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Working Group on System Design

Major Event Normalization

A white paper that explores the basis, need, and benefit from normalizing reliability performance relative to major events.

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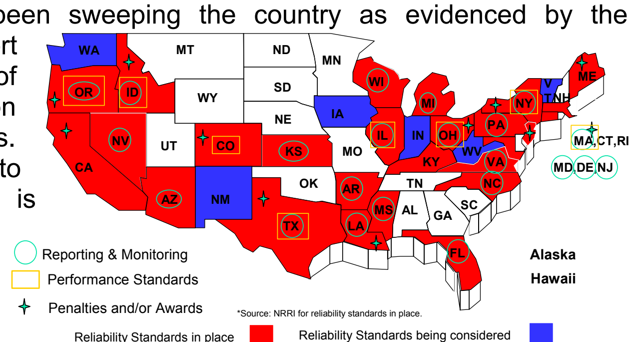
Introduction

Deregulation and re-regulation have led electric utility regulators and customers alike to scrutinize the electric power industry. Claims of improved service for less cost have been used to foster deregulation. Regulators have tried to ensure a continuation, and in some cases, an improvement in electric service reliability under the new operating conditions. Electric utility executives have endeavored to continue to maintain service levels without increasing cost, and in some cases, by decreasing expenditures. As a result both internal and external goals have been set around reliability performance. This paper discusses the need to normalize reliability performance metrics prior to use for such purposes.

Distribution reregulation has been sweeping the country as evidenced by the embedded figure. A few short years ago, only a hand full of states had formal distribution reliability reporting requirements. Today the number has grown to over half of all states and is continuing to rise. Extensive reporting requirements have been requested by some regulators, as evidenced by the Illinois Commerece Commission



("ICC") requirements, where utilities are required to file an annual report that is often over 100 pages long. Some states have now gone so far as to require utilities to purchase outage management systems ("OMS")[1]. It is clear, that executives and regulators alike require a reasonable method for tracking and reporting reliability performance; a method that provides information for proper decision making.

The IEEE Working Group on System Design, that authored the *Full-Use Guide on Electric Power Distribution Reliability Indices-1366-2001*[2], has recently developed a statistics based methodology (herein referred to as the "Beta Method") for identifying outlying performance (otherwise known as Major Event Days or MEDs). Using the

[1] Reliability on the Regulatory Horizon by Cheryl A. Warren and Michael J. Adams, Presented by Charlie Williams at the IEEE T&D Conference in Atlanta 2001.

[2] Full-Use Guide On Electric Power Distribution Indices – 1366-2001

Beta Method, utilities can calculate indices on both a normalized and unadjusted basis. Appropriate decision-making can be performed on each set of indices. Normalized indices provide metrics that can, and should, be used for both internal and external goal setting. Unadjusted indices, when compared to the normalized indices, provide information about utility performance during major events. Events that may be included in unadjusted information are major weather events, major substation events, or unexpected catastrophic events such as earthquakes. It is anticipated that both executives and regulators will scrutinize those events that cause MEDs and take appropriate action to mitigate their future impact on reliability. There could be cases where no additional action is required.

Development of the Method

The Working Group is comprised of over 100 active members from thirty-one states and six countries that hail from universities, utilities, regulatory agencies and consultancies. The group has spent the last two years working on development of a methodology that would:

- Be fair to all utilities regardless of size,
- Allow segmentation of reliability data into normal and abnormal categories, based on the identification of outlier events that cause Major event Days,
- Allow use of normalized indices for internal and external goal setting,
- Be consistent for various amounts of data availability and for all utilities, and
- Be easy to understand and execute.

Many members of the working group anonymously donated their outage data for methodology development. A volunteer contingent of members of the working group performed rigorous analysis of all provided data while evaluating the efficacy of a number of proposed methods. Before the final methodology was chosen, several other methods were developed and abandoned due to their inability to meet the criteria noted above. The working group has selected the Beta Method as the method best meeting the criteria.

The Beta Method

The method is easily applied to reliability data and can be set up to run automatically from an OMS, or be manually applied by using MS Excel™ and/or MS Access™. Its purpose is to allow major events to be studied separately from the reliability performance results that occur during what would be considered normal operation, and, to better reveal trends in normal operation that would be hidden by the large statistical effect of major events.

This process is used to identify major event days (“MED”). A major event day is a day in which daily SAIDI exceeds a threshold value T_{MED}.

In calculating daily SAIDI, interruption durations that extend into subsequent days accrue to the day on which the interruption begins.

The major event day identification threshold value T_{MED} is calculated at the end of each reporting period for use during the next reporting period as follows:

1. Values of daily SAIDI for a number of sequential years, ending on the last day of the last complete reporting period, are collected. Consistency of future results is enhanced if five or six years of data are used, but, if fewer than five years of historical data are available, all of the available, complete year, historical data should be used. Use of more than six years of data may distort the effects of major events and minimize the impact of the analysis.

