WHAT ARE SAIFI, SAIDI AND MAIFI? ON RELIABILITY ISSUES

SAIFI, SAIDI, MAIFI are some of the indices used to measure distribution system reliability. Before explaining them a little on the subject of reliability.

Reliability can be defined as the ability of the power system components to deliver electricity to all points of consumption, in the quantity & with the quality demanded by the consumer. Reliability is often measured by the outage indices defined in one international standard called IEEE 1366. (IEEE is the Institution of Electrical & Electronics Engineers, the biggest professional body of Electrical & Electronics Engineers. IEEE has its head office in the USA & has presence in most countries). These outage indices are based on the duration of each power supply interruption & the frequency of interruption. It is clear that all three major functional components of the power system – generation, transmission & distribution contribute to reliability. As far as the consumer is concerned, transmission & distribution outages are important. In fact, surveys (in developed countries) show that 80-90% of the outages experienced by consumers are caused by distribution outages.

A power supply outage is an unplanned event & can be described in terms of the frequency, duration & amount of load (or consumers) affected. A momentary outage is defined as an outage lasting less than 5 minutes, corresponding to the time taken by automatic re-closure schemes to restore temporary faults; a sustained outage lasts longer than 5 minutes (NERC 1996). IEEE standard 1366 gives the definition for outage indices. These indices are calculated using details of consumer interruptions collected from past year's or several year's data. Definitions of few of the indices are given below:

System Average Interruption Frequency Index (SAIFI)

SAIFI is the average number of sustained interruptions per consumer during the year. It is the ratio of the annual number of interruptions to the number of consumers.

SAIFI = (Total number of sustained interruptions in a year) / (Total number of consumers)

System Average Interruption Duration Index (SAIDI)

SAIDI is the average duration of interruptions per consumers during the year. It is the ratio of the annual duration of interruptions (sustained) to the number of consumers. If duration is specified in minutes, SAIDI is given as consumer minutes.

SAIDI = Total duration of sustained interruptions in a year / total number of consumers

SAIFI & SAIDI are the most used pair of reliability indices. A North American survey showed SAIFI figure of 1.1 (indicating 1.1 interruption/year/consumer) & SAIDI of 1.5 hours. Singapore is reported to have a SAIDI of 3 minutes. For comparison, the NDPL tariff submission for 2005-06 gives SAIDI figure of 38 hours for 2003-04 & a target of 30 hours for 2004-05 (23)

Consumer Average Interruption Frequency Index (CAIFI)

CAIFI is the average number of interruptions for consumers who experience interruptions during the year. It is the ratio of the annual number of interruptions to the number of consumers affected by interruptions during the year. Consumer is counted only once regardless of the number of interruptions.

CAIFI = Total number of sustained interruptions in a year/Total number of consumers affected.

Consumer Average Interruption Duration Index (CAIDI)

CAIDI is the average duration of an interruption, calculated based on the total number of sustained interruptions in a year. It is the ratio of the total duration of interruptions to the total number of interruptions during the year.

CAIDI = Total duration of sustained interruptions in a year/total number of interruptions.

It can also be seen that CAIDI = SAIDI/SAIFI

Momentary Average Interruption Frequency Index (MAIFI)

MAIFI is the average number of momentary (less than 5 minutes) interruptions per consumer during the year. It is the ratio of the annual number of momentary interruptions to the number of consumers.

MAIFI = (Total number of momentary interruptions in a year) / (Total number of consumers)

The AP regulation suggests using 3 supply reliability indices SAIFI (System Average Interruption Frequency Index), SAIDI (System Average Interruption Duration Index) & MAIFI (Momentary Average Interruption Frequency Index). These are typical reliability indices related to consumer supply, calculated using annual field data. The AP regulation (and as seen subsequently, all other State regulations) use these indices in the feeder context, with some change in the formula for calculations. Thus SAIFI, SAIDI & MAIFI refer to 11 kV feeder interruptions (not consumer interruptions) & the index is calculated using one month data (not annual data). The interruption is also given a weight age, based on the connected load on the respective feeder. To illustrate using the case of SAIFI.

SAIFI = SUM (Connected load of feeder X Number of sustained interruptions of this feeder in the month)

(Total connected load on all feeders)

It can be seen that this is not an average value, since the total number of interruptions is not used in the calculation. SAIFI as calculated here is the weighted total number of feeder interruptions, i.e the sum of individual feeder interruption weighted by the proportion of load it carries. Thus, it cannot be used to compare reliability figures of two utilities which have different number of feeders.

Indices for rural & urban feeders are to be calculated separately. Feeders serving predominantly agriculture loads are excluded from the calculation & indices for those are also to be separately calculated. Since these calculations are now, the regulation does not suggest any target values for these indices.

Considering the lack of reliable data on consumer interruptions, it is a good idea the SoP regulation suggests using feeder interruption data to calculate reliability. But then, it was perhaps not necessary to employ jargon like SAIFI, SAIDI etc, especially since the formula suggested are not as per the standard. Calculating the average duration & frequency of 11 kV feeder interruptions, calculating the per km interruption of 11 kV feeders etc would have been easier & sufficient to assess system reliability.