are the issues? Not enough staff on a daily basis. Training has also been impacted due to not having sufficient personnel to cover the operation and still afford to provide adequate training schedule. We are looking into implementing the 12-hour shift shcedule that may temporarily fix the problem, but I believe the ultimate solution is to increase staff where needed

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.)
Yes, I have attended the conference since 2001. I have had the opportunity to bring back new ideas to my company and make contact with other personnel who have some of the same issues that we have in operations. I have also raised the interest of other groups in the company and have included them in attending the conference.

16. Have you participated in the EPRI program? No

17. Have you attended any of the 9 annual conferences Yes

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? First, standardizing a company's procedures related to Switching, Clearances, Hot Line Work, and Data Reporting. Second, the training of personnel involved in the use or that are affected by the procedures. Third, the enforcement of those procedures to ensure that all participants are compliant. Fourth, adequate staffing to match the work load. And finally, reward the personnel for improvements.

INTERVIEW # 15

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: Transmission -Control Area Operations Supervisor
    e. Responsibilities: Transmission System Operations- 69, 138, 161, & 345 KV
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 2800
    b. Number of circuits: 2800 + miles transmission
    c. Number customers: 500,000
3. What is the track record of the company in terms of switching incidents? Have not tracked this type of historical information.
4. Are there any specific switching incidents that you can share?
    a. Description: N/A
    b. Customers affected: N/A
    c. Injuries, if any: N/A
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: System Operators issue all switching orders to field personnel, orders are recorded, repeated back for confirmation, executed, confirmed by switchman, reported to system operator, repeated back by the system operator to the switchman for confirmation.
    b. Elaborate on safeguards: Ten Step Switching Procedure
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Unique switch numbers (substation prefix-switch number)
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? Switchman carries a copy of the orders for all pre-scheduled switching requests.
8. What are the practices for temporary grounding at work sites? Grounds are installed by field personnel, installing grounds are not part of the system operators switching orders.
    a. Any documentation that can be shared with us? This information has been supplied to the EPRI Power Switching Safety & Reliability working Group.
9. What are the procedures for securing relays, reclosers, sectionalizers? Reclosers turned off are worked under a "Caution Order". All automated sectionalizers are decoupled and locked open
    a. What are the procedures for training personnel on proper procedures? Hands on & video training.
    b. Who reviews switching orders? Operations Engineer & System Operators
    c. Are protective relaying people involved? As needed
10. What is the level of monitoring at the distribution level:

a. Distribution SCADA? N/A

b. Distribution Automation? N/A

c. Other? N/A

d. Is it uniform throughout the company? No

e. What are the plans? Only operate and monitor transmission, member Cooperatives monitor distribution

11. How many Distribution Operations Centers ('DOC') operate on your system? 16

12. Are the DOC's co-located with your Transmission OC offices? No

a. System OC? No

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of. We are transmission only…….

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☐	☐	☐	☐
Open Switches	☐	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☐	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Switching requests are generated as needed during emergencies.

a. Do you have specific policies for processing and monitoring switching orders under these conditions? Orders are reviewed by another operator.

b. Do you have priority lists? Yes

c. Is information flow adequate under these conditions? Yes

d. What are the issues? None

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) I currently am a member of the Steering Committee

16. Have you participated in the EPRI program? Yes

17. Have you attended any of the 9 annual conferences All 9…….

18. Are your responsibilities:

a. Distribution? ☐

b. Transmission? ☒

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Increase focus on Training personnel.