2. Replace any day in the data set that has a value of zero for SAIDI with the lowest non-zero SAIDI value in the data set. (This permits the calculation of the logarithm of a SAIDI value for every day. While not technically precise, this does enhance the overall accuracy and consistency of the method.)

3. The natural logarithm (ln) of each daily SAIDI value in the data set is calculated.

4. The average of the logarithms, α (Alpha), (also known as the log-average) of the data set is calculated.

5. Find the standard deviation of the logarithms, β (Beta), (also known as the log-standard deviation) of the data set is calculated.

6. The major event day threshold, T_{MED}, is calculated by using the equation:

$$T_{MED} = e^{(\alpha + 2.5\beta)}$$

(Note that this value should in theory give, on average, 2.3 major event days every two years. In practice, using the donated utility data, higher numbers of major event days per year, from two to eight, are seen. This is not unexpected since the actual data does not conform precisely to the log-normal distribution.)

7. Any day with daily SAIDI greater than the threshold value T_{MED} that occurs during the subsequent reporting period is a major event day.

It is the group's recommendation that major event day performance be reviewed in a different, possibly more rigorous, manner than normal day performance.

Some Results

Using data provided from member utilities, two illustrative examples are presented here. Utility 4 used three years of data to determine threshold values while utility 10 used seven years of data.

Figure 1 and Figure 2 show analysis results from utility 4. The lower light blue bars show the normalized values for SAIFI and CAIDI. The upper orange bars show the contribution from abnormal events to SAIFI and CAIDI. The summation of the two bars is the total system SAIFI and CAIDI or unadjusted SAIFI and CAIDI. Note that the normalized SAIFI performance was constant, with no more than 3% variance from year to year. The normalized CAIDI was relatively constant, with no more than an 8% variance. Unadjusted, SAIFI varied 11% from year to year and CAIDI varied between 56% and 70% over the study period.

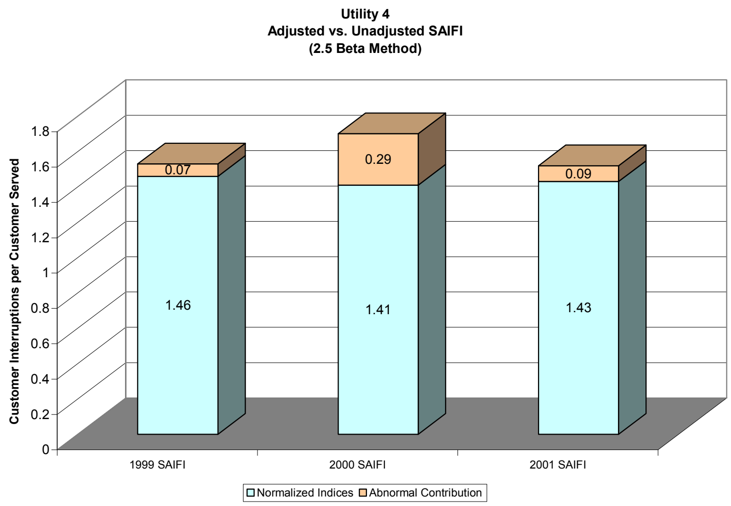


Figure 1 SAIFI for Utility 4

2000 was the stormiest year of the three in this data set and had almost as much contribution to CAIDI attributed to major event days as was attributed to normal operating days. Notice that the normalized CAIDI was operating within a reasonable band (no more than 8% variance from year to year). This fact gives both utilities and regulators comfort that the system is still performing to acceptable design limits. The fact that major event contributions to the indices are ever changing from year-to-year is to be expected. This may occur as weather patterns change. If the major event variation is due to conditions within the utility's control, then executives and regulators should take appropriate action.

