Measuring Performance Of Electric Power Distribution Systems – IEEE Std. 1366-2003

Presented at the NARUC

Staff Subcommittee on Electric Reliability

in Salt Lake City, UT

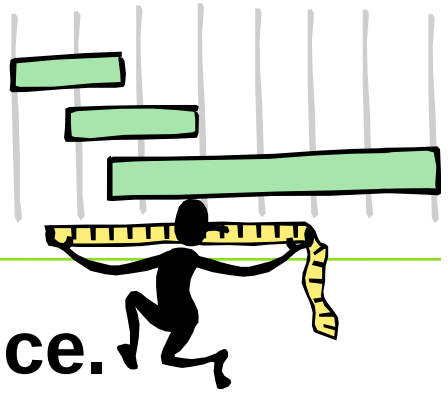
by Cheryl A. Warren (cwarren@ieee.org)

Chair, IEEE WG on System Design

Topics for Today

- **Why use 1366-2003 - *Guide for Electric Power Distribution Reliability Indices***
- **What changed between 2001 and 2003?**
- **The Major Event Day Definition**
- **Potential Impact on Regulation**
- **Summary**

Why Use 1366-2003



- **Sound Basis for Measuring Performance.**
- **A clearer view of performance, both on a**
  - **Daily basis and**
  - **During Major Events**
- **Can form a solid basis for review of operational effectiveness, decision making and policy making.**
- **More consistent benchmarking.**

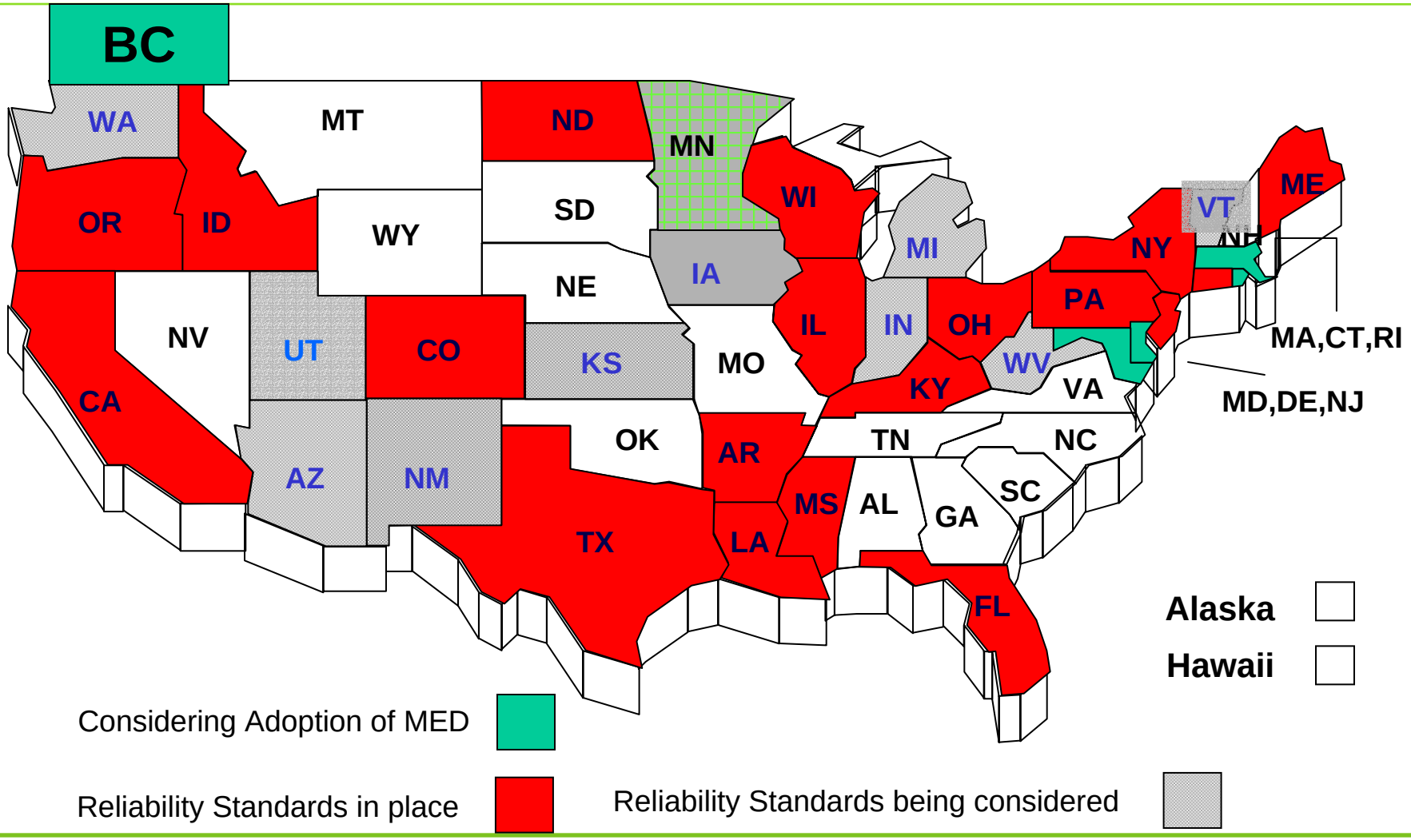
Industry Guidelines Developed

- **IEEE Std 1366, 2001 Edition, Revised in 2003**
  - **Refines definitions**
  - **Created the Major Event Day concept**
  - **Ballot passed w/98% affirmative**
  - **Approved by IEEE REVCOM in December 2003**
  - **Approved by ANSI April 2004**
  - **Published by IEEE SA June 2004**
    - Available at *www.ieee.org*

