Common Metering Errors

Presented by

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Metering Errors

- General Categories:
  - Over-registration

  You might at first believe that over-registration is a good thing for a utility. Wrong! Management types view this type of error as the absolute worst!
  - Under-registration

  If meters that are under-registering are either wide spread and/or on large consumers, the revenue loss can adversely affect the financial health of a utility.

Over-registration

- There are a number of causes of over-registration, including:
  - Incorrect meter multiplier (K_r), or register ratio (R_r)
  - Improper meter application *
  - Inadvertent *Q* meter *
  - Meter damaged by lightning or other transients
  - Improper programming of electronic register

* Expanded upon in later slide

Over-registration

- Improper meter application-

A number of application errors can cause an over-registration. The following is a short list of some examples:

Over-registration

1. Use of a Form 6S (36S) meter with phase-to-phase connected potentials and three Current Transformers (CTs) on 480/277-volt, four-wire wye. Usually occurs with 4:1 Voltage Transformers (VTs), where the primaries of the two VTs are connected phase-to-phase. If the load is balanced, the registration will be 200%!
2. Another common metering mistake can result in an inadvertent Q. A Q meter is nothing more than a Kwh meter connected in a particular way. There are two types of Q meters: a lagging Q, and a leading Q. A Q meter is designed to be used in conjunction with a Kwh meter, utilizing a special formula, to obtain Power Factor (PF). A lagging Q meter is designed to obtain PF with load PFs ranging from 0 PF lagging to .866 PF leading. A leading Q meter, on the other hand, is designed to obtain PF with load PFs ranging from .866 PF lagging to 0 PF leading. A lagging Q meter is much more common as it encompasses the majority of loads.

Over-registration

- 2. Continued-

  An inadvertent Q can be obtained with remarkable ease. For example, if a contractor mounts bushing type CTs backwards on a pad mount transformer, and then makes the secondary runs, the meter will runs backwards if everything else is correctly hooked. If the meter installer does not correct for the current reversal, but instead rolls either the three CT secondaries, or more likely, the three potentials in the socket, they now have an inadvertent Q! If he gets a lagging Q and the load PF equals ~.866 lagging, the Q meter will record precisely the same consumption as a correctly connected Kwh meter. However, if the load PF is more lagging than .866, the lagging Q meter will actually record more than a correctly connected Kwh meter. The percent registration of a lagging Q meter follows the following formula:

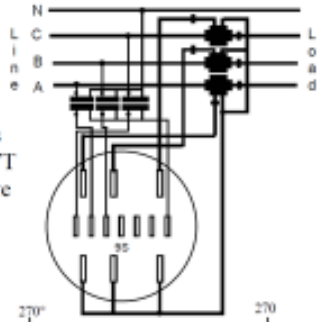
  (Cos (Θ + 60°) / Cos Θ) X 100 = % Registration

  Cos Θ = PF Lagging PF has (-) sign.

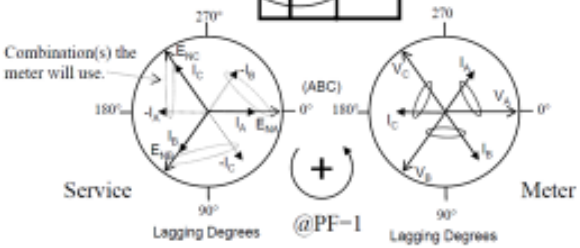
  A load PF of .707 lagging would have a % registration = (Cos (-45° + 60°) / Cos -45°) X 100 = ~136.6%. In other words, the load would be over-registered by ~36.6%!

Over-registration

Miswired 9S
Inadvertent Qhour Meter



Note: CT polarities are reversed, and VT inputs to meter have been "rolled".



For a balanced 3 - phase load :

Assume: $E_{SA} = E_{SB} = E_{SC} = E_{SL} = V_{L(Meter)}$

$E_{SA} = V_{B(Meter)}, E_{SB} = V_{C(Meter)}, E_{SC} = V_{A(Meter)}$

$I_A = I_B = I_C = I_L$

Meter Watts $= V_A I_A \cos(60-\theta) + V_B I_B \cos(60-\theta) + V_C I_C \cos(60-\theta)$

$= 3 V_L I_L \cos(60-\theta)$

$= 3 V_L I_L [\cos 60 \cos\theta + \sin 60 \sin\theta]$

$= 3 V_L I_L \left[\frac{1}{2}\cos\theta + \frac{\sqrt{3}}{2}\sin\theta\right]$

Load Watts $= 3 E_{SL} I_L \cos\theta$

$\%\text{Registration} = \frac{\text{Meter Watts}}{\text{Load Watts}} \times 100\% = \left[\frac{1}{2} + \frac{\sqrt{3}}{2}\tan\theta\right] \times 100\%$

% Registration	
@ θ=0°	50%
@ θ=30°	100%
@ θ=60°	200%

Under-registration

- There are a number of causes of under-registration, including:
  - Incorrect meter multiplier (K_r), or register ratio (R_r)
  - Improper meter application
  - Meter damaged by lightning or other transients
  - Improper programming of electronic register
  - CTs (shorted turns, shorting links left on, tampering, bad automatic shorting devices) *
  - Defective meters *
  - Improper placement of CTs
  - Meter or instrument transformer tampering *
  - Miswiring

* Expanded upon in later slide

Under-registration

- Automatic CT shorting devices are the largest single source of revenue loss in the Electric Coop and Municipal market. On a polyphase service, one or more shorting devices may stay engaged (shorted) with the meter in service. It is even possible that a single phase meter having one CT can run slowly with the shorting device engaged! This is due to the fact that the shorting device and the meter form a low impedance parallel circuit.

Under-registration

- Defective meters-

  With the use of modern solid state meters, a common misconception is that a malfunction will always result in a diagnostic error. Wrong! Some malfunctions will not result in any error at all. These malfunctions will have to be discovered as the result of good detective work on the part of the meter tech.

Under-registration

- Tampering- This can take many forms, including the meter, socket, instrument transformers, and associated devices. Remember, if a dishonest consumer is allowed access to metering equipment, the possibilities are almost endless. A consistent numbered sealing program backed up with vigorous prosecutions is the most effective policy to eliminate tampering!

Under-registration

- Improper placement of CTs.
  - Many Coops make their own 4-wire delta “padmounts” using two or three single phase padmount transformers. They generally use two padmounts when only two primary phases are available. This is described as open delta. The issue becomes: where to place the metering CTs?
  - If one places bushing type CTs on the transformer bushings, you are most likely placing them inside of the Delta Buss – or the jumpers that connect the individual transformers together to make 4-wire delta – either open delta or closed delta.

Under-registration

- Improper placement of CTs, cont.
  - It is important to place the CTs outside of the delta buss in order to capture all of the current. Not doing so can result in substantial under-registration.

Thank You

TSTM, Inc.

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