EDISON ELECTRIC INSTITUTE

STATE OF DISTRIBUTION RELIABILITY REGULATION IN THE UNITED STATES

PREPARED FOR:

EDISON ELECTRIC INSTITUTE

PREPARED BY:

DAVIES CONSULTING, INC.

SEPTEMBER 2005

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- Expanding Market Opportunities
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1. EXECUTIVE SUMMARY

1.1. State Approaches to Service Quality

Over the past decade, state regulators across the United States have increased their scrutiny of utility power delivery performance. Many state regulators have passed reliability reporting requirements, reliability performance targets, and performance based rates. In addition, the issues of reliability and incentives/disincentives to drive utility reliability performance have been "hot topics" at the National Association of Regulatory Commissioners (NARUC) meetings. The regulatory landscape is constantly changing and regulations are increasingly having an effect on how and where funds are expended. Within the last year numerous utilities have developed strategies to deal with this accelerating trend.

This paper is a comprehensive study of the issues that electric utilities are facing with respect to state reliability statutes, standards, and regulation for both electric distribution and transmission systems within each state and the District of Columbia. Table 1-1 provides a list of the states under some form of performance regulation; a detailed description about each of these methods can be found in Section 4.

Table 1-1: Summary of State Approaches to Performance Regulation

Method of Performance Regulation	No. of States	States
Return on equity based PBR	2	Mississippi, North Dakota
Quality of service PBR – penalties and rewards	3	California, Massachusetts, Rhode Island
Quality of service PBR penalties only	11	Colorado, Florida, Maine, Michigan, Minnesota, Ohio, Oregon, Texas, Utah, Vermont, Washington
Quality of service - targets	11	Arkansas, Illinois, Indiana, Iowa, Kansas, Louisiana, New Jersey, New York, Oklahoma, Pennsylvania, Virginia
Quality of service – reporting	12	Alabama, Connecticut, Delaware, District of Columbia, Georgia, Hawaii, Kentucky, Maryland, Missouri, New Hampshire, Nevada, Wisconsin
No reporting requirement	12	Alaska, Arizona, Idaho, Montana, Nebraska, New Mexico, North Carolina, South Carolina, South Dakota, Tennessee, West Virginia, Wyoming

1.2. Index of Individual State Information

The following table provides a quick reference guide to the page on which the details of state's performance-based regulations can be found. States currently having no reporting requirements are listed as N/A.

2. OVERVIEW

2.1. Purpose of Study

In January 2005, the Edison Electric Institute (EEI) commissioned Davies Consulting, Inc. (DCI) to conduct a study on the state of reliability regulation in the United States. The purpose of the study was to discuss the history of reliability regulation, research the current state of regulation, and examine the future of reliability regulation. The main areas of analysis included: (1) Methods of Performance Regulation; (2) Reliability Standards; (3) Customer Service Standards; and (4) Penalties and Rewards. The report is primarily focused on distribution system reliability with some references to reliability of the transmission system. EEI intends to use the 2005 study as the first of several periodic publications on the status of reliability regulation in the United States.

2.2. Research Methodology

Prior to commencing the *State of Distribution Reliability Regulation in the United States*, DCI and EEI developed, refined, and agreed to the study's scope and objectives. The study is based on secondary research, as well as surveys and interviews with the selected state public utility commissions. Phone interviews and visits were conducted with utility regulatory managers and staff from eighteen utilities operating in 39 states and the District of Columbia. DCI compiled the data gathered from the survey and interviews into a 2005 State of Reliability Regulation database[1] for use in analyzing the current situation and emerging trends. Furthermore, DCI analyzed the effects of reliability regulation on utility performance using data submitted to EEI. Finally, DCI supplemented findings with experience working with utility clients in jurisdictions across the United States.

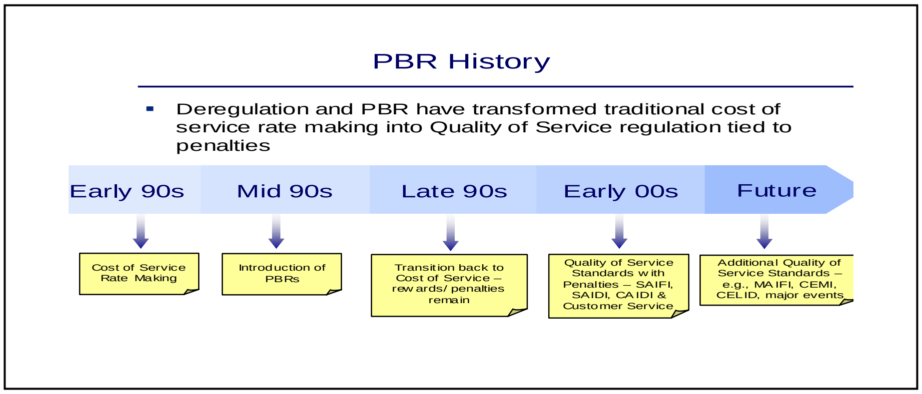
[1] The level of regulation within a state is represented in the database by the utility with the most stringent requirement (e.g., if at least one utility within a state has a Quality of Service (QOS) standard with penalties, that state is represented as having QOS with penalties). See i*nfra*, p. 5, for a more detailed discussion and definition of QOS.

3. PERFORMANCE REGULATION BACKGROUND

3.1. Back to Basics

The utility industry of the last decade has been subject to dramatic change. The 1990s were characterized by deregulation, a focus on non-regulated ventures, and industry consolidation through mergers and acquisitions. During these years, performance based regulation (PBR), tied to return on equity rather than cost of service, was also introduced (*see Figure 3-1 below*).

Figure 3-1: Illustrated History of PBR



Each of these areas has had varying degrees of success. As a result of the California energy crisis in 2001, national deregulation activity essentially came to a halt. Close to 60 percent of states surveyed indicated that they have no plans for deregulation in the next two to three years.[2] The collapse of Enron, the terrorist attacks of 9/11, the bursting of the internet bubble, and limited access to capital has slowed non-regulated activity. Beginning in 2000, merger activity diminished significantly. Large events such as the Chicago substation outage of 1999, the North Carolina ice storm of 2002, and the Northeast Transmission Grid blackout of 2003 have increased regulatory and legislative focus on utility reliability performance.

All of this has not only led utilities to a "back to basics" focus but also heightened regulator emphasis on reliability and quality of service. Utilities are focusing management and financial capital on the core business of delivering electricity, which includes improving customer information systems and developing more strategic infrastructure-related reliability investments. Furthermore, utilities have initiated strategic business process improvement initiatives aimed at sustainable cost reduction and service improvement.

3.2. Performance Regulation Triggers

While utilities have begun implementing the changes noted above, regulators have begun emphasizing the development and implementation of mechanisms designed to monitor and measure utility performance. This changed emphasis has been driven by a number of factors, including mergers and significant events.

[2] Newton-Evans Research Company, Inc., September 2003.

Performance guarantees are often linked to merger agreements in order to provide regulators with some level of comfort that the merged entities would, at the very least, maintain the existing level of performance. As mentioned above, in the past five years the industry has experienced a number of major events (North Carolina ice storm, Chicago substation outage, Northeast blackout, and Florida hurricanes) that have heightened public interest in the regulation and legislation of utilities. The result has been increased regulatory oversight and, in some cases, in-depth investigations of utility performance.

Another trigger for increased regulatory scrutiny has been public and federal concern over the aging of the United States electric grid.[3] Despite evidence that some age-focused replacement programs are not cost-effective (customers are not willing to pay for the "perfect" system) and are less efficient than other methods, such as replacement based on failure history, the aging infrastructure continues to be a focus of regulators. Utility cost-cutting initiatives have also contributed to increased regulator scrutiny because regulators are often skeptical of these initiatives and perceive them solely as mechanisms designed to manage earnings during slow growth periods. Regulators have indicated that they fear that utilities will implement cost cutting measures without regard for customer service and reliability.

3.3. The Challenges for Regulators

While it is true that in the last decade the industry has witnessed increased regulatory scrutiny, the level of that scrutiny and performance regulation activity has varied across the United States. Indeed, 27 percent of utility commissions in the United States do not have any reliability standards whatsoever in place.