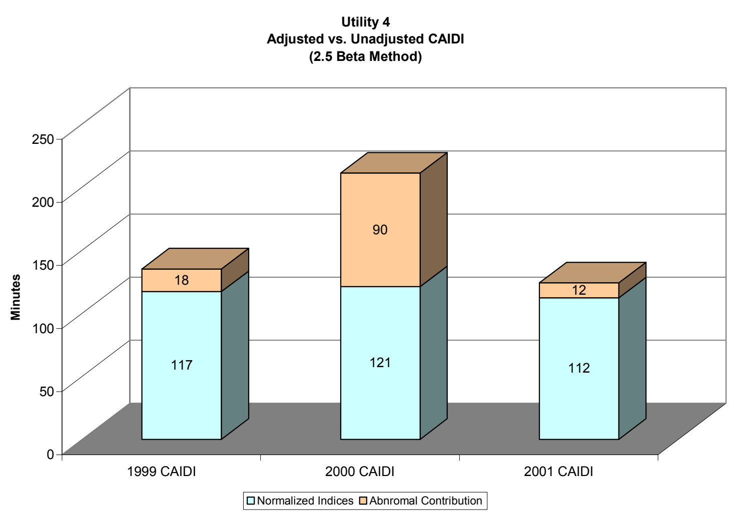


Figure 2 Utility 4 CAIDI

Figure 2 is a clear example of why normalizing indices is critical to customers, regulators and internal utility goals. If the unadjusted data were used to target spending, then this utility would likely be trying to solve non-problems (e.g., events that occurred as a result of one major storm and are unlikely to occur again in the foreseeable future). In short they could be focused on the wrong issues and thus spend ratepayer money on the wrong solutions.

Many state regulators are requesting reports on worst performing circuits ("WPC"). The number of circuits reported presently varies from 4% to 10% of the total circuits on the system and each state allows different reliability data adjustments. However, only a few at the present time review circuit performance based on storm-adjusted, or major event, information. Consequently, utilities may be required to investigate non-problems. The Beta Method will allow utilities to apply worst performing circuit criteria to adjusted data, thus identifying circuits that are most likely to remain worst performing if actions are not taken.

Figure 3 and Figure 4 show results from Utility 10. SAIFI, even adjusted, is still increasing at a steep rate, while CAIDI is oscillating and is fairly constant. Given this type of information, executives from this utility may alter spending and action plans.

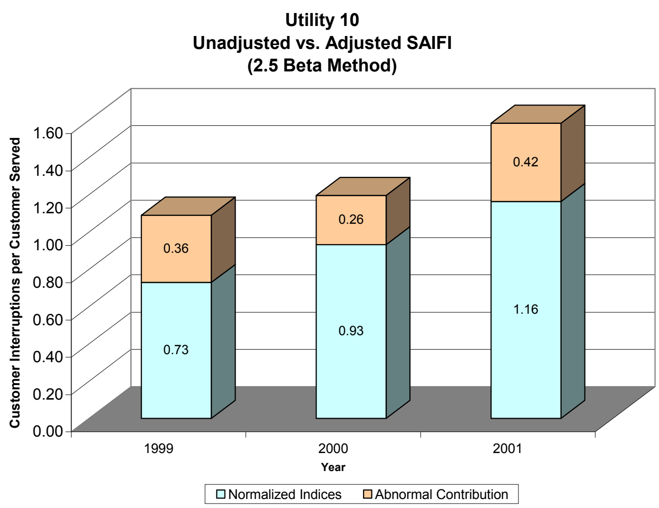


Figure 3 Utility 10 SAIFI

Unadjusted CAIDI varies as much as 69% while adjusted CAIDI varies only as much as 28% a year. While 28% is a high percentage, it is significantly better than unadjusted statistics. This information points to crew overload on major event days. It appears that the major events were significant enough to completely saturate crew availability and thus restoration efforts were sequential and lengthy.

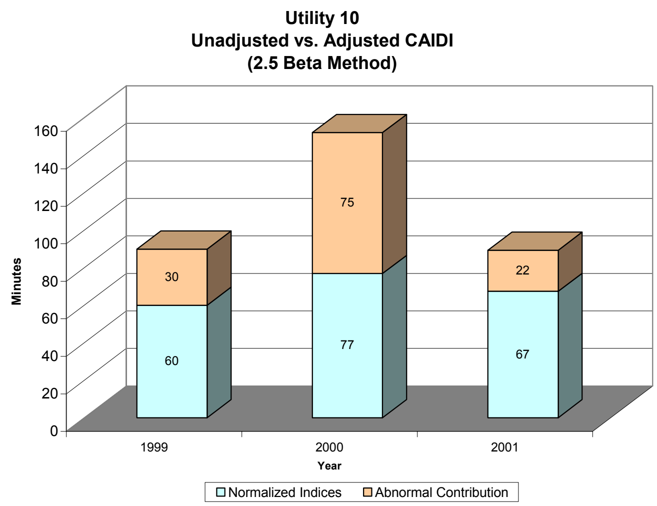


Figure 4 Utility 10 CAIDI

Benefit Summary

Daily, decisions are made at utilities based on perceived risk versus anticipated reward. The Beta Method provides a mechanism to segment information into appropriate categories allowing different decision paths to occur thus potentially resulting in better business decision-making. Regulators, utilities, and customers benefit from the Beta method because utilities will be guided towards real problems and can then focus resources on solving those problems.

A large group, that represents all interested parties, created this methodology. The Beta method allows utilities and regulators to confidently set goals/targets based on normal, and expected future performance. It also provides a technique to review performance during severe events.

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