Major changes between 2001 & 2003

- **Tightened definitions.**
- **Created the Major Event Day Concept.**
- **A tool that can assist company decisions and regulatory policy making by standardizing engineering metrics and approaches.**
  - **Standard definitions are offered that will lead to better comparability.**
    - Still need to address data collection methods.
  - **Policy decisions are left to the regulatory community.**

States are Moving Toward Reliability Regulation

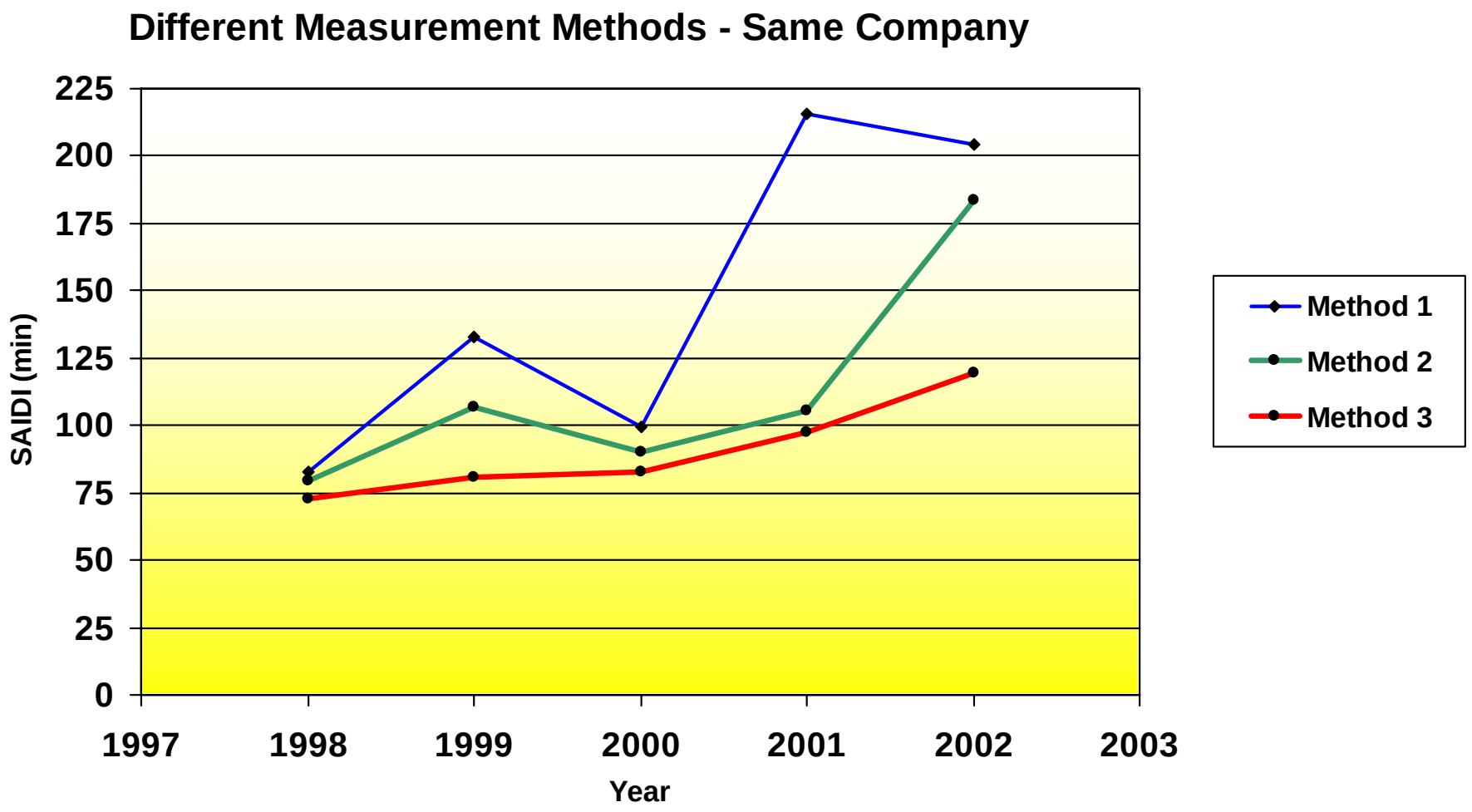


**source NRRI 1991 survey & other regulatory documents*

Three State's Rules

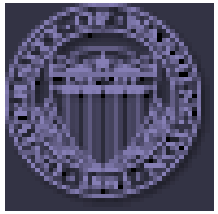
- **State 1**
  - Major Storms excluded if **15% of customers served** are interrupted over the duration of the event.
- **State 2**
  - A Major Storm is a period of adverse weather during which service interruptions affect at least **10 percent of the customers in an operating area and/or** result in customers being without electric service for durations of **at least 24 hours**.
- **State 3**
  - It was the result of a major weather event which caused more than **10% or a district or total company customers** to be without service at a given time.