Although state regulators are concerned with utility performance, they face a number of important challenges in providing effective oversight. First, given the vast differences in service territories and infrastructure across the United States, regulators face a difficult challenge in comparing utilities. Despite these difficulties, a few state regulators are considering state-wide performance standards. Second, while many regulators are quite sophisticated and experienced, they simply do not have the same level of knowledge as utility managers and staff, who run the utility's day-to-day operations. Third, regulators should be sensitive to the fact that regulatory reporting standards can often have a significant impact on a utility's resources and costs. Finally, because monitoring, evaluating, and comparing utility performance against agreed standards requires a significant number of qualified regulators, many state regulatory agencies do not have adequate resources to effectively perform the necessary oversight.

[3] Chairman Alan Greenspan of the Federal Reserve Board has said, "If the electricity infrastructure of this country is inadequate or in some way excessively costly, it will undermine economic growth, and is therefore a major issue that must be addressed." Testimony of Alan Greenspan, U.S. Senate Budget Committee Hearings, January 26, 2001.

4. CURRENT PERFORMANCE REGULATION ENVIRONMENT

4.1. Methods of Performance Regulation

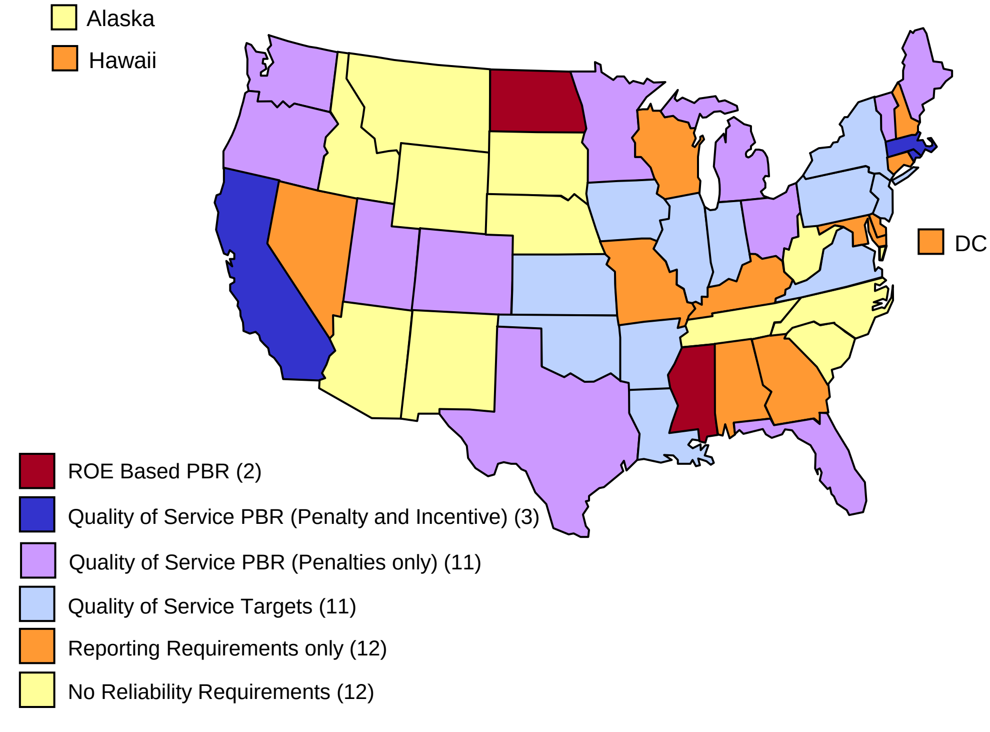
Since the PBR concept was introduced in the 1990s, definitions and applications of it have varied widely among state regulatory commissions. Interviews with utilities and regulators confirmed that PBR does not have one universally accepted definition. For example, while only two states have Return on Equity (ROE) Based Performance Based Rates, many utility representatives and regulators indicated that they had PBR when what they actually had was some form of Quality of Service Standards. Below are the definitions used throughout the report:

- **ROE Based PBR** (PBR) exists where the Rate of Return is set with a dead band (range where the utility and shareholders assume all benefits and cost) and a live band (range above and below the dead band that would have a sharing mechanism assigned).
- **Quality of Service PBR** (QSP) exists where the Rate of Return is set using the conventional cost of service methodology and the utility has reliability and/or customer service targets imposed by the commission with penalties and/or rewards.
- **Quality of Service Targets** (QST) exist where the Rate of Return is set by using the conventional cost of service methodology and the utility has reliability and/or customer service targets imposed by the commission without penalties or rewards.
- **Reporting Only** exists where the utility has to file reports but does not have specific targets imposed by the commission.

4.2. Reliability Regulations in the United States

The map in figure 4-1 (*see next page*) illustrates current reliability regulations in the United States (*see Section 7 for a listing of states by type of reliability regulation*).

Figure 4-1: Reliability Regulations in the United States



Source: DCI interviews/survey with 29 state commissions and 18 utilities.

ROE-Based PBR: As illustrated in the map, only two states currently have an ROE-based PBR. Below is a summary of the ROE-based PBR mechanisms used in North Dakota and Mississippi.

North Dakota: The North Dakota Commission has adopted a PBR methodology that allows Otter Tail Power to adjust its allowed rate of return based on the results of four performance areas: reliability, customer satisfaction, customer price, and employee safety. The reliability metrics used are System Average Interruption Frequency Index (SAIFI) and Customer Average Interruption Duration Index (CAIDI). The customer satisfaction metrics employed are the figures generated from an annual Relationship Survey and a semi-annual Transactional Survey. The customer price metrics utilized are a competitive price comparison and a comparison of the annual change in price. The employee safety metric employed is the Occupational Safety and Health Administration (OSHA) Incident Rate for utilities with fewer than 1000 employees. Each of the seven metrics is worth ±25 basis points for a maximum total of 175 basis points and is used to adjust the upper and lower limits of a dead band around Otter Tail's allowed ROE. The dead band is ±100 basis points. For example, if Otter Tail's ROE was 12 percent, the dead band would be 11 percent to 13 percent. If Otter Tail performed above the reward threshold on all seven metrics, the upper band would move up to 14.75 percent (13 percent + 1.75 percent). The lower band would remain the same (11 percent). Therefore, Otter Tail's allowed ROE would move up to the midpoint between 11 percent and 14.75 percent, or 12.88 percent, and the new dead band would be 11.88 percent to 13.88 percent.

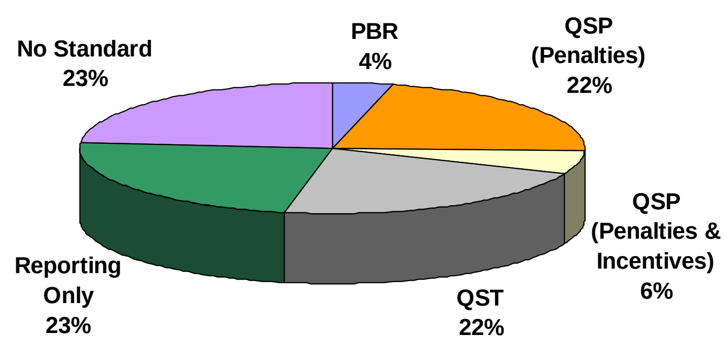
Mississippi: The Mississippi Public Service Commission has adopted a PBR approach that allows Mississippi Power to increase (or decrease) its return on investment based on three service quality metrics. The metrics adopted by the Commission are:

1. Customer Price – Determined by comparing Mississippi Power's average price per kWh to the average price charged by Southeast Electrical Exchange Utilities.
2. Customer Satisfaction – Determined from the results of an independent semi-annual customer survey.
3. Customer Reliability – Determined by measuring reliability performance over a 36-month period.

The three performance metrics are combined to establish a company performance rating. This performance rating is used to adjust the upper and lower limits of a "dead band" around Mississippi Power's allowed return on investment. The "dead band" is ±50 basis points. The projected return is then compared to the company performance rating adjusted return, and if Mississippi Power's projected return is above (or below) the dead band of the company performance rating adjusted return, the revenue can be increased (or decreased) to reflect performance.

