P1366 Major Event Day Language Draft
2.5 Beta Method

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Existing Language

(From IEEE Std 1366-1998)

In section 3. Definitions:

3.13 major event: Designates a catastrophic event which exceeds reasonable design or operational limits of the electric power system and during which at least 10% of the customers within an operating area experience a sustained interruption during a 24-hour period.

Proposed Language

<new> **Major Event Day (MED):** A calendar day on which a major event begins.

4.4 Major Event Day Determination

The following process ("Beta Method") is used to identify major event days ("MED"s). Its purpose is to allow major events to be studied separately from normal operation, and to better reveal trends in normal operation that would be hidden by the large statistical effect of major events.

A major event day is a day in which the daily SAIDI exceeds a threshold value, T_{MED}.

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

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. Collect values of daily SAIDI for five sequential years ending on the last day of the last complete reporting period is collected. If fewer than five years of historical data are available, use all of the available historical data.

2. If any day in the data set has a value of zero for SAIDI, replace it with the lowest non-zero SAIDI value in the data set. (This permits taking the logarithm of every day.)

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

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

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

6. Compute the major event day threshold, T_{MED}, using the equation:

$$T_{MED} = e^{(\alpha + 2.5\beta)} \qquad \text{(renumber eqns)}$$

Note that this value should in theory give, on average, x major event day every two years. In practice, higher numbers of major event days per year are seen.

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.

4.4.1 Computing indices with major event days removed

Reliability indices for a given reporting period must be corrected to account for separate reporting of major event days by assuming that the average daily value of the index would have resulted if a major event had not occurred. For generic reliability index R, with D_{rp} days in the reporting period, which had D_{MED} major event days, the corrected index is

$$R = \frac{D_{rp}}{D_{rp} - D_{MED}} R_{raw} \qquad \text{(renumber eqns)}$$

where R_{raw} is computed omitting all interruption events occurring on the major event days.

5.3 Example three

This example illustrates the; calculation of the daily SAIDI, calculation of the major event day threshold T_{MED}, identification of major event days, and calculation of normalized indices.

Table 4 gives selected data for all outages occurring on a certain day for a utility that serves 2000 customers.

Table 4—Outage data for 1994

Date	Time	Duration (mins)	No. of customers	Interrupt Type
3/18	18:34:30	20.0	200	Sustained
3/18	18:38:30	1.0	400	Momentary
3/18	18:42:00	513.5	700	Sustained

Note that although the third outage was not restored until the following day, its total duration is applied to the day that the outage occurred. Note also that SAIDI considers only sustained outages. Therefore, daily SAIDI for 3/18/1994 is:

$$\text{SAIDI} = \frac{(20 \times 200) + (513.5 \times 700)}{2000} = 181.725\ \text{mins}$$

One month of historical daily SAIDI data is used in the following example to calculate the Major Event Day threshold T_{MED}. Five years of historical data is preferable for this method, but printing that many values in this standard is impractical, so only one month is used. The data is shown in Table 5.

Table 5—One month of daily SAIDI and ln(SAIDI/day) data

Date	SAIDI/day (mins)	ln(SAIDI/day)	Date	SAIDI/day (mins)	ln(SAIDI/day)
12/1/93	26.974	3.295	12/17/93	0.329	-1.112
12/2/93	0.956	-0.046	12/18/93	0	-4.967
12/3/93	0.131	-2.033	12/19/93	0.281	-1.268
12/4/93	1.292	0.256	12/20/93	1.810	0.593
12/5/93	4.250	1.447	12/21/93	0.250	-1.388
12/6/93	0.119	-2.127	12/22/93	0.021	-3.876
12/7/93	0.130	-2.042	12/23/93	1.233	0.209
12/8/93	12.883	2.556	12/24/93	0.996	-0.004
12/9/93	0.226	-1.487	12/25/93	0.162	-1.818
12/10/93	13.864	2.629	12/26/93	0.288	-1.244
12/11/93	0.015	-4.232	12/27/93	0.535	-0.626
12/12/93	1.788	0.581	12/28/93	0.291	-1.234
12/13/93	0.410	-0.891	12/29/93	0.600	-0.511
12/14/93	0.007	-4.967	12/30/93	1.750	0.560
12/15/93	1.124	0.117	12/31/93	3.622	1.287
12/16/93	1.951	0.668			

Note that the SAIDI/day for 12/18/93 is zero. The natural logarithm of zero is undefined. Therefore, for 12/18/93, the natural log of the smallest non-zero SAIDI/day value in the month, occurring on 12/14/93, is used. With multi-year data, the smallest non-zero SAIDI/day value in the data set would be used.