SAIDI Performance



Methodology Development

- **IEEE WG on System Design, that has over 130 members, developed the "2.5 Beta methodology" in IEEE Std 1366 - 2003.**
  - **Members include utility employees, regulatory staff, employees from manufacturers, consultants and academics.**
  - **Seven members stepped up to perform the analysis.**




Foundations of the Process

- **Definition must be understandable by all and easy to apply.**
- **Definition must be specific and calculated using the same process for all utilities.**
- **Must be fair to all utilities.**
  - **Large and small, urban and rural….**
- **SAIDI was chosen as the indicator…**
  - **because it is size independent and**
  - **it is the best indicator of system stresses beyond those that utility's staff, build and design to minimize.**

Foundations of the MED Definition

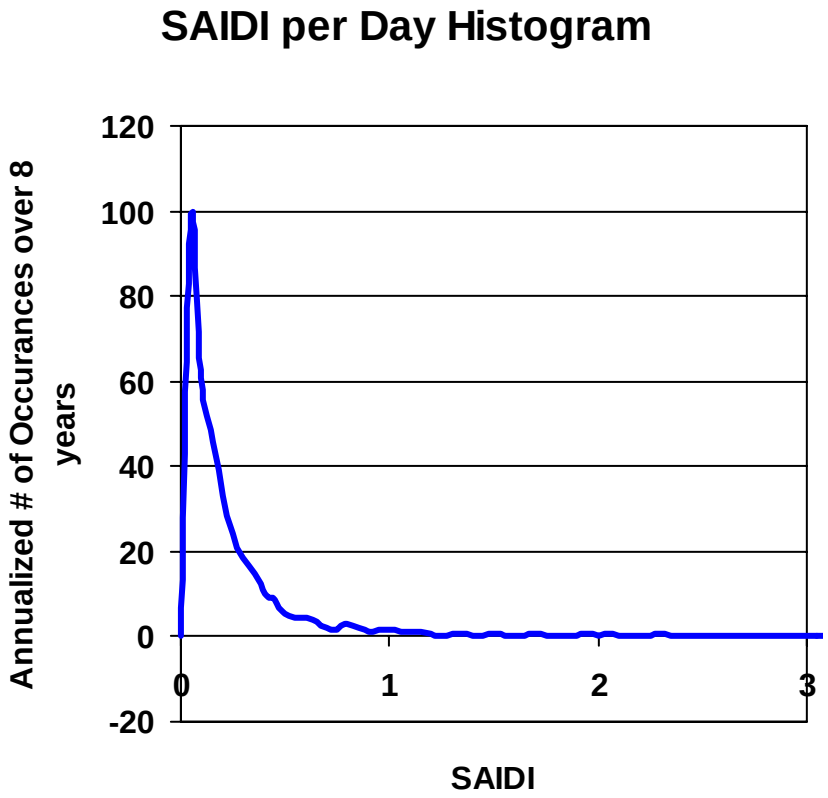
- **To allow appropriate review of both operating conditions partition the data into**
  - **daily performance and**
  - **major event day performance.**
- **Major event days are days where the system operational and/or design limits are exceeded.**
- **We suggest**
  - **Using day-to-day events for trending, internal goal setting, and Commission mandated targets.**
  - **Separately reporting performance during major events.**

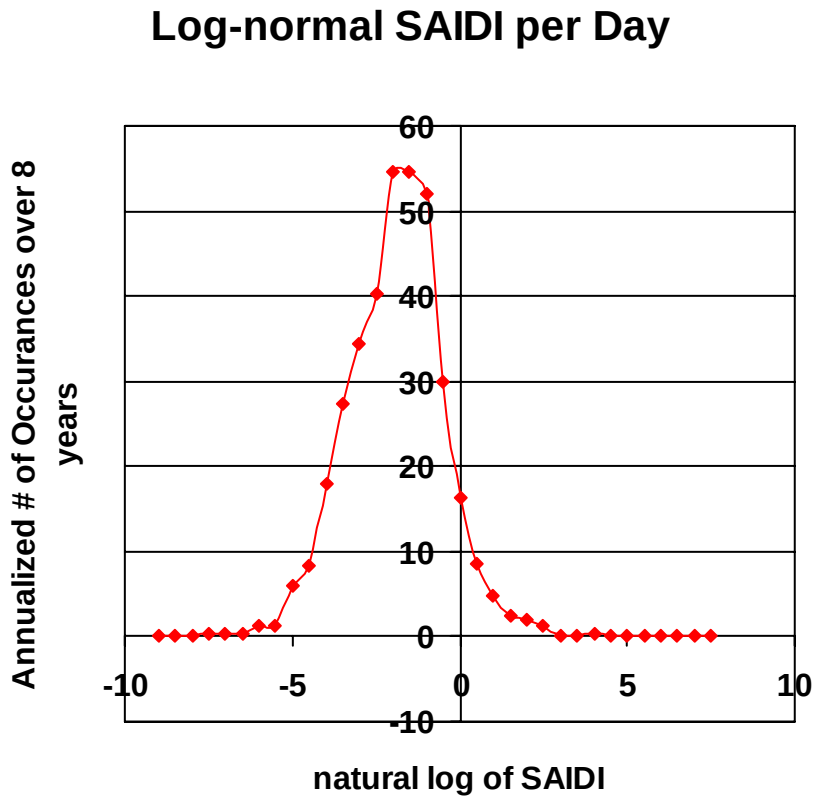
Methodology Development

- **Several methods were tested and rejected because they did not meet the basic requirements stated in foundations of the process.**