INTERVIEW # 16

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Name:
    d. Position: Director, Distribution Dispatch
    e. Responsibilities: Distribution (station transformer high side down to customer meter, energy control and trouble dispatching response)
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 38,000
    b. Number of circuits: 6,000 (distribution)
    c. Number customers: 5,100,000
3. What is the track record of the company in terms of switching incidents? We had 93 switching errors in 2004 and have had 39 for the first 11 months of 2005. We count many more items as switching errors than what I have seen compared to other companies. We include such items as a crew operating equipment without authority, non-reclose being applied to the incorrect circuit, a circuit left in the non-reclose mode when reclose should have been restored to dropping customer load and energizing facilities that should not be energized.
4. Are there any specific switching incidents that you can share?
    a. Description:
    b. Customers affected:
    c. Injuries, if any:
    d. Other info:
5. Information about company switching procedures.
    a. Brief descriptions:
    b. Elaborate on safeguards:
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? We have the switching orders checked by two other dispatch persons and the field prior to performing the switching. The switch person is required to conduct a "walk-thru" prior to actually starting the switching procedure. The dispatcher and the switch person have the same switching order in front of both of them during the switching activity.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Yes
    a. How do you monitor compliance to procedures? Yes, we have an audit process.
8. What are the practices for temporary grounding at work sites? Work site grounds are typically placed by the field person and under their control. We have a step in the arrangement statement that reminds them to install their personal grounds when the order is given to the crew and they tell us all personal grounds have been removed when the order is released, but we do not track personal grounds. We do track grounds in network switching.
    a. Any documentation that can be shared with us? No
9. What are the procedures for securing relays, reclosers, sectionalizers?

a. What are the procedures for training personnel on proper procedures?

b. Who reviews switching orders?

c. Are protective relaying people involved?

10. What is the level of monitoring at the distribution level:

    a. Distribution SCADA? Yes - about 45% of the distribution breakers have SCADA.

    b. Distribution Automation? Very limited

    c. Other? No

    d. Is it uniform throughout the company? Currently being standardized for new installations.

    e. What are the plans? Being developed.

11. How many Distribution Operations Centers ('DOC') operate on your system? 7

12. Are the DOC's co-located with your Transmission OC offices? In some locations, but not all.

    a. System OC? No.

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☐	☐	☐	☐
Open Switches	☐	☐	☐	☐
Tagged Switches	☐	☐	☐	☐
Transformer loading	☐	☐	☐	☐
Overloads by type	☐	☐	☐	☐
etc	☐	☐	☐	☐

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? The station breaker remains under the control of the dispatch center along with any switching that will tie two circuits together. The radial/laterial circuits can be transferred to the field person in charge.

    a. Do you have specific policies for processing and monitoring switching orders under these conditions? Yes

    b. Do you have priority lists? Yes

    c. Is information flow adequate under these conditions? Most of the time, however there are times where improvement is needed.

    d. What are the issues?

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation

analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) Yes

16. Have you participated in the EPRI program? Yes, in the past.

17. Have you attended any of the 9 annual conferences Yes, I have attended 5 of the 9 conferences.

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Attention/scorecard - you must keep the information in front of those performing the work and leading the groups so they know where they stand.

INTERVIEW # 17

1. Please provide information about yourself:
    a. Name:
    b. E-Mail:
    c. Phone:
    d. Position: DOC Manager -
    e. Responsibilities: Three (3) DOC's in the northern half of the Company. Responsibilities include System Operations, Service Order Dispatch, Trouble Dispatch, and 153 First Responders LOL's (Local Operations Linemen)
2. Please provide information about company – size of system (MW, circuits), customers, etc.
    a. Size of system (MW): 12,200
    b. Number of circuits: 2200
    c. Number customers: 1,400,000
3. What is the track record of the company in terms of switching incidents? 4-6 per year
4. Are there any specific switching incidents that you can share?
    a. Description: High side switch and safety switch in substation had similar sounding ID numbers. Field personnel opened wrong device. Dropped a 46 KV substation.
    b. Customers affected: 2500
    c. Injuries, if any: None
    d. Other info: N/A
5. Information about company switching procedures.
    a. Brief descriptions: Very formalized procedures with System Operator controlling switching from the distribution substation down to and including the radial taps.
    b. Elaborate on safeguards: Written switching procedures to issue switching steps, pins and tags on DOC electronic mapboard, written switching and tags in the field.
6. What methods are in place at your company to reliably verify that a switching action has been correctly implemented? Documentation on written switching forms and verbal repetition of the step; both issuance and completion.
7. Are switching orders and procedures formal (i.e. Standard paperwork, supervision, etc)? Developed standard switching form for recording switching steps and eliminated all other "non-approved" forms.
    a. How do you monitor compliance to procedures? Periodic audits by supervisors.
8. What are the practices for temporary grounding at work sites? Single point grounding at the work site is the preferred method unless continuity is broken then bracket grounding is used to work between grounds.
    a. Any documentation that can be shared with us? N/A
9. What are the procedures for securing relays, reclosers, sectionalizers? As part of issuing clearance on a section of line, reclosing is disabled by the System Operator before the device is opened, then air gaps (disconnects) are opened and tagged.
    a. What are the procedures for training personnel on proper procedures? Classroom training, field training, testing, OJT.