Quality of Service PBR: As illustrated in Figure 4-2, 27 states (54 percent) analyzed in our study have either ROE-based PBR or some form of Quality of Service regulation.

Figure 4-2: Breakdown of Reliability Regulations



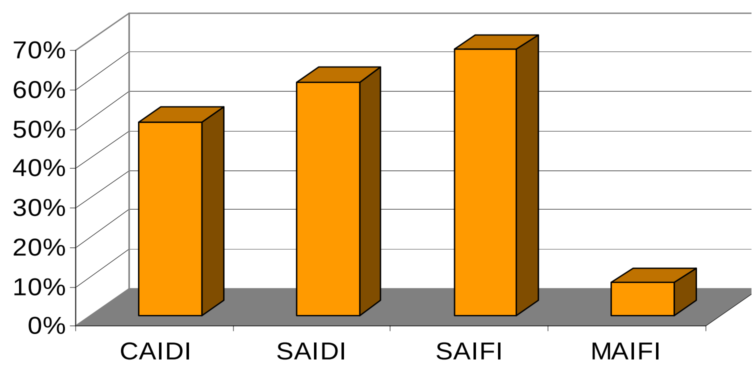
Source: DCI analysis of 50 states and the District of Columbia.

Interviews with utilities and regulators indicated that several states with reporting-only requirements seemed to be in the process of establishing reliability and/or customer service targets geared toward Quality of Service ratemaking. The key difference in the Quality of Service methods is the assignment of penalties and/or rewards. Currently, only 14 states (28 percent) assign penalties and/or rewards and, of these, seven states (50 percent) have actually enforced the penalties and/or rewards.

4.3. Reliability Standards

Reliability standards continue to be a significant focus of many state regulators. As Figure 4-3 illustrates, System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI), and Customer Average Interruption Duration Index (CAIDI) are the primary reliability metrics used by utilities, while Momentary Average Interruption Frequency Index (MAIFI) is not.

Figure 4-3: Reliability Metrics Used by Utilities

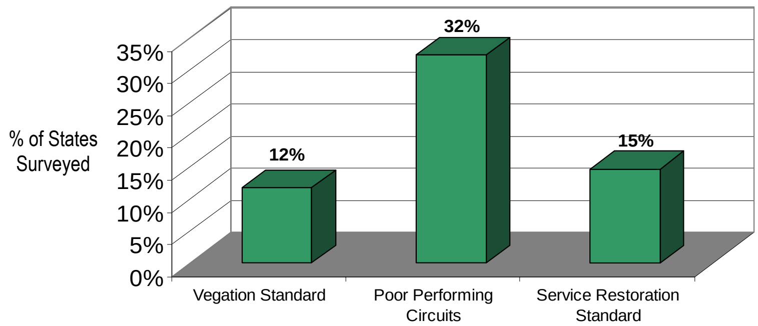


Source: DCI analysis of 50 states and the District of Columbia.

A number of factors have contributed to the use of SAIFI, SAIDI, and CAIDI as the key reliability indicators. First, current outage management systems (OMS) are configured to report on these indicators. Second, momentary interruptions are difficult to capture accurately, since such interruptions are more often captured at the circuit breaker level or at the recloser. Third, most studies and Key Performance Indicators use a combination of CAIDI, SAIFI, and SAIDI to measure reliability performance. Finally, when state regulators evaluate reliability, they focus on these indicators because they recognize that utilities are comfortable using them.

A number of additional metrics focused more on the individual customer experience and less on SAIFI, SAIDI, and CAIDI are also beginning to emerge. These include MAIFI, Customers Experiencing Multiple Interruptions (CEMI), and Customers Experiencing Longest Interruption Durations (CELID). Regulator interest in Worst Performing Feeder (WPF) programs and vegetation management programs (*see Figure 4-4*) is also increasing.

Figure 4-4: Additional Metrics Used by Utility Regulators



Source: DCI analysis of 50 states and the District of Columbia.

Reliability Standard Key Characteristics: While the specific targets for key reliability metrics vary across states and utilities, this study uncovered some key characteristics related to the most used performance areas. The common characteristics include:

- SAIFI, SAIDI, and CAIDI calculations include storm adjustments, or lack thereof; the validity of historical outage performance to set targets; and the system level or operating area.
- Tree trimming cycle requirements, with an average four year cycle as the most common benchmark.
- Worst performing feeders, although formulas for identifying WPF vary from state to state. The focus is on repeat offenders.
- Service restoration targets; for example, the percentage of customers restored within a specific timeframe, or the number of outages over a specified length of time.

Examples of Reliability Targets: Consistent with the key characteristics of reliability standards, the specific reliability targets established by regulators and utilities vary significantly. Below are a few examples of specific targets:

Worst performing feeder

- Feeders with Feeder Average Interruption Duration Index (FAIDI) exceeding SAIDI by 300 percent
- Feeders with 10,000 customers out for more than 24 consecutive hours for two consecutive years
- FAIDI greater than four times SAIDI or in the top 10 percent for two consecutive years

Service Restoration

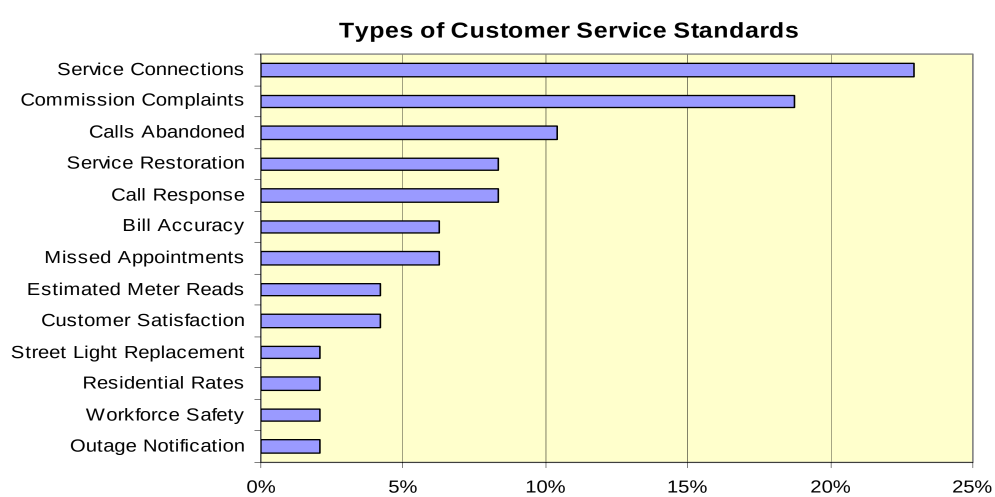
- By restoration time frame
  - Greater than 90 percent restored in 36 hours for all conditions other than catastrophic, and greater than 90 percent restored in 60 hours for catastrophic conditions.
- By number of outages over a specified time frame
  - Customers who have had more than six outages for three consecutive years or outages totaling more than 18 hours per year for three consecutive years.

- By voltage level
  - Customers served at 69 kV or higher can have no more than three occurrences and no more than nine hours for controllable outages in each of the previous three years.
  - Customers served between 15 kV and 69 kV can have no more than four occurrences and no more than 12 hours for controllable outages in each of the previous three years.
  - Customers served below 15 kV can have no more than six occurrences and no more than 18 hours for controllable outages in each of the previous three years.

4.4. Customer Service Standards

In the last decade, regulators have begun to focus more broadly on the wide spectrum of utility issues that affect customers. Through various strategic and continuous improvement efforts, utilities have also focused on meeting specific customer expectations. In fact, most utilities have vastly improved their customer service infrastructures with new billing and relationship management systems, focused product and service offerings, and enhanced communications and public relations efforts. Since most of these improvements required significant investments and, in order to ensure that service improves, many regulators have begun to require specific customer service metrics as part of their Quality of Service ratemaking standards. In addition, poor customer service often leads to an increase in customer complaints to the commission, which is a warning sign that regulators need to become more actively involved in order to protect customers. As illustrated in Figure 4-5, many of these standards address commitments to communicate with customers (e.g., customer complaints, call abandonment, average speed of answer, and outage notifications).

Figure 4-5: Types of Customer Service Standards



Source: DCI analysis of 39 states.