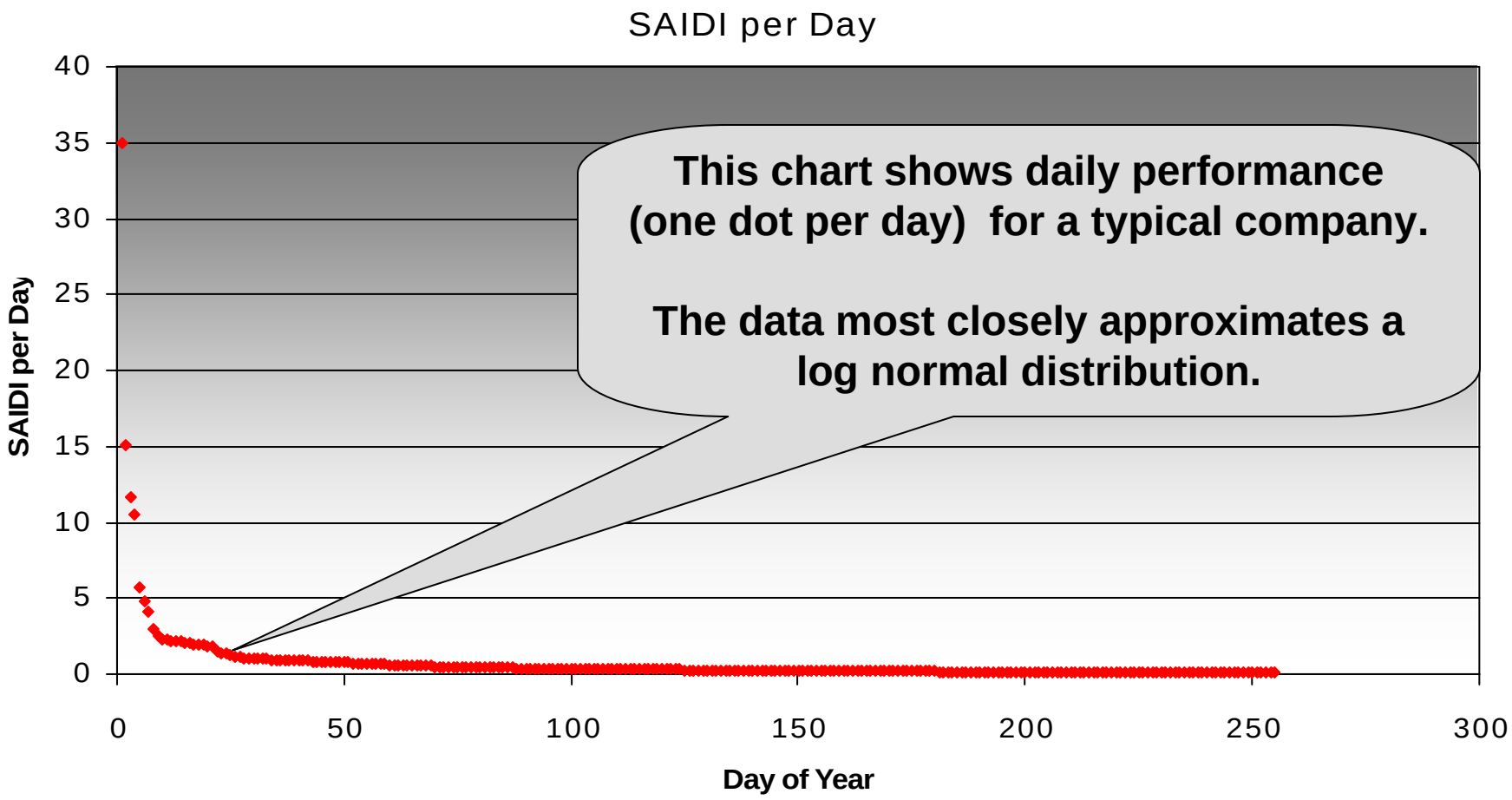
- **Epiphanies**
  - **SAIDI is a good indicator of major events.**
  - **Interruption data is most closely represented by the log normal distribution.**