b. Who reviews switching orders? Other System Operators, Field Serivce Foremen, Supervisors.

c. Are protective relaying people involved? Yes, in developing and updating substation switching proceures.

10. What is the level of monitoring at the distribution level:

a. Distribution SCADA? >90% of subs are on SCADA. Analog voltages and currents on breakers, buses, and banks. Voltage regulator control, cap bank control, breaker operation control, reclosing disable, and Hot Line tagging.

b. Distribution Automation? 1000 line devices with remote DA control and analog voltages and currents.

c. Other? Fault Isolation and Feeder Restoration automated with local logic on 32 feeders.

d. Is it uniform throughout the company? Yes

e. What are the plans? Continue feeder breaker automation and line device automation as budgets allow.

11. How many Distribution Operations Centers ('DOC') operate on your system? Five (5) during the day with a rollup to two (2) after hours

12. Are the DOC's co-located with your Transmission OC offices? No

a. System OC? No

13. Identify system data available to the DOC on a real-time viewable basis, what is available real-time off-line, what is missing? Fill any additional columns and/or rows you can think of.

	On-Line / Realtime	Offline / Realtime	Missing Information	etc
Circuit/line loading	☒	☒	☐	☐
Open Switches	☒	☐	☐	☐
Tagged Switches	☒	☐	☐	☐
Transformer loading	☐	☒	☒	☐
Overloads by type	☒	☒	☐	☐
etc	☐	☐	☐	☒

14. In case of a major event, multitude of alarms and a very busy time in the control center, how do you handle switching orders? Switching procedures remain the same for the DOC. We decentralize to staging areas or "miami plan" hardest hit areas by shifting system control to the field.

a. Do you have specific policies for processing and monitoring switching orders under these conditions? No

b. Do you have priority lists? Yes

c. Is information flow adequate under these conditions? Once control of the system has been de-centralized, information flow from the field back to the center is limited and really not adequate to maintain good restoration updating.

d. What are the issues? network availiblity in the field, commercial wireless bandwidth, time required to establish satellite connectivity.

15. Are you aware of the Annual Power Switching and Reliability Conference? (The Conference is sponsored by EPRI's Transmission and Substation program and addresses all issues from switching protocol to outage management considering technical, safety, reliability, metrics, human factor elements, situation analysis, etc. While not focused on the Distribution area, many Distribution concerns are addressed.) No

16. Have you participated in the EPRI program? No

17. Have you attended any of the 9 annual conferences No

18. Are your responsibilities:

    a. Distribution? ☒

    b. Transmission? ☐

19. In your opinion, what is the single most important improvement that will lead to safer operations, more accurate switching procedures and operations, and/or a more efficient operation considering safety, reliability, data availability, decision making, etc.? Technology. The intergration of system operations tools, real time data, and switching information is currntly the biggest challenge. This needs to be pulled together and presented to the Operator in a simple and easy to use platform to allow the system operators to make better decisions. Real time versus system planning data readily available for on the fly what if's to determine how to effectively pick up load.

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