The Need to Segment Abnormal Events from the Calculation of Reliability Indices

James D. BOUFORD, Senior Member, IEEE

Abstract—The abnormal events that seriously impact an electric utility’s operational ability to provide reasonable customer service must be removed from the calculation of reliability indices, and be reviewed individually. This will allow an accurate indication of both the system’s reliability trend and the ability of the system to respond to abnormal events. Different processes, management talent, workforce efforts, and leadership are required to respond to these two types of reliability impacts. Different reviews are also required.

Index Terms—Abnormal Events, Classification of Events, Major Storms, Reliability

The use of customer reliability indices is almost universally accepted by utility management and regulators as a measure of customer service level. Increasingly, they are being proposed as a measure of the adequacy of a utility’s system infrastructure addition and maintenance efforts. In addition, the comparison of utility reliability performance is being utilized in benchmarking studies. With this level of scrutiny being applied, it is imperative that the measures of reliability are a true representation of the system’s performance.

The electric utility delivery industry has developed standard reliability indices to be used for the above purposes. These can be found in IEEE Full Use Guide for Electric Power Distribution Reliability Indices 1366-2001, and the specific indices will not be discussed in any detail herein. The indices are accepted because they are easy to calculate, the data required can reasonably be obtained, and they provide a fair insight into the system performance.

No electric delivery system can economically be constructed and/or operated to provide power 100% of the time under all possible conditions to all customers. It is generally understood by those who operate, maintain, manage and regulate electric utilities that the delivery systems are planned, designed, constructed and run in an economical manner that anticipates their occurrence. However, external factors are not evenly distributed as to their severity.

The majority of interruption events are of a recurring nature and affect the reliability measures, over periods of time, in a rather consistent manner. The system can be planned, designed, constructed and run in an economical manner that anticipates their occurrence. However, external factors are not evenly distributed as to their severity.

Some external events are of such magnitude in their effect on the reliability of the utility that the reliability measures are distorted. These abnormal events occur infrequently. Usually, the system owners must implement extraordinary procedures to address the impact of these events; reassignment of personnel between operating areas, request mutual aid, and request emergency delivery of materials from suppliers, for example. These events should not be utilized in the measurement of the system’s reliability performance.
An abnormal event must exceed the reasonable design and operational limits of the electric delivery system. The effect of design limits being exceeded is severe damage or destruction of the electric delivery infrastructure. An ice storm, hurricane, widespread and severe lightning storm, tornado, avalanche, forest fire, or a myriad of other such events would exceed reasonable design limits. This list is not meant to be complete. No system, even those built to the National Electrical Safety Code (NESC) requirements, could be expected to withstand the onslaught of such events.

The effect of operational limits being exceeded is the inability to adequately respond to the interruptions with the available manpower, equipment, materials, or automated systems. The events noted in the prior paragraph would also tend to exceed reasonable operational limits. An abnormal event requires a lengthy restoration period. Workers must be reassigned and/or brought into the system from outside. Automated restoration systems must be unable to effect the restoration by themselves. Damage must occur to the infrastructure. This may involve a rather small number of customers, such as when a tornado sweeps through an area, but will always involve a large number of customer hours. If an event does not involve a large number of customer hours, it has not exceeded the reasonable operational limits.

Some types of events could exceed design limits, with the result of limited damage or destruction to the infrastructure, which would not require emergency operational efforts to repair. These events should not be designated abnormal events on the sole basis that they exceeded the design limits.

Chart 1 shows the result of abnormal events on the SAIDI per day values for a large utility. This chart only plots the values for the highest 60 days of the three years of data available in order to present the details. The large exponential increase in SAIDI for the few highest days is an indication that the operational forces available at this utility were being overcome by the severity of the events on those days. It can also be seen that at lower levels of SAIDI per day step increases occur that appear to show initial levels of breakdown of the ability of the utility to handle the events that occurred on those days.

Chart 2 is a presentation of the past seven years of actual SAIDI data for a utility system. The solid line is the yearly SAIDI values and the dashed line is the average SAIDI over the seven-year time frame. In this chart, no events were excluded from the calculation of SAIDI. It would appear that this system had 3 years of improving performance, from 1996 to 1998, followed by two reasonably average years, one slightly worse than the average and one slightly better than average, and then, one terrible year. The initial impression of most folks viewing this data would be that the reliability of this system is degrading quickly.

However, two things need to be noted. First, a new system of capturing the interruption data was installed in 1998 that appears to now find the 20%, or so, of the events that had previously been lost in the prior, mostly manual, system of data collection. Second, 2001 brought a new type of thunderstorm to the region where this utility is located. Instead of the storms quickly blowing through the region, hitting an area with wind, lightning and sometimes hail for an hour or so and then moving on, storms would just sit in an area and pummel it for a whole day. Wind, rain and lightning would be continuous for 8 to 12 hours.

So, now the points I wanted to make:
1) The design limits of the system were not exceeded. The system has been designed and built to the NESC. The operational limits were exceeded. This system, as every other utility system, was not, and will not be staffed to meet the requirements of the aberrational storms that occur. Even though the number of events for the day of a storm may not be above average, the impact of them occurring within a very short period of time will exceed the utility’s ability to respond in a normal manner.

2) Not removing the effects of those events that exceed the design or operational limits of a system will distort the efforts, or lack thereof, of a system to respond to reliability issues.

Chart 3 shows the effect of removing abnormal events.
A separation of the two very different interruption conditions allows regulators to actually better review the operational ability of the companies to respond to the reliability portion of service quality issues. This is done by separating out the impact on reliability indices, resulting from the company's daily, or normal operational readiness, from the impact that the company's storm, or emergency preparedness has on the impact of abnormal events; storms, earthquakes, floods, terrorist attacks, etc. If a company tried to game the process, the detailed review of the abnormal events; questioning the adequacy of the staffing, the inventory levels, the use of mutual aid from other utilities, the shifting of resources between operating areas, etc., would ferret out this behavior.

An electric delivery system that is allowed to deteriorate will tend to have an increasing number of abnormal events over time. This system will also have an increasing number of normal events over time. The measure of the system reliability will show that the system is deteriorating. The increasing number of abnormal events may indicate that the system is deteriorating, the number of significant external factors may indeed be increasing, even for a system that is improving its normal reliability.

I. CONCLUSION

The calculation of reliability indices, without removing the abnormal events that distort the year-to-year results, will not accurately represent the efforts of the utility to provide the required customer service. It is the trend of the system reliability, and, the response to individual major events that is important.

II. REFERENCES

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