Log-normal nature of the data

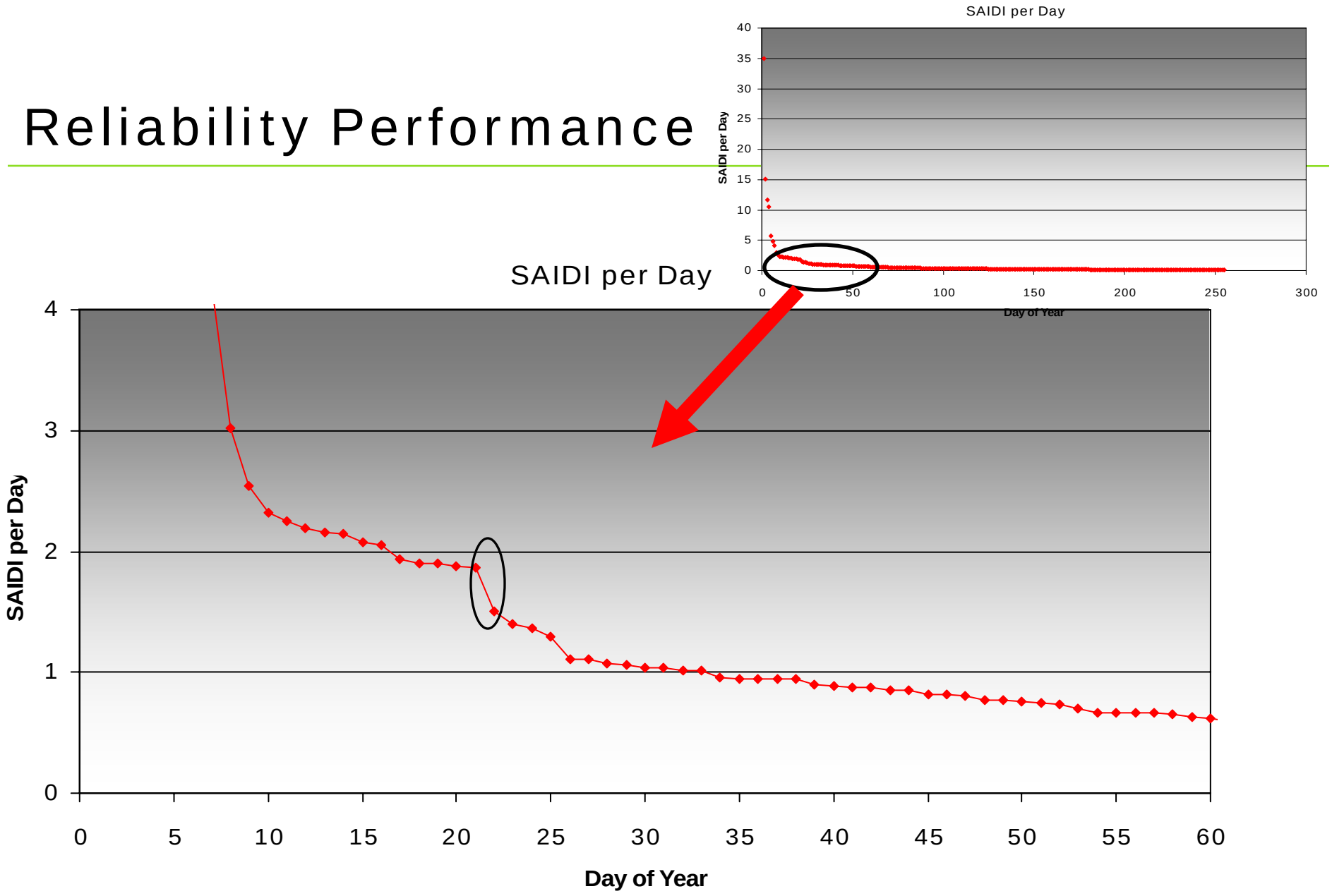




Reliability Performance



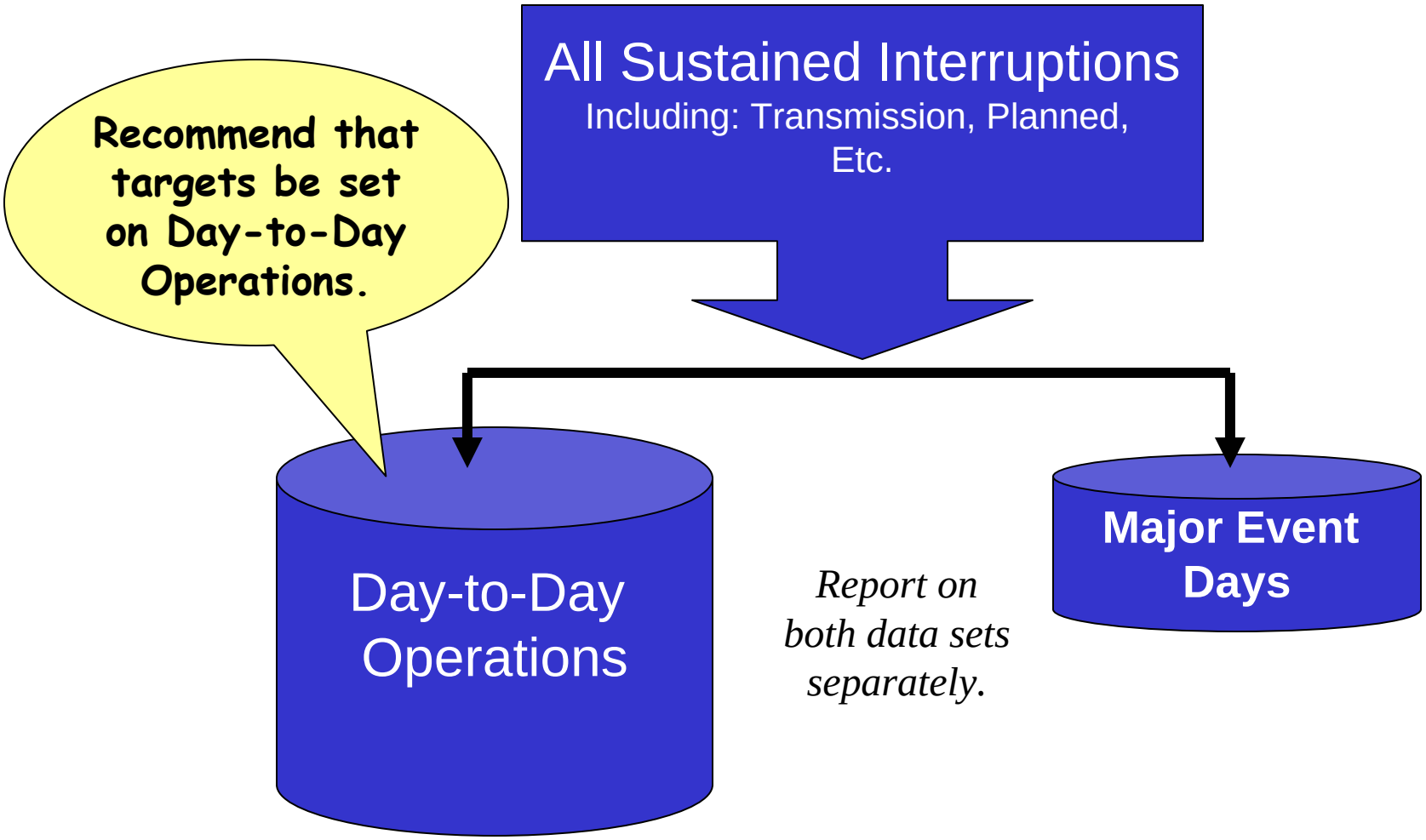
Reliability Performance



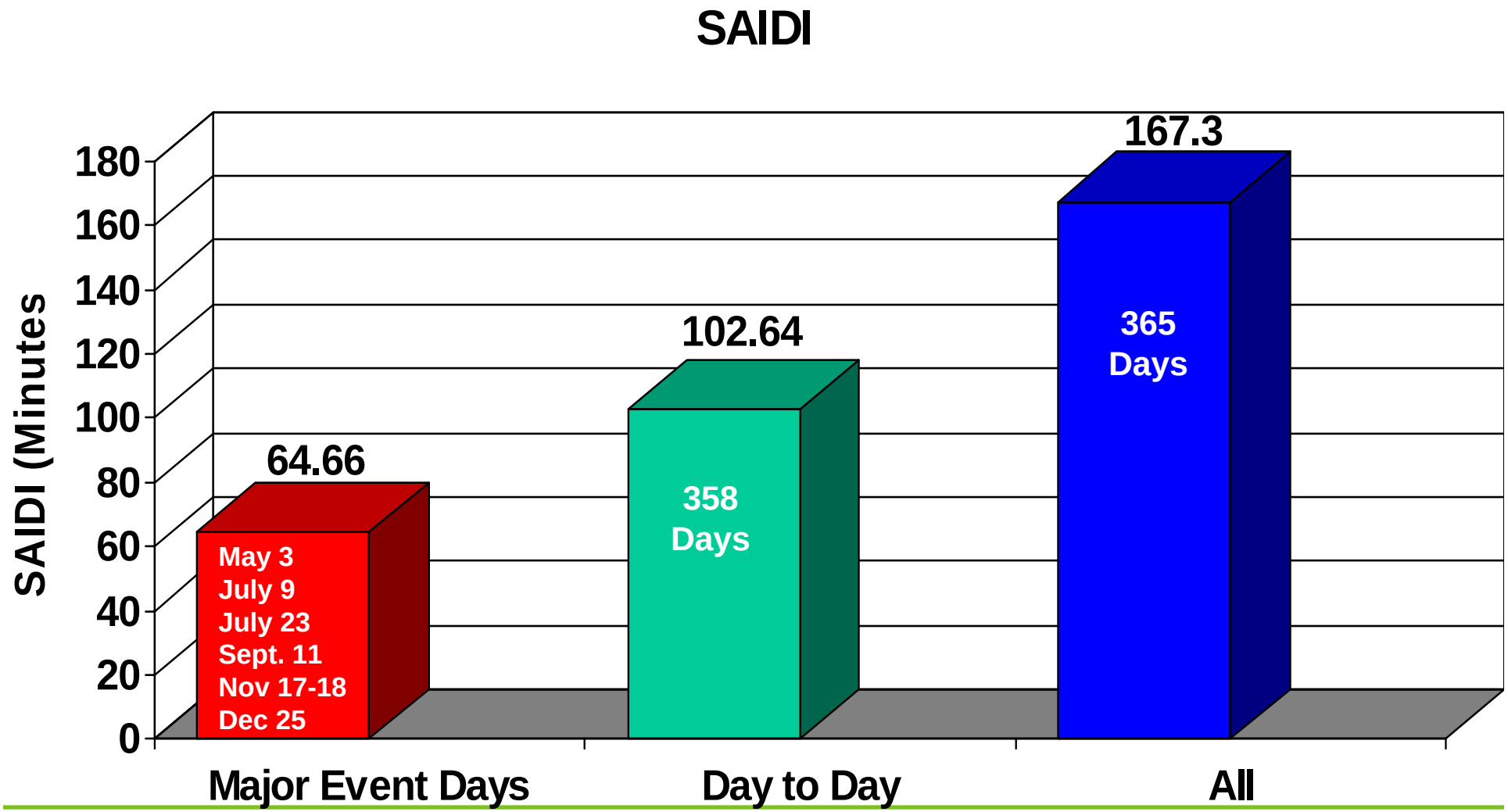
Two Categories for Measurement

- The 2.5 Beta Methodology allows segmentation of reliability data into **two** distinct sets for review.
  - One set represents those events of such a reliability magnitude that a ***crisis mode*** of operation is required to adequately respond. (***major events***).
  - The other set represents the reliability impact of those events that a company has built the system to withstand and staffed to respond to in a manner that does not require a crisis mode of operation. (***day-to-day operation***).

Major Events versus Day to Day Operations



Results from One Company



Seven Simple Steps

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

2. If any day in the data set has a value of zero for SAIDI, do not include that day in the analysis.

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:

