# Calculation Methods for Metering System Accuracy

Metering Task Force, Session 1

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- The overall accuracy of the metering system is dependent on the accuracy of the different instruments, such as CTs, PTs, and the meter.
- The overall metering accuracy is a combination of all these instruments, and improving the accuracy of one of these components can improve overall accuracy significantly.

 

- Instrumentation transformers are not 100% accurate, therefore they contribute to the overall metering system error.
- If we assume a Gaussian distribution (a bell curve), the instrumentation transformer error is:

$$\boldsymbol{\varepsilon IT = \sqrt{\varepsilon CT^2 + \varepsilon PT^2}}$$

$\varepsilon IT$ is instrumentation transformer error

$\varepsilon CT$ is the current transformer error

$\varepsilon PT$ is voltage transformer error

 

- Therefore, if we consider a typical meter installation where both CT and PT error rate is 0.1%, the overall instrumentation error becomes:

$$\varepsilon IT = \sqrt{(0.2\%)^2 + (0.2\%)^2} = 0.283\%$$

$$\left.\begin{array}{l} \varepsilon CT = 0.2\% \\ \varepsilon PT = 0.2\% \end{array}\right\} \quad \varepsilon IT = 0.283\%$$

 

- The same principal can be applied to take into account the measurement error of the meter while calculating the total system error of the metering.

$$\boldsymbol{\varepsilon S} = \sqrt{\boldsymbol{\varepsilon IT}^2 + \boldsymbol{\varepsilon M}^2}$$

$\varepsilon S$ is total system error

$\varepsilon IT$ is the instrumentation transformer error

$\varepsilon M$ is the measurement error of the meter

- Consider a 0.3% error on the metering device added to the previous instrumentation transformer:

$$\varepsilon S = \sqrt{(0.3\%)^2 + (0.283\%)^2} = 0.412\%$$

$$\left.\begin{aligned} \varepsilon CT &= 0.2\% \\ \varepsilon PT &= 0.2\% \\ \varepsilon M &= 0.3\% \end{aligned}\right\} \quad \varepsilon S = 0.412\%$$

# Other Factors to Metering System Accuracy

- Note that the total system error is worse than the each component's error, but better than the sum of the error of all components.

- If there are other known factors that might impact total error after the meter, it can be incorporated in the total error using the same method.
  – RTU error
  – Analog to Digital Conversion error

 

- For example, NERC BAL-005-0.2b R17 states the following requirements for devices that enter into the PJM ACE calculation (such as external Tie Lines):

MW, MVAR, and voltage transducer ≤ 0.25 % of full scale

Remote terminal unit ≤ 0.25 % of full scale

Potential transformer ≤ 0.30 % of full scale

Current transformer ≤ 0.50 % of full scale

$$\Longrightarrow \varepsilon IT = \sqrt{0.3\%^2 + 0.5\%^2} = 0.583\%$$

$$\varepsilon S = \sqrt{(0.583\%)^2 + (0.25\%)^2 + (0.25\%)^2} = \mathbf{0.683}\%$$

- Even using a relay CT instead of a meter CT significantly diminishes total accuracy:

**System with Meter CT**

$$\varepsilon CT_1 = 0.50\%$$
$$\varepsilon PT_1 = 0.30\%$$
$$\varepsilon M_1 = 0.25\%$$

$$\varepsilon S_1 = \mathbf{0.634}\%$$

**System with Relay CT**

$$\varepsilon CT_2 = 3.00\%$$
$$\varepsilon PT_2 = 0.30\%$$
$$\varepsilon M_2 = 0.25\%$$

$$\varepsilon S_2 = \mathbf{3.025}\%$$

# Equivalent $ Value of Metering Accuracy

- Depending on the amount of MW associated with the measurement point, the inaccuracy of the metering system may represent a significant or insignificant amount of money.
- Let's consider 2 systems, one with high accuracy and one with low accuracy:

$$\varepsilon CT_{HA} = 0.20\% \qquad \varepsilon CT_{LA} = 1.20\%$$
$$\varepsilon PT_{HA} = 0.20\% \qquad \varepsilon PT_{LA} = 1.20\%$$
$$\varepsilon M_{HA} = 0.50\% \qquad \varepsilon M_{LA} = 0.50\%$$

$$\varepsilon S_{HA} = \mathbf{0.574}\% \qquad \varepsilon S_{LA} = \mathbf{1.769}\%$$

# Equivalent $ Value of Metering Accuracy

- If we assume $0.03/kWh price, then the equivalent dollar value of the system error per MW for a year becomes:
- High Accuracy System:

$$0.574\% \times \frac{\$0.03}{kWh} \times 1\,MW = +/- \frac{\$1508}{year}$$

- Low Accuracy System:

$$1.769\% \times \frac{\$0.03}{kWh} \times 1\,MW = +/- \frac{\$4649}{year}$$

- Total $ Transacted: $262,800/year

# Equivalent $ Value of Metering Accuracy

- For low capacity power applications, the expense of very accurate equipment may not have a good payoff, but for high capacity power applications, the potential payoff of more accurate system is significant.
- For 100 MW system, the potential transaction error for both systems is:
- High Accuracy: +/- $150,800/year
- Low Accuracy: +/- $464,900/year

**$314,100/year**

- Total Amount Transacted=$26,280,000

- In conclusion, the accuracy of the system is not only dependent on the meter itself, but also the other equipment supporting the metering, from CT/PTs to the RTU.
- The total system error is worse than the each component's error, but better than the sum of the error of all components.
- Having one component with low accuracy impacts the overall accuracy significantly.
- Higher accuracy metering does cost more in equipment and maintenance, but the costs can be easily measured against the resulting level of uncertainty of $ equivalent of the power.