4.5 Penalties and Rewards

In addition to the two states with ROE-based PBR, 13 other state jurisdictions have some type of penalty and/or reward associated with their reliability regulation approach, and 10 of those use only penalties. Based on interviews with regulators and utilities, it is clear that this trend toward the use of penalties versus rewards will be maintained. Given the regulators' role as protectors of the public interest, their primary objective is to ensure that a fair rate of return is earned based on levels of service and reliability. Regulators apparently believe that penalties are the best method to insure utility companies provide the consumer with reliable service at a fair rate.

One area that requires a more rigorous analysis is the calculation of penalties and/or rewards. Calculating a fair reliability target is a complex and challenging proposition. Utility companies and commissions need to pay careful attention to the intent of the penalty/reward and the calculation methods used. In setting fair penalty targets, utility companies and commissions are trying to account for the probability that the following year's SAIFI or SAIDI is below a value that would indicate a utility company is not providing acceptably reliable service to its customers. Because of the randomness of customer interruptions and durations, utility commissions and companies should ensure a robust analysis that provides insights into the probabilities of penalty and reward targets. Ideally, the probability of reward and the probability of penalty should be the same.

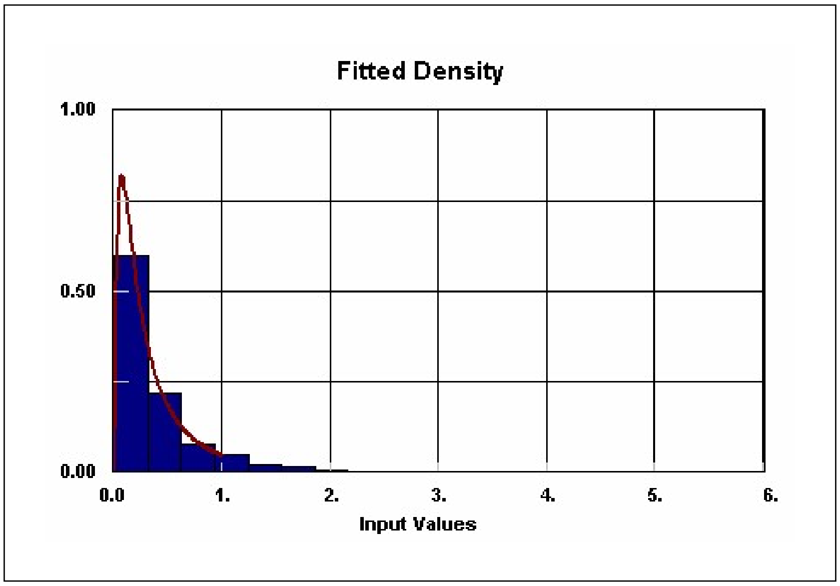
The formulas for SAIFI and SAIDI are:

$$SAIFI = \frac{\text{Total Number of Customer Interruptions}}{\text{Total Number of Customers Served}}$$

$$SAIDI = \frac{\sum \text{Customer Interruption Durations}}{\text{Total Number of Customers Served}}$$

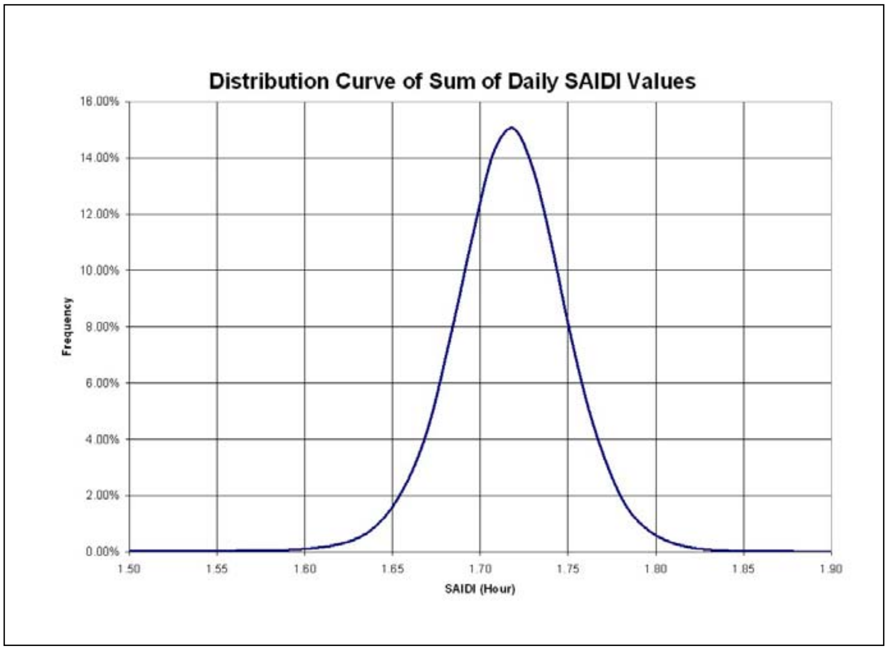
Annual SAIFI and SAIDI are usually reported to a utility commission. The daily SAIFI and SAIDI values have been shown to be approximately a log-normal distribution. Figure 4-6 illustrates the frequency distribution of one year of daily SAIFI observations (*see page 14*).

Figure 4-6: Sample Probability Distribution Plot of Daily SAIFI Observations



According to the Central Limit Theorem, the sum of independent, identically distributed observations are approximately normally distributed. A reported annual SAIFI or SAIDI is only one realization of the sum of log-normally distributed values. A computer simulation can produce multiple realizations of the sum. Figure 4-7 shows the resulting distribution of the sum of daily SAIDI observations that are log-normally distributed, using simulation. To account for the probability of a fair target, utility commissions and companies could incorporate simulation analysis to evaluate the fairness of proposed reliability targets.

Figure 4-7: Simulation Results



The Institute of Electrical and Electronic Engineers (IEEE) 1366 Guide for Electric Power Distribution Reliability Indices establishes a methodology for identifying major event days in reliability performance data. IEEE 1366 Appendix B demonstrates the rationale of translating daily SAIDI values using a log-normal transformation to determine major event days.

Daily SAIFI and SAIDI values follow a log-normal distribution. The targets being set by utility commissions are based on annual values. The underlying probability distribution of annual SAIFI and SAIDI values must be considered, or utility commissions and companies could establish targets that would not be advantageous to one of the parties. By the Central Limit Theorem, the sum of the daily SAIFI or SAIDI values will be normally distributed. This is a key point to understand in setting targets: the annual SAIFI and SAIDI values are not log-normally distributed.

Table 4-1 depicts an arithmetic mean and standard deviation of five years of SAIDI observations and the results of the log-normal adjustment used by a utility company in setting targets. Note that in the table the targets are close. This may not always be the case and care must be given to ensure a fair method is employed.

Table 4-1: Parameters for Target Establishment

Year	SAIDI	LnSAIDI	SAIFI	LnSAIFI
1996	72.80	4.29	1.03	0.03
1997	59.50	4.09	0.91	-0.09
1998	42.20	3.74	0.89	-0.12
1999	68.40	4.23	1.05	0.05
2000	74.40	4.31	1.09	0.09
2001	69.00	4.23	1.11	0.10
2002	71.10	4.26	0.98	-0.02
2003	92.00	4.52	1.24	0.22
Average	68.68	4.21	1.04	0.03
Std Dev	14.07	0.22	0.11	0.11
Penalty Target Avg + 1 SD	82.74	84.16	1.15	1.15
Reward Target Avg - 1 SD	54.61	53.78	0.92	0.93

To continue with the analysis of the example, a computer simulation is used to determine probabilities of rewards and penalties associated with targets developed using a normal distribution with arithmetic average and standard deviation and the targets derived by the log-normal translation and the standard arithmetic mean plus one standard deviation. Table 4-2 indicates that in this case, the probability associated with the reward (13.53 percent) is lower than the probability associated with the penalty (14.44 percent) when log-normal distribution is used to establish annual SAIDI targets. It is clear that more analysis and research in applying IEEE 1366 to setting targets is needed.