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

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

Major Event Days – A few facts

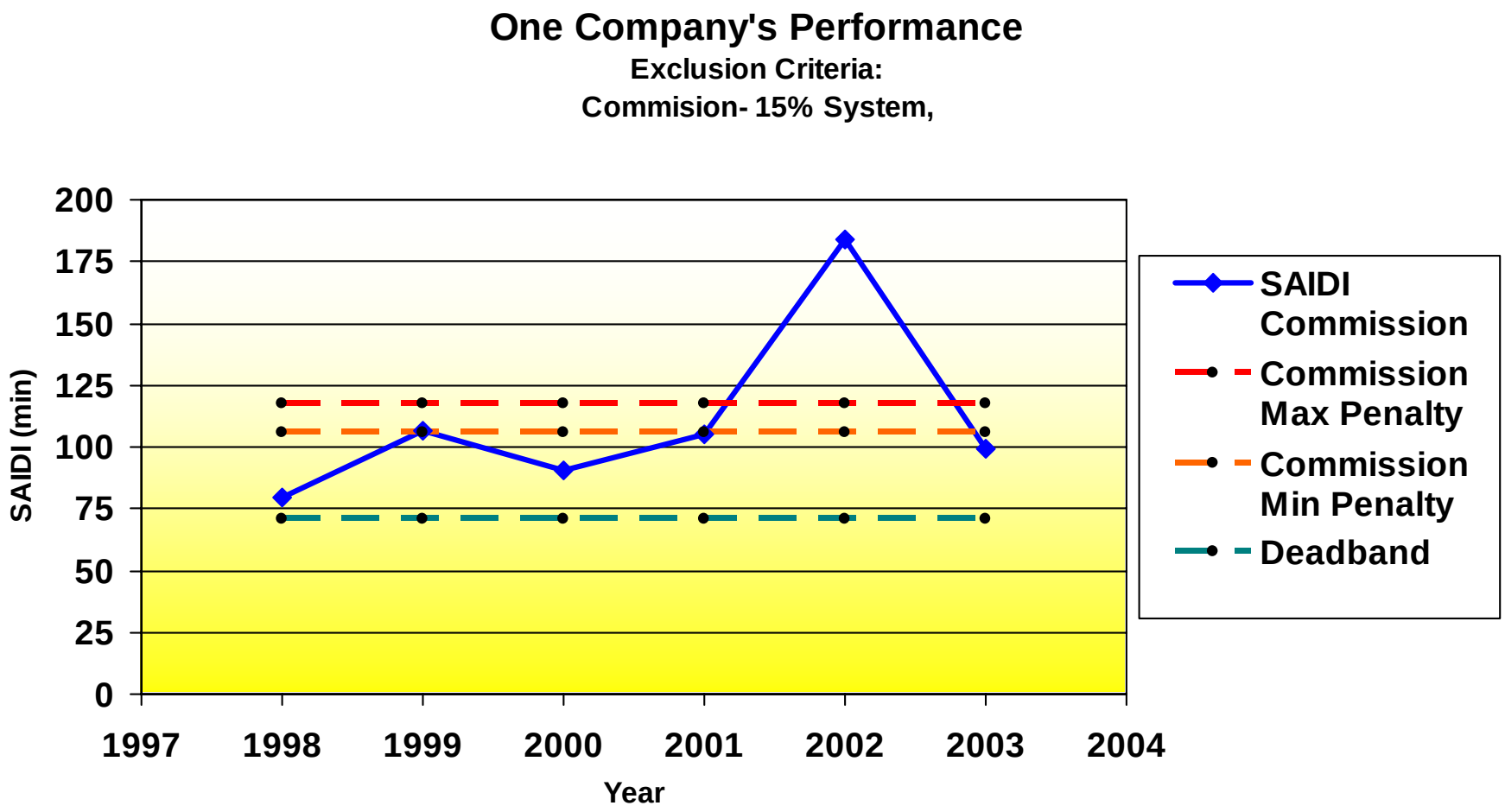
- **A day in which the daily system SAIDI exceeds a threshold value, T_{MED} that is determined by using the 2.5 beta method.**
  - ***For example, if T_{MED} = 3 minutes, than any day where more than 3 minutes of SAIDI is accrued is declared a major event day***

- **Activities that occur on major event days should be separately analyzed and reported. Nothing is "Excluded"!!**