The value of α, the log-average, is the average of the natural logs, and equals -0.699 in this case.

The value of β, the log-standard deviation, is the standard deviation of the natural logs, and equals 2.04 in this example.

The value of $\alpha + 2.5\beta$ is 4.391.

The threshold value T_{MED} is 80.72 and is the value used to evaluate the future period of time (e.g., year).

Table 6 shows example SAIDI/day values for the first month of 1994.

Table 6—Daily SAIDI data, January 1994

Date	SAIDI/Day	Date	SAIDI/Day
1/1/94	0.240	1/17/94	5.700
1/2/94	0.014	1/18/94	0.109
1/3/94	0.075	1/19/94	0.259
34338	2.649	1/20/94	1.142
1/5/94	0.666	1/21/94	0.262
1/6/94	0.189	1/22/94	0.044
1/7/94	0.009	1/23/94	0.243
1/8/94	1.117	1/24/94	5.932
1/9/94	0.111	1/25/94	2.698
1/10/94	8.683	1/26/94	5.894
1/11/94	0.277	1/27/94	0.408
1/12/94	0.057	1/28/94	237.493
1/13/94	0.974	1/29/94	2.730
1/14/94	0.150	1/30/94	8.110
1/15/94	0.633	1/31/94	0.046
1/16/94	0.434		

1/28/94 is classified as a major event day because its SAIDI/day value of 237.493 exceeds example threshold value T_{MED} of 80.72. All other days in the table represent normal reliability performance.

Suppose that during 1994, three (3) days have SAIDI exceeding the major event day threshold. At the end of 1994, the raw annual system SAIDI value calculated according to section 4.2.1, which omitted events occurring during major event days such as January 28th, is 2.52 hours. This is corrected for the omitted major event days as follows:

$$\text{SAIDI} = \frac{365}{365-3} * 2.52 = 2.54 \text{ hours}$$

The raw SAIFI value calculated according to section 4.2.2, which omitted events occurring during major events days such as January 28th, is 1.43. This is corrected for the three omitted major event days as follows:

$$\text{SAIFI} = \frac{365}{365-3} * 1.43 = 1.44$$

Justifications (to be added to the Annex on Major Events where other data will be shown)

The statistical approach to identifying major event days was chosen over the previous definition because of the difficulties experienced in creating a uniform list of types of major events, and because the measure of impact criterion (percent of customers affected, for example) needed when using event types results in non-uniform identification.

Daily SAIDI values are preferred to daily Customer Minutes Interrupted (CMI) values for major event day identification because the former permits comparison and computation among years with different numbers of customers served. Consider the merger of two utilities with the same reliability and the same number of customers. CMI after the merger would double, with no change in reliability, while SAIDI would stay constant.

Daily SAIDI values are preferred to daily SAIFI values because the former are a better measure of the total cost of reliability events, including utility repair costs and customer losses, than the latter. The total cost of unreliability would be a better measure of the size of a major event, but collection of this data is not practical.

The selected approach for setting the major event day identification threshold, known as the "Two Point Five Beta" method (since it is using the log-normal SAIDI values rather than the raw SAIDI values), is preferred to using fixed multiples of standard deviation (e.g. "Three Sigma") to set the identification threshold because the latter results in non-uniform MED identification among utilities with different sizes and average reliabilities. The β multiplier of 2.5 was chosen because, in theory, it would classify 2.3 days per year as major events. If significantly more days than this are identified, they represent events that have occurred outside the random process that is assumed to control distribution system reliability. The process and the multiplier value were evaluated by a number of utilities with different sized systems from different parts of the United

States and found to correlate reasonably well to current major event identification results for those utilities. A number of alternative approaches were considered. None was found to be clearly superior to Two Point Five Beta.

When a major event occurs which lasts through midnight (for example, a six hour hurricane which starts at 9:00 PM), the reliability impact of the event may be split between two days, neither of which would exceed the T_{MED} and therefore be classified as a major event day. This is a known inaccuracy in the method that is accepted in exchange for the simplicity and ease of calculation of the method.

The preferred number of years of data (five) used to calculate the major event day identification threshold was set by trading off between the desire to reduce statistical variation in the threshold (for which more data is better) and the desire to see the effects of changes in reliability practices in the reported results, and also to limit the amount of data which must be archived.

Remarks:

To generate the example data, values of α and β were taken from an actual utility data set, and then daily SAIDI/day values were artificially generated using a log normal distribution with these values of α and β. The daily SAIDI values were then adjusted to illustrate all aspects of the calculation, e.g. a day in Table 5 was assigned a SAIDI value of zero, and a day in Table 6 was assigned a SAIDI value higher than the computed threshold.