Table 4-2: Results of Analysis

	SAIDI	LnSAIDI
Average	73.13	4.28
Std Dev	10.63	0.14
Penalty Target Avg + 1 SD	83.76	83.49
Reward Target Avg - 1 SD	62.51	62.99
Probability of Being Less than Reward	15.83%	13.53%
Probability of Exceeding Penalty	15.83%	14.44%

Below are a few examples of penalty calculations that are being used by utilities.

Reliability Penalty Calculations

- Absolute maximum penalty per standard – e.g., $18 million for failing to meet SAIDI target ($2 million per one minute increment up to $18 million)
- Per customer penalty per standard – e.g., $1 per customer for failing to meet each standard
- Credit per outage occurrence – e.g., $25 credit per occurrence to customers with seven interruptions or more in 12 months

Customer Service Penalty Calculations

- Absolute maximum penalty per standard – e.g., $3 million for missing telephone response and customer complaint targets and $300,000 for missing the estimated meter read target
- Per customer penalty per standard – e.g., $40 bill credit for missed service connections
- Per day penalty per standard – e.g., $1,000 per day until compliance for missing new service connections and average speed of answer targets

5. EFFECTS OF RELIABILITY REGULATION

5.1. Correlation of Method and Impact

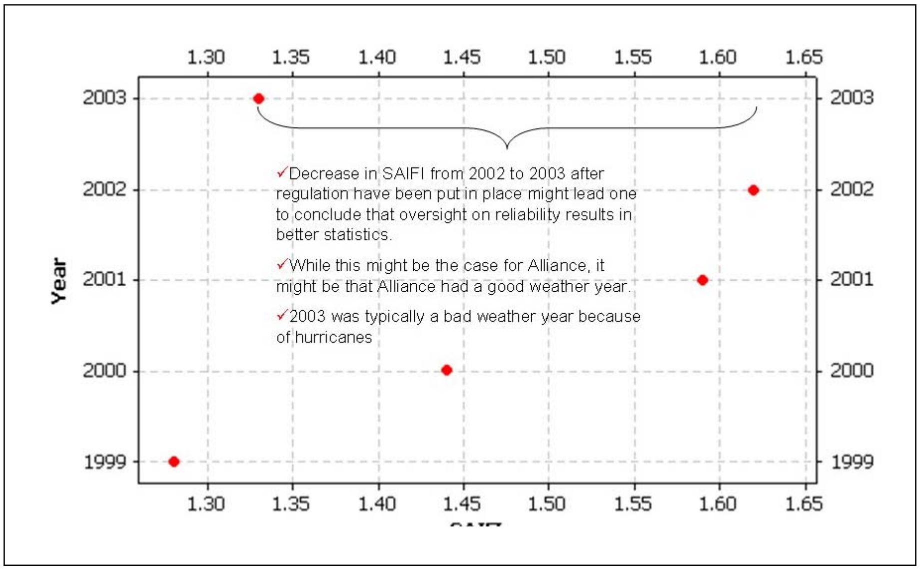
As the utility industry improves the technologies for data capture and analysis, it will be likely that a correlation between the annual reliability statistics and events such as regulatory mandates will exist. Additionally, reliability statistical data is not something utility companies provide to the general public. As a result, the limited data sets available for each utility do not support any correlation conclusions.

The correlation work was initiated with the hypothesis that within a year or two of Quality of Service mandates being placed upon a utility company an improvement would result, and that a consistent correlation across utility companies was expected. For each example that supported the hypothesis, however, there was one that did not, or there was a lack of data that made a conclusion suspect. While it is true that the hypothesis may be valid, there are also factors affecting the reliability statistics, such as more consumer oversight, that question the validity of the hypothesis.

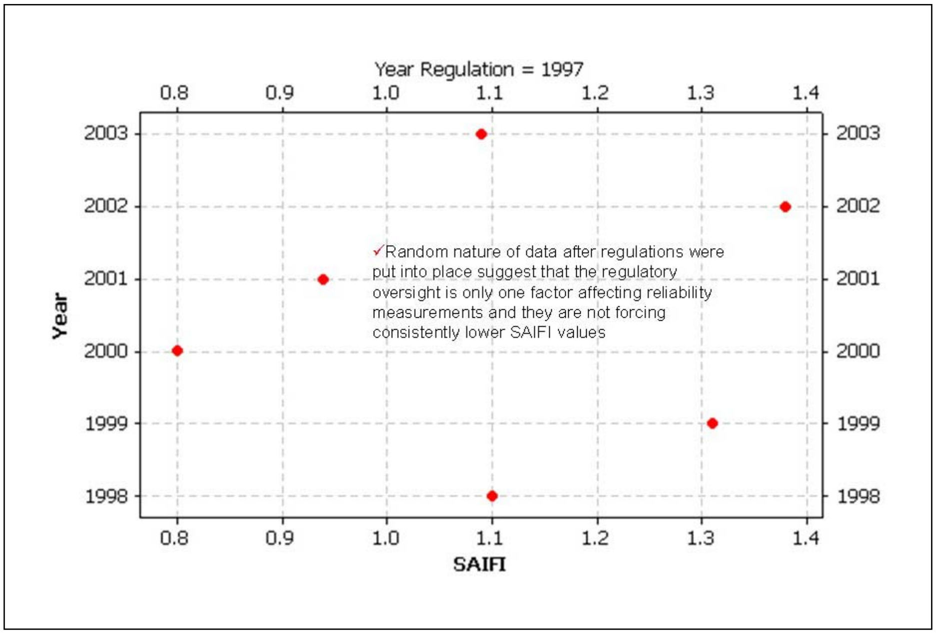
Below are examples of charts that support the hypothesis (A), contradict the hypothesis (B), and support the hypothesis but have missing data (C).

Figure 5-1: Scatterplots of Year Regulation in Place vs SAIFI

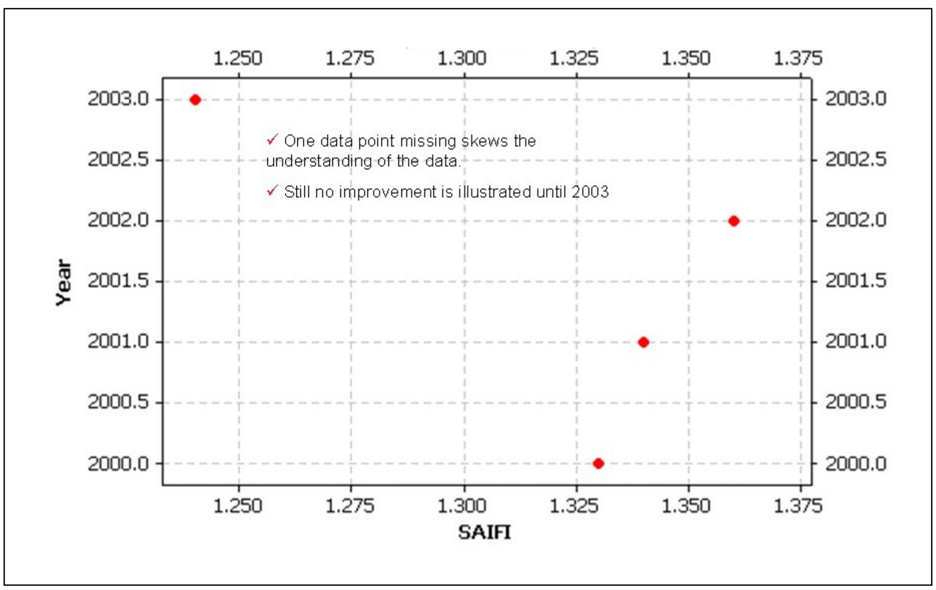
(A)



(B)


Year Regulation = 1997
0.8
0.9
1.0
1.1
1.2
1.3
1.4
2003
2002
2001
2000
1999
1998
Year
SAIFI
✓Random nature of data after regulations were put into place suggest that the regulatory oversight is only one factor affecting reliability measurements and they are not forcing consistently lower SAIFI values

(C)


1.250
1.275
1.300
1.325
1.350
1.375
2003.0
2002.5
2002.0
2001.5
2001.0
2000.5
2000.0
Year
SAIFI
✓ One data point missing skews the understanding of the data.
✓ Still no improvement is illustrated until 2003

6. PERFORMANCE REGULATION EMERGING TRENDS

Our evaluation of Reliability Regulation in the United States has revealed the following emerging trends that will be important for utilities to monitor.