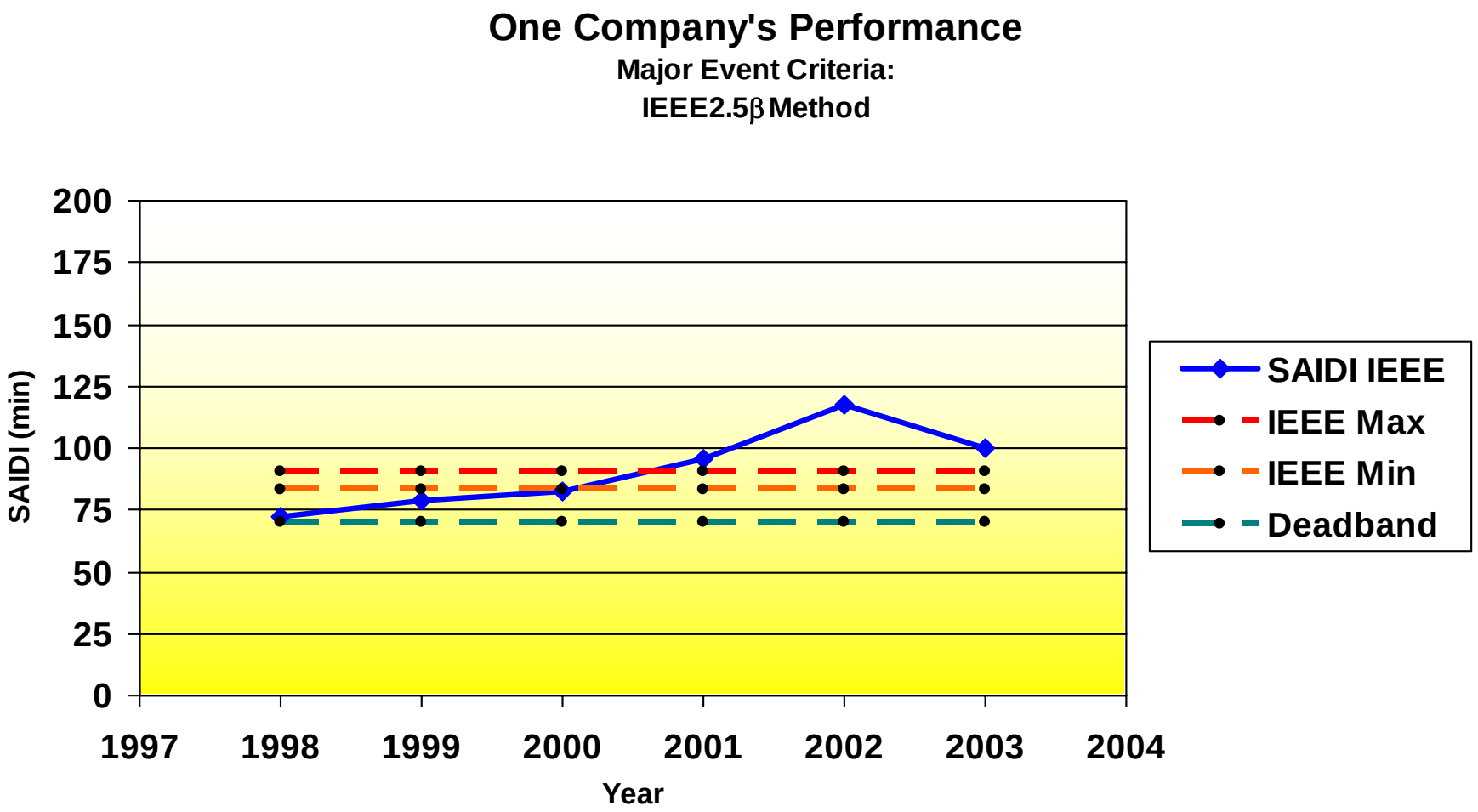
Benefits of the Approach

- **Adoption of the 2.5 Beta methodology**
  - **will allow for consistent calculation of reliability metrics,**
  - **provide companies and commissions with a more accurate indication of a Company's controllable service quality results,**
  - **allow a clear review of company response to crisis mode events, and**
  - **provide a less distorted indication of the reliability results for companies of all sizes.**

Ramifications on Commission Mandated Targets



Ramifications on Commission Mandated Targets



Ramifications on Commission Mandated Targets

- **The existing reliability targets will require adjustment.**
  - **The *variability in year to year performance* should be *significantly reduced* by using the IEEE methodology, therefore performance bands should be adjusted.**
  - **Since we know that reliability data is most closely represented by the *log-normal distribution*, bands should be developed using the log-normal data.**

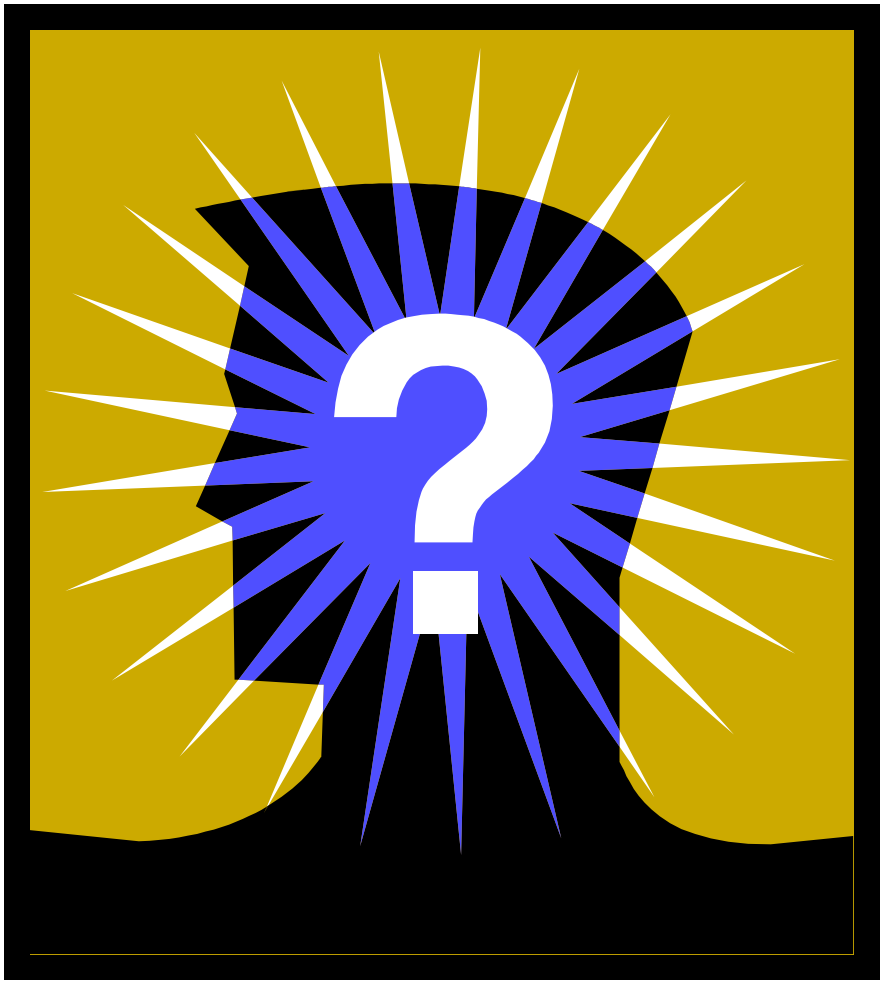
Summary of IEEE 2.5 Beta Methodology

- **Improves the ability to view system reliability performance, thereby making goal setting and trending more meaningful.**

- **Provides a mechanism for reporting on both day-to-day performance and performance during major events. A mechanism that:**
  - **allows for review of day-to-day performance without considering the outliers that often mask it.**
  - **AND, meaningfully focuses on major event performance in its own right to give a clear view of this very different operating condition.**

- **Consistent method that can be applied by all.**

Questions...



Benchmark

- **We have anonymously analyzed data for 79 companies throughout the US & Canada during the MED development process.**
- **Basic Results for 2003.**

All Respondents						
Quartile	**SAIDI IEEE**	**SAIDI All**	**SAIFI IEEE**	**SAIFI All**	**CAIDI IEEE**	**CAIDI All**
1	89.31	126.71	0.93	1.23	77.61	90.55
2	114.57	223.68	1.29	1.54	95.34	158.78
3	154.63	407.93	1.45	2.04	116.51	212.83
4	401.55	2352.29	2.88	5.53	424.74	1154.85
Average	**129.55**	**381.36**	**1.28**	**1.81**	**106.14**	**192.69**

includes results from 48 respondents.