1. Shift from ROE PBR to Quality of Service PBR
2. Regulators are not poised to impose more stringent standards
3. Nationwide/state standards are unlikely
4. Major event-related standards will become more prevalent
5. Regulators will continue to focus primarily on penalties
6. Reliability centered maintenance (RCM) may become another area of focus for regulators

In this section we will provide our analysis regarding each emerging trend.

6.1. Shift from ROE-Based PBR to Quality of Service PBR

Based on discussions with regulators and utilities, it appears that the future of ROE-based PBR seems limited. Specifically, as illustrated by the map in Figure 4-1, only two states currently have an ROE-based PBR and, while at least two other states (Kansas and Nevada) are considering it, there does not seem to be a great deal of momentum from state regulators or utilities to actively pursue ROE-based PBR. Additionally, Xcel's North Dakota ROE-based PBR tariff will expire at the end of 2005 and Xcel has not yet decided if it will support an extension of the tariff or if it will request a return to a cost of service tariff.

The shift away from ROE-based PBR seems to be a function of two important factors. First, the mechanisms for calculating, monitoring, and reporting ROE-based PBR are fairly complex and cumbersome. Second, utilities are more accustomed to traditional cost of service regulation and the introduction of penalties and rewards associated with specific performance standards is seen as a less cumbersome mechanism.

This shift is likely a short-term trend given that ROE-based PBR seems to provide the best vehicle to address the objectives of both state regulators and utilities. ROE-based PBR will likely afford utilities greater opportunities to seek higher returns and will allow regulators to establish greater controls for ensuring that reliability and customer service performance levels remain satisfactory.

6.2. Regulators Are Not Poised to Impose More Stringent Standards

State regulators have had varying degrees of focus regarding reliability regulation and seem to be mostly concerned with monitoring reductions in reliability performance based on historical data rather than establishing complex, stringent regulatory requirements. Interviews with regulators and utilities suggest that all parties are struggling with developing relatively simple and fair mechanisms for monitoring utility reliability performance. It also seems clear that there is a tacit level of mistrust between utilities and state regulators based on past experiences, where regulators believed that utilities took advantage of reliability performance mechanisms and regulators believed that utilities should not be rewarded for performance they should already be delivering.

As mentioned earlier, regulators are increasingly interested in a couple of key questions. First, will reliability performance be affected by utility cost cutting efforts? Second, do utilities have sufficient measures in place to limit the effect of significant events? It seems likely that while regulators are certainly ready to react to declining performance, they are not collectively interested in creating more stringent standards.

6.3. Nationwide/State Standards Are Unlikely

As mentioned earlier, some state regulators would like to compare performance across utilities. At the present time, this appears to be an extremely challenging and potentially damaging course of action. Due to a number of differences related to their delivery systems and environment, obtaining exactly the same level of performance for all utilities within a jurisdiction, or even across regions within the same utility, is very expensive and probably not possible. For years, utilities have struggled with benchmarking their performance as a means of determining best practices and improving operational performance. The results of these benchmarking efforts have been mixed at best, for while it is true that there are a few sound utility benchmarking methodologies which use various normalization mechanisms, we believe that using these types of approaches to support rate filings is a risky proposition. However, the pressure to create statewide standards will likely continue.

Nevertheless, today there are a number of significant challenges that would make this type of standardization very difficult and potentially lead to meaningless and unfair comparisons (*see Table 5-1*). To begin with, regulators have different perspectives and interests regarding how to measure performance. Secondly, there are a number of environmental and regional issues associated with standardization, such as differing customer demographics, geography, climate, and vegetation density. In addition, each utility has a slightly different system in terms of voltage, configuration, design, and redundancy, making it difficult to compare them only on the basis of reliability performance. Finally, state regulators determine utility costs and creating a mechanism to align costs would be extremely difficult.

Table 5-1: Challenges to Nationwide/State Standardization

Utility Factors	External Factors
▪ Outage management, MDT and GIS systems ▪ Degree of automation (SCADA) ▪ System configuration (network, loop, radial) ▪ Delivery modes (OH, UG) ▪ System age	▪ Customer density (urban, suburban, rural) ▪ Geography (vegetation, terrain, coastal) ▪ Climate ▪ Environmental Factors ▪ Supply from third party (generation/transmission/substation) ▪ Major event definition

6.4. Major Event-Related Standards Will Become More Prevalent

Over the last several years, major events and the time required to restore service have come under increased regulatory scrutiny. Examples include: North Carolina and South Carolina Ice Storm (December 2003), Hurricanes Isabel and Juan (September 2003), Utah Snow Storm (December 2004), four hurricanes in Florida (Summer 2004), and the Maritime Ice Storm (November 2004). After each of these events, the respective state regulators commissioned performance reviews or investigations.

Major Event Focus Areas: The reviews and investigations have focused on three areas where standards are likely to emerge: system resiliency and whether enough money was spent to ensure that the system was capable of meeting electric system standards; the adequacy of restoration strategies, plans, and practices from the perspectives of preparedness and execution; and the effectiveness of communication processes.

Based on an analysis of these major event reviews, a number of conclusions have emerged.

- The systems are resilient.
- Adequate funds are being spent on maintenance and reliability.
- Restoration strategies, plans, and practices meet standard utility practices, but more effective resource acquisition (mutual aid) practices need to be employed, such as getting crews on the road earlier and allowing utilities to recover these costs even if they are not used.
- Communication processes with all stakeholders and customers need to be improved – before, during, and after an event.
- Restoration structures and emergency management structures and practices (e.g., Incident Command Structures) need to be aligned.

Major Event Measurement: Currently, state regulators employ different approaches to determine which events should be excluded from major event adjusted reliability measures (SAIFI and SAIDI). Through a comprehensive process, IEEE determined that exclusions based on percentage of customers or duration of an event resulted in SAIFI, SAIDI, and CAIDI measures that did not reflect the variability that can occur in reliability measures as a result of weather. IEEE 1366 2004 seems to be a sound course of action because it provides a more consistent approach for determining which major event days should be excluded from the calculation of the reported reliability measures. It also provides a more objective and fair comparison of reliability performance across various utilities.

6.5. Reliability Centered Maintenance as Another Area of Focus

Maintenance practices have a significant impact on reliability. Historically, maintenance programs for equipment like breakers, transformers, and line reclosure have been based on months in operation. This assumes that the equipment would follow a failure curve based on time rather than frequency of operation. Until the 1960s, the commercial airline industry based their maintenance programs on the same assumptions that the probability of failure increased as the asset aged (wear-out or bathtub curves). During the 1960s, however, the airline industry began to rethink their maintenance philosophy based on the increased number of daily flights. If the industry had continued to rely on a time based maintenance philosophy, they estimated the in-flight failure rate would have resulted in two air disasters per day. Out of these realizations, the airline industry developed reliability centered maintenance (RCM) programs. Utilities are beginning to evaluate the RCM philosophy to replace traditional time based programs in the hope they will reduce costs and improve reliability.

Reliability Centered Maintenance: Reliability centered maintenance, which is a scientific process designed to develop a maintenance program, focuses on equipment condition and is matched to the wear-out pattern of that equipment based on operation, not time. Those industries using RCM, such as the U.S. airline industry, the U.S. Navy (including nuclear submarines), nuclear power plants, and fossil fuel plants, indicate that adoption of RCM has increased reliability while simultaneously reducing costs.

The Implications for the U.S. Power Delivery Industry: Regulatory efforts, with regard to maintenance, follow two general approaches: development of time based maintenance intervals with compliance reporting, typically on an annual basis; and development of a higher level maintenance approach with assessments or self-certification. Time based maintenance may be cost effective for some technologies, but it is likely not effective for all assets. As more utilities evaluate the RCM model, regulators will have to review the benefits and accept the model as part of a cost effective maintenance program. If RCM-type approaches are proven to be effective, but are not accepted by the commissions, utilities will be forced to continue to use the time based methodology and may face a "wall" where assets will need to be replaced in large quantities. As a result, utilities may begin a large-scale and unfocused replacement strategy that does not produce commensurate reliability.

6.6. Regulators Will Continue to Focus on Penalties

It is likely that regulators will continue to focus on imposing penalties for not achieving reliability performance targets rather than providing incentives for utilities that go beyond targeted performance. There are two of important reasons for this punitive focus. First, many state regulators feel that utilities should not be rewarded for service they should already be providing. Second, many regulators believe that there is no tangible benefit to most customers when a utility achieves performance beyond targets. A number of utilities have explored offering superior reliability service to customers at a premium, only to find that most customers are not willing to pay this premium.

7. STATE PERFORMANCE REGULATION SUMMARIES

7.1. Summary of State Approaches to Service Quality

Method of Performance Regulation	**No. of States**	**States**
Return on equity based PBR	2	Mississippi, North Dakota
Quality of service PBR – penalties and rewards	3	California, Massachusetts, Rhode Island
Quality of service PBR penalties only	11	Colorado, Florida, Maine, Michigan, Minnesota, Ohio, Oregon, Texas, Utah, Vermont, Washington
Quality of service - targets	11	Arkansas, Illinois, Indiana, Iowa, Kansas, Louisiana, New Jersey, New York, Oklahoma, Pennsylvania, Virginia
Quality of service – reporting	12	Alabama, Connecticut, Delaware, District of Columbia, Georgia, Hawaii, Kentucky, Maryland, Missouri, New Hampshire, Nevada, Wisconsin
No reporting requirement	12	Alaska, Arizona, Idaho, Montana, Nebraska, New Mexico, North Carolina, South Carolina, South Dakota, Tennessee, West Virginia, Wyoming

7.2. ROE Based PBR

Mississippi	
Overview of the Requirements	Mississippi has a true ROE based PBR. The risk/reward is set at +/- 50 basis points and is collected as a surcharge or paid as a credit on the bill. There are three metrics that comprise the bonus/penalty calculation. Price is weighted at 40 percent, customer satisfaction weighted at 20 percent, and reliability weighted at 40 percent.
Reliability Metrics	The reliability standards are calculated for each utility to obtain the weighted contribution but the base reliability metric is an approximation of CAIDI.

Docket/Case Number	Mississippi Power – Rider PEP-4 (6/18/2004) Entergy Mississippi – Docket #02-UN-526 (12/31/2002)
Misc. Comments	Both regulated utilities are measured by the same metrics: price, customer satisfaction, and reliability. However, they differ in the formulas used to calculate the performance metrics.

North Dakota	
Overview of the Requirements	North Dakota has a true ROE based PBR. The base rate of return was negotiated, as were all of the performance standards. The risk/reward is set at 25 basis points and is collected as a surcharge or paid as a credit on the bill.
Reliability Metrics	CAIDI and SAIFI
Docket/Case Number	Excel – Case #PU-400-00-195 Otter Tail – Case # PU-401-00-36 (effective date: 12/29/00)
Misc. Comments	The PBR tariff will end this year. It is not known if the PBR ratemaking methodology will be extended for either utility. Both regulated utilities have the same rate methodology at the macro level.

7.3. Quality of Service PBR – Penalties and Rewards

California	
Overview of the Requirements	California has a cost of service based PBR.
Reliability Metrics	SAIFI, SAIDI, CAIDI, and MAIFI
Docket/Case Number	96-09-045 (effective date: 09/04/96)
Misc. Comments	California has very stringent vegetation inspection and tree trimming requirements for some utilities. Baseline reliability targets increase each year for some utilities. The state also has customer service metrics with targets but they are not subject to rewards or penalties.

Massachusetts	
Overview of the Requirements	Massachusetts has a cost of service based PBR.
Reliability Metrics	SAIFI, SAIDI, and CAIDI
Docket/Case Number	D.T.E. 99-84 (effective date: 06/29/2001)
Misc. Comments	All reliability benchmarks are set on company specific historic data.

Rhode Island	
Overview of the Requirements	Rhode Island has a cost of service based PBR.
Reliability Metrics	SAIFI and SAIDI.
Docket/Case Number	2930, order 16200 (effective date: 03/24/00)
Misc. Comments	All rewards are banked as a credit to offset future penalties.

7.4. Quality of Service PBR – Penalties Only

Colorado	
Overview of the Requirements	Colorado has a cost of service based PBR
Reliability Metrics	Performance standards and targets are negotiated, in some cases as part of a merger agreement. SAIDI is the reliability metric.
Docket/Case Number	95A – 531EG (effective date: 08/23/96)
Misc. Comments	Penalties are also applied to some customer service metrics.

Florida	
Overview of the Requirements	One company has a SAIDI related target which is evaluated annually and carries a potential penalty if the performance exceeds the threshold.
Reliability Metrics	SAIDI, SAIFI, CAIDI, and MAIFI
Docket/Case Number	011351-EI/OSC-02-01424 (effective date: 10/18/02)
Misc. Comments	None

Maine	
Overview of the Requirements	Maine has a cost of service based PBR.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	Not available
Misc. Comments	All reliability benchmarks and customer service targets for large utilities in the state are set on company specific historic data. Penalties are also applied to some customer service metrics for the large utilities in the state.

Michigan	
Overview of the Requirements	Michigan a has cost of service based PBR.
Reliability Metrics	SAIDI, SAIFI, and CAIDI are used but penalties are tied to other metrics.
Docket/Case Number	U-12270 (effective date: 11/25/03)
Misc. Comments	Service restoration and same circuit repetitive outages carry penalties. Other customer service metrics have benchmark targets but do not carry a penalty.

Minnesota	
Overview of the Requirements	Minnesota has a cost of service based PBR.
Reliability Metrics	SAIDI and SAIFI
Docket/Case Number	MN Rules Chapter 7826 (effective date: 02/13/03)
Misc. Comments	Not all utilities in the state are subject to penalties. Other customer service metrics that carry a penalty are miss-locates, customer complaints, telephone response, customer metering and billing, repeated and sustained interruptions, long interruptions, gas service interruptions, and meter readings.

Ohio	
Overview of the Requirements	Ohio has a cost of service based PBR.
Reliability Metrics	SAIDI, SAIFI, CAIDI, and ASAI
Docket/Case Number	99-1613-EL-ORD, 97-15; ESSS Rules 4901-1-10-30 (effective date: 04/16/00)
Misc. Comments	Customer service standards have benchmark targets that can carry a penalty.

Oregon	
Overview of the Requirements	Oregon has a cost of service based PBR.
Reliability Metrics	SAIDI, SAIFI, CAIDI, and MAIFI
Docket/Case Number	OAR 860-023-0080 through 0160 (effective date: 01/01/98)
Misc. Comments	Oregon has a two tiered penalty system for reliability and service quality measures. The lower penalty, or tier one, carries a lower cost than tier two. If a utility's performance drives them to the tier two level, the penalty is much higher.

Texas	
Overview of the Requirements	Texas has a cost of service based PBR.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	http://www.puc.state.tx.us/rules/rulemake/21076/21076.cfm (effective date: 12/31/99)
Misc. Comments	Targets and requirements are different for each utility in the state. Targets are set based on company specific data averaged over three years. Customer service metrics carry a penalty as well.

Utah	
Overview of the Requirements	Utah has a cost of service based PBR.
Reliability Metrics	SAIDI, SAIFI, and MAIFI
Docket/Case Number	98-2035-04 (effective date: 11/23/99)
Misc. Comments	Utah has standards for only one utility. Customer service metrics are included in the benchmark targets.

Vermont	
Overview of the Requirements	Vermont has a cost of service based PBR.
Reliability Metrics	SAIFI and CAIDI
Docket/Case Number	Rule 4.900 (effective date: 11/01/00)
Misc. Comments	Not all utilities in the state are subject to the penalty provisions. No customer service metrics are included.

Washington	
Overview of the Requirements	Washington has a cost of service based PBR.
Reliability Metrics	SAIDI and SAIFI
Docket/Case Number	UE-991168 (effective date: 03/26/01)
Misc. Comments	Not all utilities in the state are subject to the penalty provisions. Benchmark standards are negotiated with each utility. No customer service metrics are included.

7.5. Quality of Service PBR – Targets

Arkansas	
Overview of the Requirements	Annual report on performance against the benchmark targets. Not all utilities in the state have targets.
Reliability Metrics	SAIFI, SAIDI, CAIDI, and ASAI
Docket/Case Number	Not available
Misc. Comments	Failure to meet target does not result in a penalty. If targets are not met the utility is required to file a correction plan with the commission that will demonstrate what will be done to meet the target in the next report period.

Illinois	
Overview of the Requirements	Annual report on performance against the benchmark targets. Not all utilities in the state have targets.
Reliability Metrics	SAIDI, CAIDI, and CAIFI
Docket/Case Number	83 Illinois Admin Code, Part 411.140(b)(4) (effective date: 09/01/00)
Misc. Comments	Several utilities have customer service targets but there are no penalties if they fail to meet the target. If targets are not met the utility is required to file a correction plan with the commission that will demonstrate what will be done to meet the target in the next report period.

Indiana	
Overview of the Requirements	Annual report on performance against the benchmark targets.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	Not available
Misc. Comments	No actions if targets not met.

Iowa	
Overview of the Requirements	Annual report on performance against the benchmark targets
Reliability Metrics	SAIDI, SAIFI, CAIDI and MAIFI
Docket/Case Number	RMU-02-3 (effective date: 10/25/02)
Misc. Comments	Commission is scheduled to review moving to rewards and penalties in 2007.

Kansas	
Overview of the Requirements	Annual report on performance against the benchmark targets. Not all utilities in the state have targets.
Reliability Metrics	SAIFI, SAIDI, and CAIDI
Docket/Case Number	02-GIME-365-GIE (effective date: 07/01/04)
Misc. Comments	Customer service targets are included for some utilities, but not all.

Louisiana	
Overview of the Requirements	Annual report on performance against the benchmark targets. Not all utilities in the state have targets.
Reliability Metrics	SAIFI, SAIDI, and CAIDI
Docket/Case Number	U-22389 (effective date: 04/15/98)
Misc. Comments	No actions if targets not met.

New Jersey	
Overview of the Requirements	Annual report on performance against the benchmark targets.
Reliability Metrics	SAIFI and CAIDI
Docket/Case Number	EX98080528 (effective date: 10/29/01)
Misc. Comments	Commission and legislature are considering setting targets for all utilities in the state.

New York	
Overview of the Requirements	Annual report on performance against the benchmark targets.
Reliability Metrics	SAIFI and CAIDI
Docket/Case Number	Not available
Misc. Comments	No actions if targets not met.

Oklahoma	
Overview of the Requirements	Annual report on performance against the benchmark targets. Not all utilities in the state have targets.
Reliability Metrics	SAIFI, SAIDI, CAIDI, and MAIFI
Docket/Case Number	RM200400005 (effective date: 07/01/04)
Misc. Comments	Commission will set targets for those utilities that currently have three years of OMS data is available.

Pennsylvania	
Overview of the Requirements	Annual report on performance against the benchmark targets.
Reliability Metrics	SAIFI, SAIDI, and CAIDI
Docket/Case Number	M00991220 (effective date: 07/11/98)
Misc. Comments	If targets are not met the utility is required to file a correction plan with the commission that will demonstrate what will be done to meet the target in the next report period.

Virginia	
Overview of the Requirements	Annual report on performance against the benchmark targets.
Reliability Metrics	SAIDI and SAIFI
Docket/Case Number	Not available
Misc. Comments	No actions if targets not met.

7.6. Quality of Service – Report Only

Alabama	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI, SAIFI, CAIDI, MAIFI, and CAIFI
Docket/Case Number	Dockets 18117 & 18416 (effective date 2004)
Misc. Comments	None

Connecticut	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	Not available
Misc. Comments	None

Delaware	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIFI and CAIDI
Docket/Case Number	50/6298 (effective date: 11/04/03)

District of Columbia	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	FC982, FC766 (effective date: 01/22/97)
Misc. Comments	Commission is considering moving to targets in 2006.

Georgia	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI and SAIFI
Docket/Case Number	11941 (effective date: 08/03/04)
Misc. Comments	None

Hawaii	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI and SAIFI
Docket/Case Number	Not available – see comments
Misc. Comments	Commission denied utility request for PBR several years ago. Commission is re-evaluating need to place penalty on poor performance.

Kentucky	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIFI and CAIDI
Docket/Case Number	Not available
Misc. Comments	Not all utilities in the state are required to report performance. Some customer service metrics are reported as well.

Maryland	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties,
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	CN8826 (effective date: 04/15/02)
Misc. Comments	Commission is not currently considering targets.

Missouri	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	Not available
Misc. Comments	Reporting requirements are different for utilities in the state.

New Hampshire	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIFI, SAIDI, CAIDI, customers interrupted per interruption index (CIII), number of device operations (momentaries)
Docket/Case Number	DE 95-194 & DE 97-034 (effective date: 12/6/2000)
Misc. Comments	None

Nevada	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SADI, SAIFI, and MAIFI
Docket/Case Number	Not available
Misc. Comments	None

Wisconsin	
Overview of the Requirements	Report annual performance only for selected reliability metrics. No targets, rewards, or penalties.
Reliability Metrics	SAIDI, SAIFI, and CAIDI
Docket/Case Number	Ch PSC 113 WI Admin Code; (effective date: 2000)
Misc. Comments	Customer service metrics are also reported.

GLOSSARY OF TERMS

Customer Average Interruption Duration Index (CAIDI) is the average time a customer's service is out during an interruption.

Customers Experiencing Multiple Interruptions (CEMI) is the percentage of customers that experienced more than a certain number of interruptions.

Customers Experiencing Longest Duration Interruptions (CELID) is the percentage of customers that experienced outages longer than a certain threshold (e.g., 12 hours).

Feeder Average Interruption Frequency Index (FAIFI) is the average number of service interruptions per customer served by the feeder.

Feeder Average Interruption Duration Index (FAIDI) is the average number of service interruption minutes per customer served by the feeder.

Geo-spatial Information System (GIS) maintains the location and geographical information for each circuit and the characteristics of each circuit, including equipment and drawings. Outage Management System interacts with the GIS to analyze the outage and provide probable location of the interruption.

IEEE 1366 (2004) provides a method using 2.5 beta log of daily SAIDI for normalizing reliability data to account for unusual events.

Mobile Dispatch Terminals (MDT) provide utility crews with direct access to the outage information. It allows them to enter directly the detailed restoration information into the Outage Management System.

Momentary Average Interruption Frequency Index (MAIFI) is the average number of momentary interruptions per customer served at the system level.

Outage Management System (OMS) - An outage management system is a computerized system that records and analyzes outages as they are received and helps determine the probable location of the cause of the outage.

ROE Based PBR (PBR) exists where the Rate of Return is set with a dead band (range where the utility and shareholders assume all benefits and cost) and a live band (range above and below the dead band that would have a sharing mechanism assigned).

Quality of Service PBR (QSP) exists where the Rate of Return is set using the conventional cost of service methodology and the utility has reliability and/or customer service targets imposed by the commission with penalties and/or rewards.

Quality of Service Targets (QST) exists where the Rate of Return is set by using the conventional cost of service methodology and the utility has reliability and/or customer service targets imposed by the commission without penalties or rewards.

Supervisory Control and Data Acquisition (SCADA) application allows remote control of field devices and acquires the appropriate field data to allow monitoring of field conditions

System Average Interruption Frequency Index (SAIFI) is the average number of service interruptions per customer served at the system level.

System Average Interruption Duration Index (SAIDI) is the average number of service interruption minutes per customer served at the system level.

Worst Performing Feeder (WPF) refers to feeder switch poorest reliability performance based on a predetermined criteria which usually includes a combination of FAIFI and FAIDI.

ENDNOTES

Listed below are the sources for the figures.

- **Figure 4-6 Source:** DCI client database of historical SAIFI and SAIDI observations
- **Figure 4-7 Source:** DCI simulation of annual SAIDI observations using lognormally distributed Daily SAIDI values
- **Figure 4-8 Source:** DCI simulation results and application of lognormal to observed data
- **Figure 4-9 Source:** DCI simulation results
- **Figures 5-1 to 5-3 Source:** DCI Analysis of State Reliability programs

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